Maree Gosper · Dirk Ifenthaler *Editors*

Curriculum Models for the 21st Century

Using Learning Technologies in Higher Education

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Preface

Changing student profiles and the increasing availability of mainstream and specialised learning technologies are stretching the traditional models of teaching and learning in higher education. Web-based lecture technologies, for example, are often associated with reduced lecture attendance, bringing their dominant position within university culture into question; online collaborative and conferencing tools enable students to communicate and collaborate from diverse locations freeing up their need to come to campus; and the increasing use of mobile devices is changing the design of teaching and learning spaces.

Research provides strong evidence of the potential of technologies to facilitate cognition and learning. We also know that technologies do not work in isolation of the broader curriculum and where technologies have been bolted on, rather than integrated in a holistic way, students are in danger of an inferior learning experience. Hence, their use needs to be designed with awareness of not only their potential for facilitating learning, but with an understanding of their potential impact on the whole learning environment.

This edited volume gives insights into how teaching and learning can be done differently. It features current research exploring new theoretical models relevant to the changing circumstances, examples of practice which capitalise on the potential of technologies to deliver alternatives to the more traditional lecture-based model of university teaching, and an examination of the challenges facing institutions in transforming innovation into sustainable practice. We organised the chapters included in this edited volume into four major parts: (1) theoretical consideration for the twenty-first century curriculum, (2) case studies: moving beyond traditional practice, (3) technological and pedagogical innovations influencing curriculum renewal, and (4) sustainable practice in technology-rich environments.

The first chapter explores the imperatives of changing student profiles, the pervasive influence of technologies and the pressure to produce work-ready graduates with more than discipline knowledge as consistent themes giving rise to new curriculum models in the twenty-first century (Maree Gosper & Dirk Ifenthaler, Chap. 1). In Part I, chapters address theoretical foundations for the development of curricula. Chapter 2 explores many of the pedagogical options available to higher education instructors that ensure multimodal resources and constructions are included in new forms of pedagogy. It is argued that students are now able to explore new ways of accessing and connecting content to multimodal forms of representation in order to break away from text, time, and place (John G. Hedberg & Michael Stevenson, Chap. 2). The next chapter examines how curriculum design needs to be influenced by the effective development of virtual collaborative learning environments. It is suggested to devise more adaptive, educationally focused teaching and learning strategies which reflect the current realities of social Internet use (Stephen Quinton & Matthew Allen, Chap. 3). Next, the Maori concept of Ako is used to explore the reality of an open curriculum and to suggest a model for open education that is defined less by technology and more by the structured social experience of education (Stephen J Marshall, Chap. 4).

In Part II, chapters focus on case studies which move beyond traditional practice of teaching and learning. In the first chapter of this part, authors present a theoretical insight into research-based learning and teaching which integrates learning, teaching, and research. The case study describes a curriculum for descriptive and inferential statistics using the research-based learning and teaching approach and provides reflections on further implementation of research-based learning and teaching, including the adoption of new technologies to assist this important approach of university education (Dirk Ifenthaler & Maree Gosper, Chap. 5). The next chapter introduces an approach to address the changing needs of engineering education. Shifts from instructors to orchestrators of learning, from passive students to active students, from lower cognitive levels to higher levels, and to creative learning communities are illustrated (Farrokh Mistree, Jitesh H Panchal, Dirk Schaefer, Janet K. Allen, Sammy Haroon, & Zahed Siddique, Chap. 6). Chapter 7 provides insights on how to create and sustain an enterprise-based curriculum as an alternative curricular model to educate instructional designers (Ana-Paula Correia, Chap. 7). Next, the interteaching approach is introduced which shifts the focus from lectures to tutorials. The case study describes the implementation of interteaching in a second-year psychology course, exploring the impact for both students and staff (Mandy Kienhuis & Andrea Chester, Chap. 8). The case study reported in Chapter 9 reports a blended learning approach using situated learning to redesign the curriculum of cell, plant, and microbiology courses in a first-year science programme. Findings indicate efficiencies and heightened motivation for both staff and students (Danilla Grando & David Santandreu Calonge, Chap. 9). In the final chapter of this part, the case of Chiropractic instructors who changed the curriculum for their second-year undergraduate students by integrating case-based learning in a multimedia format is reported. The media annotation tool positioned the case videos into an active environment requiring small group and scaffolding activities to stimulate clinical thinking (Meg Colasante, Amanda Kimpton, & Jennifer Hallam, Chap. 10).

In Part III, chapters address technological and pedagogical innovations influencing curriculum renewal. In first chapter of this part, three common ways in which students are helped to make connections between their university learning and their more practically oriented learning are discussed: work integrated learning, inquiry-based learning designs and simulations. Then, rich media technologies are addressed which can link university classrooms with sites of professional practice (Barney Dalgarno, Gregor Kennedy, & Alan Merritt, Chap. 11). The next chapter presents a combination of technological and pedagogical advances. This techno-pedagogy is fostering a transition from the traditional learning management system model to a more integrated social learning network (Benjamin E. Erlandson, Chap. 12). Chapter 13 investigates the characteristics of effective podcasting in an educational psychology class. It is argued that when podcasts are used as primary method of instruction, there is a need to address students' perceptions of lecturer intent (Penny Van Bergen, Chap. 13). Next, an overview of research issues related to digital game-based learning with an emphasis on its application in formal education settings is provided (Hercules Panoutsopoulos, Demetrios G. Sampson, & Tassos Mikropoulos, Chap. 14). Chapter 15 explores changing conceptions of learning brought about by technological changes and opportunities, and examines more closely potentials of video games for education (Dana Ruggiero, Chap. 15). Next, theoretical instructional design foundations are discussed that are helping revolutionise simulation in the fields of aviation and healthcare (Jill E. Stefaniak, Chap. 16). The potential of virtual worlds for higher education is addressed in the next chapter. The range of challenges associated with implementing these environments into curricula is critically reflected (Helen Farley, Chap. 17). The final chapter of this part reports on the results of a pilot of an e-portfolio tool involving different curriculum contexts across two semesters. The need for e-portfolios to be embedded into appropriately designed tasks is made evident through a mixed methods approach (Margot A McNeill, Amanda, Parker, Andrew Cram, Chap. 18).

In Part IV, chapters present sustainable practice in technology-rich environments. The first chapter of this part investigates art students' experiences of inquiry using technologies. The study emphasises that effective curriculum design requires an "a priori" understanding of quality experiences of technology-mediated learning (Robert A. Ellis, Chap. 19). The next chapter discovers common challenges faced by innovators and explores ways that universities could become more active contributors to sustainable curriculum change (Cathy Gunn, Chap. 20). Chapter 21 identifies challenges of an academic leader working to improve and sustain quality learning and teaching in an information-rich environment (Judyth M. Sachs, Chap. 21). The final chapter presents an adaptive model that embeds learning technologies into pedagogical design at an early phase of curriculum renewal and development. It demonstrates the processes and resources needed for a learning design approach that integrates technologies into curricula for sustainable practices (Judith P. Lyons, John Hannon, & Claire Macken, Chap. 22).

Without the assistance of experts in the field of curriculum design, the editors would have been unable to prepare this volume for publication. We wish to thank our board of reviewers for its tremendous help with both reviewing the chapters and linguistic editing.

Sydney, NSW, Australia Maree Gosper
Melbourne, VIC, Australia Dirk Ifenthaler

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Part IV Sustainable Practice in Technology-Rich Environments

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Janet K. **Allen** (The University of Oklahoma, janet.allen@ou.edu) holds the John and Mary Moore Chair of Engineering and is Professor of Industrial and Systems Engineering. Professors, Allen and Farrokh Mistree, have established the Systems Realization Laboratory at the University of Oklahoma which is home to a multidisciplinary group of students. The focus of Dr. Allen's research is engineering design and especially the management of uncertainty when making design decisions especially supporting collaborative decision making and design—several hierarchical procedures and game theory have been used to model collaborative design. Dr. Allen and her students study/have studied aerospace systems, materials, energy systems, mechanical systems, and design methods. Before coming to OU, she retired from the Woodruff School of Mechanical Engineering at Georgia Tech where she is Professor Emerita. Janet K. Allen and her students have published over 200 papers in journals, conference proceedings, and edited books. She is a Fellow of ASME, a Senior Member of AIAA, an Honorary Member of the Mechanical Engineering Honor Society Pi Tau Sigma, and is Associate Editor of *The Journal of Mechanical Design*.

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As one of a small team, Meg received the "RMIT University 2010 Teaching and Research Team Award for Programs that Enhance Learning: Innovation in curricula, learning and teaching." The citation for this was: "For the creation of the Media Annotation Tool (MAT), a pedagogically based learning tool which facilitates student learning with media, through reflection, feedback and sharing."

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Chapter 1
Curriculum Design for the Twenty-First Century

Maree Gosper and Dirk Ifenthaler

Abstract Changing student profiles, the pervasive influence of technologies and the pressure to produce work-ready graduates with more than discipline knowledge are three consistent themes giving rise to new curriculum models in the twenty-first century. The new approaches are both exciting and challenging—exciting because they offer new and enhanced opportunities for students to learn and challenging because they are charting new territory which has implications for institutional infrastructure, learning, and teaching. In this chapter we explore the imperatives for change and set the context for the theoretical models, curriculum designs, and innovations presented by the contributing authors.

Keywords Curriculum design • Learning technologies • Student diversity • Graduate capabilities

1.1 Introduction

A necessary precursor to exploring curriculum designs for the twenty-first century is to highlight that there is not a shared understanding of the notion of curriculum by either theorists or practitioners in higher education. As a theorist, Grundy (1987) frames curriculum as a way of organizing educational practices based on three rationales: product where the focus is on reproducing knowledge for a defined outcome, practice which emphasizes the development of understanding in order to make

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judgments and apply knowledge, and praxis which focuses on critical reflection with outcomes determined by the community of learners. Print (1993), on the other hand, takes a more instrumental approach, offering three perspectives: curriculum as experience, defined by a set of planned learning experiences encountered by students; curriculum as intention, characterized by predetermined aims, goals, and objectives describing what students should learn; and curriculum as a process, emphasizing personal growth and self-actualization through experiential learning.

From a practitioner's perspective the curriculum can be conceived of as a blueprint of actions which includes the purpose (goals, aims), the content, learner needs, learning activities, instructional processes and resources, assessment and evaluations methods (Stark & Lattuca, 1997). A more recent study by Fraser and Bosanquet (2006) revealed that conceptions held by practicing academics were influenced by the epistemological and philosophical beliefs of individuals. Compared to the earlier conceptions (Stark & Lowther, 1986), their conceptions are more inclusive of both teaching and learning processes and encompass curriculum as being the structure and content of a subject or a whole program of study, students' experiences of learning, and a dynamic and interactive process of teaching and learning. While recognizing variation is important as the various conceptions reflect and shape the design of education for students (Cornbleth, 1990; Fraser & Bosanquet, 2006), we have chosen to adopt the broadest possible conception of curriculum which is reflected in Print's (1993) definition of curriculum as:

> …all the planned learning opportunities offered by the organisation to learners and the experiences learners encounter when the curriculum is implemented. This includes those activities that educators have devised for learners which are invariably represented in the form of a written document (p. 9).

If we take a systems view of the educational experience, the curriculum both shapes and is informed by the learning experiences of students and the outcomes set and achieved. Biggs (2003) illustrates this through the 3P model comprised of *presage*, *process*, and *product* factors which dynamically interrelate to define the learning and teaching landscape. Presage factors relate to what the learner brings into the system and the teaching context. Their predispositions in the form of prior knowledge and skills, abilities, values, and expectations will all influence their learning. The teaching context is defined by the ethos and values of the institution, the curriculum and teachers' conceptions of learning and teaching. Together these presage factors influence the learning *process* and *products* (or outcomes) that emerge, which are then fed back into the cycle. The cycles of influence within the system are such that curriculum design is informed by desired outcomes (product); the expectations, needs, and aspirations of learners; as well as our understanding of the factors that influence the learning process.

The interrelatedness of this model makes it highly responsive to societal change and provides a way of framing the issues and imperatives that have shaped the new curriculum models and pedagogies that are presented in this volume. Changing student profiles, the pervasive influence of technologies and the pressure to produce work-ready graduates with more than discipline knowledge are just some of the themes to emerge that are influencing the nature and dynamics of presage, processes, and products informing the design of the twenty-first century curriculum.

1.2 Engaging a Diverse Student Cohort

The twenty-first century has brought with it an escalating demand for tertiary qualification, and between 1995 and 2009, entry into degree programs on average has increased by 25 % (OECD, 2007, 2011). With this increase, the student profile in universities is far more diverse than that of ten or more decades past (Euler, 2010; Fasuga, Holub, & Radecký, 2010; Ramos & Carvalho, 2011). A globally mobile population has led to an increasingly multicultural student body, particularly in those disciplines with a professional orientation (Cancela & Ayán, 2010). Universities are more international than they were in the 1980s, with over 50 % of international students coming from Asian countries, most commonly from China, India, and Korea and destined mainly for the United States, the United Kingdom, Germany, France, and Australia (OECD, 2011). Lifelong learning, a popular concept in the 1990s, has become a reality due, in part, to the changing nature of the workforce giving rise to more mature-aged students seeking their first degree or returning to up-skill or further their studies at postgraduate level (Chiţiba, 2012). The open education movement and widening participation agendas (OECD, 2007), targeting those from nontraditional backgrounds, have introduced further diversity in relation to the background, needs, and expectations of students.

With diversity comes a richness to the student cohort that is both exciting and challenging. The richness comes from the multiple perspectives that students bring to the learning environment. The challenges come in many forms—the diversity in background and experiences arising from different cultural backgrounds, life, and professional experiences; prior knowledge and academic experiences; and attitudes and beliefs about learning and teaching. Another is balancing competing priorities with the tension between paid employment and work being one of the most significant factors impacting the relationship between students and their studies (Baron & Corbin, 2012). Evidence of this can be seen in an Australian study by James, Krause, and Jennings (2010) which revealed that 61 % of full-time students in 2009 were in paid employment for around 13 h per week and two thirds were working to support their basic needs.

How are institutions and teachers responding to these and other challenges arising from students' changing circumstances? One avenue has been through the adoption of digital technologies. A classic example is the pivotal role that web-based lecture technologies (Gosper et al., 2010), learning management systems, and various other tools have played in responding to requirements for more flexible learning environments. An outcome has been the development of online and blended curriculum models which combine face-to-face lectures and tutorials with online resources, communication, and collaboration opportunities (Lefoe & Hedberg, 2006). More recently, mobile and Web 2.0 applications (e.g., social networking, tagging, RSS feeds) have added richness and vitality to online and blended learning designs, offering enhanced learning opportunities for students to form communities of practice and not just to consume and interact but to truly construct knowledge in a collaborative environment (Oliver, 2007).

Oblinger's reminder that "it is not the technology that is most important but the activity it enables: the activity, not the technology, is what advances learning" (Oblinger & Oblinger, 2005, p. 74) still holds true. Understanding students' experiences and managing their expectations are integral to the provision of an effective and engaging curriculum. However, the complexity and diversity of the student cohort is such that we need to be wary of the generalizability of popular assumptions about students. Take for example the generation of students born after 1980, commonly referred to as the Net Generation. The homogenous nature of their experiences of technologies has come under question (Kennedy, Judd, Churchward, Gray, & Krause, 2008), reminding us of the need to make a more contextualized evaluation of student characteristics. For instance, is it the case that the early attributions of digital and visual literacy, comfort with social and networked media, inclination towards collaboration, and preference for use of the internet for research over the library (Oblinger & Oblinger, 2005; Prensky, 2001b) still hold? Are the claims of digital literacy in everyday life not translating into academic literacy still relevant to the net generation and indeed those generations before and after (Oblinger & Hawkins, 2006)?

Research on students' experiences and expectations of technologies in universities certainly indicates their expectation is for technologies to be integral to the university experience, whether for accessing information, interacting with content, communicating and collaborating with teachers and peers, or creating and presenting ideas (ECAR, 2010; Gosper, Malfroy, & McKenzie, 2013). Nevertheless, students are quite strategic about their preferences for and uses of technologies with some disparity emerging between the technologies used for everyday life and those for learning. For instance, even though popular in everyday life, there is a reluctance to use social networking tools for learning (Gosper et al., 2013; Jones, Blackey, Fitzgibbon, & Chew, 2010; Madge, Meek, Wellens, & Hooley, 2009) which may be due to a lack of exposure to their potential, concerns of privacy and confidentiality, or a desire to maintain a divide between personal and learning spaces. With time, experiences and attitudes will change; however, this only goes to reinforce the need to monitor the student experience (Kuh, 2003).

The strength of changing student profiles as a force for change is evident in the new designs presented in this volume, as is the role of technologies in facilitating innovation and change. Collis and Gommer (2001) maintain that there comes a point where we cannot stretch the existing models and practices any further to accommodate the changes taking place, and a more comprehensive reconceptualization of the curriculum becomes necessary. Have we reached that point?

The new models and designs that are presented in this volume are examples of more wholesale curriculum change, many as a direct response to changing student circumstances. Kienhuis and Chester (Chap. 8) found that the introduction of more resources and flexibility into a traditional teaching/lecture model was not sufficient to engage students, prompting the development of a new Interteaching model which reversed the role of lectures and tutorials. Erlandson (Chap. 12) along with Quinton and Allen (Chap. 3) propose that the philosophical foundations of social networking technologies are fostering a transition from the traditional learning management system model to a more integrated social learning network. The network is more able to engage students and enable them to take ownership over the learning process. Marshall (Chap. 4) proposes that the emergence of open education resources is best matched with an open approach to curriculum design. He suggests a model based on the Māori concept of Ako which is defined less by technology and more by the structured social experience of education. Hedberg and Stephenson (Chap. 2) urge us to capitalize on the power of new technologies to support simultaneous delivery of multiple topics and learning activities by exploring new pedagogical options that break away from linear and time-constrained pedagogies.

1.3 Enabling Graduate Outcomes

How do we design curricula to prepare graduates for an uncertain world, equip them with the knowledge and skills of their chosen profession and give them a competitive advantage in a globalized and competitive workplace? These issues are emerging as significant challenges for universities and teachers of today.

Placed within the broader university context, these issues can be linked to the teaching of graduate capabilities (Andrews & Higson, 2008; Barrie, 2004; Cranmer, 2006). Otherwise known as graduate attributes, capabilities gained popularity in the 1980s and 1990s in the United Kingdom in response to employers' criticisms of universities for failing to develop the skills of employability (Brew, 2010). Stephenson and Yorke (1998) maintained that capable graduates:

> …not only know about their specialisms; they also have the confidence to apply their knowledge and skills within varied and changing situations and to continue to develop their specialist knowledge and skills long after they have left formal education…Taking effective and appropriate action within unfamiliar and changing circumstances involves ethics, judgments, the self-confidence to take risks and a commitment to learn from the experience (p. 3).

With the advent of the new millennium, the focus of employability has been extended to include lifelong learning, preparing for an uncertain future, and acting for the social good (Bosanquet, Winchester-Seeto, & Rowe, 2010), imperatives mirroring *UNESCO Declaration on Higher Education for the Twenty-First Century* which sets out the role of universities to (UNESCO, 1998):

> …enhance their [students'] capacity to live with uncertainty, to change and bring about change, and to address social needs and to promote solidarity and equity; ….preserve and exercise scientific rigor and originality, in a spirit of impartiality, as a basic prerequisite for attaining and sustaining an indispensable level of quality; and ….. place students at the centre of their concerns, within a lifelong perspective, so as to allow their full integration into the global knowledge society of the coming century.

For universities, the issue is not so much in defining capabilities as in their teaching. Expectations of graduates are relatively similar throughout the world (Barrie, 2004; Chalmers & Partridge, 2012). Even though academics may accept the relevance of graduate capabilities, many lack the confidence to teach and assess them, particularly the higher-order capabilities of critical thinking and creativity (Hanke, Ifenthaler, & Seel, 2011; McNeill, Gosper, & Hedberg, 2012) and more broadly, those not closely tied to discipline knowledge (de la Harpe et al., 2009). Because higher-order capabilities are integral to the research process, research-based learning designs linking research, teaching, and learning (Ifenthaler and Gosper, Chap. 5) offer a solution that may be appealing due to their strong research orientation. Integrating the teaching of graduate capabilities into the curriculum can be conceptualized at three levels (Cranmer, 2006):

- Total embedding where skills have low visibility in the curriculum, are not taught in context, and have no explicit assessment.
- Explicit embedding and integration where skills are highly visible, taught in context, and have explicit assessment.
- Parallel development taught outside the academic program, often by a careers office. Characteristically they are bolt-on development with limited contextualization and separate assessment.

Cranmer (2006) maintains that in comparison to total embedding and parallel development, the impact of explicit embedding in the curriculum is far higher. Furthermore, work-integrated learning models involving employers in the design and delivery can provide a structured experiential approach (Kolb & Kolb, 2005).

The more purposeful integrated and experience-based approach can be seen in a number of models presented in this volume. Although the designs variously draw on principles from well-established approaches to design (e.g., experiential learning, inquiry case-based and problem-based learning), what sets them apart is the use of technologies to bridge the theory-practice divide and bring new levels of authenticity, collaboration, and connectedness to the learning experience. The role of technologies has been pivotal in providing the leverage to explore and implement new approaches. Web 2.0 technologies in particular, which enable users to both consume and create content, often for sharing, have played a significant role in many of these designs (Churchill, 2007).

The personalized engineering curriculum designed by Mistreee and colleagues (Chap. 6) is underscored by principles of experiential learning. Working within dispersed environments supported by Web 2.0 technologies, their design offers authentic opportunities to facilitate self-determined motivation and metacognition. Farley (Chap. 17) provides insights into how virtual worlds can provide students with more authentic learning experiences that more closely replicate real life contexts through the provision of credible tasks and activities. In the teaching of chiropractic clinical thinking, Colasante and colleagues (Chap. 10) transformed case-based learning through the introduction of interactive media annotation platform (*MAT*). A holistic approach was taken to position the case videos into an active environment requiring small group and scaffolding activities to stimulate clinical thinking. Delgarno and colleagues (Chap. 11) discuss the use of rich media such as video conferencing, web conferencing, and mobile video traditional to enhance traditional approaches to practice-based education (e.g., work-integrated learning programs, inquiry-based learning designs, and simulations). By connecting university classrooms to sites of professional practice, they maintain that students are helped to make connections between their university learning and their more practically oriented learning. To ensure students can meet current and future workforce needs and have seasoned problem-solving skills, Grando and Calonge (Chap. 9) have developed digital wet laboratories as a means of providing reality-based experiences which engage them in and outside the classroom. Finally, in a step beyond more traditional forms of experience-based education, Correia (Chap. 7) presents an enterprise-based curriculum in which students are partners of a working enterprise, called *Learning Design Solutions*. This approach was in response to employer demand for work-ready graduates able to be entrepreneurial, think critically solve problems, and show initiative.

1.4 Facilitating Cognitive Processing

Technologies in some form have always been integral to learning and teaching in higher education. Beginning with print technology, we have witnessed a progression through multimedia technologies, computer-based instruction, teleconferencing and broadcast technologies, to interactive multimedia and internet-based technologies (Taylor, 2001) which have undergone their own evolution from the information focus of Web 1.0 through to the collaborative and networked focus of Web 2.0 (Behrendt & Zeppenfeld, 2008; Oliver, 2007) and more recently to Web 3.0 (Ifenthaler, 2012).

Established in 2002, the NMC Horizon Project (http://www.nmc.org) has in their yearly reports identified and described the emerging technologies with considerable potential for education. A number of these appear in this volume, namely, Web 2.0, RSS and social networking technologies, personal learning environments, virtual worlds, digital games, immersive simulations, podcasts, ePortfolios, conferencing and collaborative media, and annotated video.

Even though the literature offers many examples of innovative uses of technologies, in practice, Maor (2006) suggests a tension between technology and pedagogy, with academics often unsure of how to effectively design and implement new approaches. When time is scare and resources for innovation and support hard to come by, it is easy to default to making decisions based on one's own conceptions of teaching, the availability of technologies and comfort with their use. The inherent danger in this is that it can be self-limiting, leading to impoverished curriculum designs which fail to capture and retain the imagination of students.

This leads to the persistent question of which technologies to use and for what purpose? Ellis and Goodyear (2010) suggest the starting point is with an understanding of cognition and learning: "When teachers do not focus on the development of student understanding and have poor conceptions of learning technologies, they tend to use e-learning as a way of delivering information bolting it on to course design in an unreflective way" (p. 104).

In an aligned curriculum, aims, outcomes learning activities and assessment strategies are all in tune with each other. As Abel (2007) points out, if the aim is to assess higher-order thinking, then activities and technologies must be aligned accordingly. Understanding complex concepts, for example, can be facilitated by the use of simulations (de Jong, 1998; Ifenthaler, 2009), spreadsheets and relational databases (Jonassen, 1999), as well as games (Eseryel, Ge, Ifenthaler, & Law, 2011; Ifenthaler & Eseryel, 2013; Ifenthaler, Eseryel, & Ge, 2012). Remembering and understanding factual and simple conceptual knowledge is best achieved with activities that exhibit clear objectives, sequenced exercises, and immediate feedback (Fletcher-Flinn & Gravatt, 1995; Ifenthaler, 2010, 2011; Kulik & Kulik, 1988). In practice, alignment is rarely unilateral, rather it is multifaceted in the sense that an activity can be associated with multiple outcomes and processes. Simulations and multiplayer games, for example, can be used to develop lower-order factual knowledge for understanding and remembering through to the higher-order planning, judgment, and reasoning necessary for solving complex problems (Ang, Avni, & Zaphiris, 2008; Prensky, 2001a), thus reinforcing the need for a clear understanding of intent in order to ensure aims, outcomes activities, and technologies are effectively aligned.

The link between activity and technologies is consistent with the notion of computers as cognitive tools (Jonassen & Cho, 2008), whereby the cognitive processing requirements are matched with affordances of technologies. The significance of this for curriculum design is that it refocuses the choice of technologies back on the learner and the learning process, rather than on the technologies and their availability. Paas, Renkl, and Sweller (2003) have found that if learning activities and the technologies in use engender processing requirements that are not within the capabilities of the learner, then an unmanageable cognitive load can be imposed, with the consequence of poor learning. It then follows that the capabilities of the learner ought to be more clearly articulated in the curriculum design process. The MAPLET Framework which focuses on the development of expertise and makes explicit links between teaching aims, cognitive processes, learner expertise, and technologies provides a model for achieving this (Gosper, 2011).

The revised version of Bloom's Taxonomy of Learning Outcomes (Anderson et al., 2001) shown in Table 1.1 makes the distinction between knowledge types (factual, conceptual, procedural, and metacognitive) and cognitive processes (remember, understand, apply, analyze, evaluate, and create). The two-dimensional representation becomes a useful tool for analyzing and mapping aims and outcomes against knowledge and processes. Bower, Hedberg, and Kuswara (2010) have used the Framework to conceptualize Web 2.0 learning designs. However, the challenge comes when designing activities as we move from the lower-order learning in the top left-hand corner to the higher-order learning in bottom right. This comes from a lack of understanding of how to design activities and assessment tasks for this type of learning, and there is a tendency towards addressing the easier and less demanding outcomes (Race, 2006; Shephard, 2009).

In practice, when addressing higher-order capabilities, although intended learning outcomes may be well articulated in curriculum documents, the activities and technologies used to facilitate learning and assessment are not necessarily well

Table 1.1 Revised Bloom's taxonomy (Anderson et al., 2001)

The knowledge dimension	The cognitive process dimension					
	Remember	***Understand***	***Apply***	***Analyse***	***Evaluate***	***Create***
Factual knowledge						
Conceptual knowledge						
Procedural knowledge						
Metacognitive knowledge						

aligned (McNeill et al., 2012). The advent of Web 2.0 tools may change this (Ifenthaler, 2012). With their capacity to support networking and collaboration (Choy & Ng, 2007; Johnson & Levine, 2008) and reflective practices (Churchill, 2007), they provide the capability to facilitate and capture the processes and outputs of higher-order learning, particularly as related to the metacognitive capability and the analytical, critical, and creative skills. ePortfolios (McNeill, Chap. 18) have been shown to be particularly useful as a tool for students to capture and display their development of expertise in a wide range of skills and knowledge, whether specific to their discipline or more broadly applicable graduate capabilities.

As technologies become more sophisticated, and the teaching and learning context more diverse, we are witnessing a more nuanced approach to integrating technologies into the curriculum, particularly in relation to intent, purpose, knowledge type, and processing activity. Many of the contributions in this volume have taken this step, linking their use with specific knowledge types and processes. Van Bergen (Chap. 13) found that the effective use of podcasts in her context hinged on the provision of choice for students and a clear understanding of the lecturer's intent; purpose built podcasts for the development of procedural skills were more widely accepted than automated recordings of lectures. In a similar vein, Panoutsopoulos and colleagues (Chap. 14) explore the use of digital games to facilitate active learning processes, Stefaniak (Chap. 16) links the active engagement of players in immersive simulations with complex problem-solving processes, and Ruggiero (Chap. 15) explores the potential of video game creation as a way of linking problem-solving strategies to gaming strategies. Ellis (Chap. 19) introduces the element of *space* as a further consideration when aligning curriculum elements. In a blended environment where students integrate ideas presented in class with online discussions, he found close associations between students' perceptions of the learning space, how students approach the task, learning technologies, and academic achievement.

1.5 Closing Comments

In this volume we have attempted to prompt reflection on curriculum models for the twenty-first century. We have explored the imperatives and issues that are giving leverage for change and shaping the emergence of new curriculum designs. It may be useful at this point to reflect on the past in order to better understand the implications of these changes for the future. At the close of the twentieth century, Toohey (1999) identified five approaches to curriculum design prevalent in universities, each underscored by particular philosophical and epistemological perspectives. By far the most common was a *traditional discipline-based approach* giving primacy to a structured approach to the development of discipline-based knowledge and skills. The other four, in no particular order of uptake, are a *performance- or systems-based approach* seen in competency-based education, a *cognitive approach* with a focus on the development of intellectual abilities, an *experiential or personal relevance approach* giving students some say in the skills and knowledge they would like to acquire and the context in which they are explored, and *a socially critical approach* seeking to develop a critical consciousness in students and motivation for change. Whether these approaches are still relevant in the more global, technology-rich, and networked world of the twenty-first century is open for question. It may be the case that a combination of several approaches could help in negotiating the delicate balance between responding to the changing needs and expectations of a diverse student body while at the same time fulfilling the requirements articulated through statements of graduate outcomes. Indeed, many of the new models and designs discussed can be seen to be a fusion of two or more approaches which may tempt us to question whether the introduction of more socially critical approaches can assist in preparing students for an unknown future. Can the integration of more experiential and personal relevance approaches help to engage students, break down the theory to practice divide, and increase their competitiveness in a global workforce? Or, by introducing cognitive approaches are we better able to scaffold the development of a full range of graduate attributes from lower to higher-order outcomes?

Transformational change takes time, is multidimensional, involving individuals and organizations (Fullan, 2001; Scott, 1999), and is best achieved when there is evidence about the benefits of the innovation (Nicol & Draper, 2009). The contributions chosen for this volume provide such evidence, giving insights into the transformational changes that are possible or already taking place through the judicious application of learning technologies. We have attempted to move beyond speculation and rhetoric by providing working models and designs that have been evaluated for their strengths and weaknesses and the implications these have for sustainable practice. In addition Sachs (Chap. 21) has captured an institutional-level perspective of the imperatives, issues, and implications for sustainable practice, while Gunn (Chap. 20) and Lyons (Chap. 22) highlight the importance of early consultation, collaborative partnerships, and collective ownership of the change process.

As we move through the twenty-first century, technological advances and societal change will continue to influence the dynamics of the presage factors, processes, and products within the learning and teaching landscape (Pirnay-Dummer, Ifenthaler, & Seel, 2012). Change will be inevitable. We hope that the ideas, models, and curriculum designs presented will provide insights into what is possible and inspire you to capitalize on the potential of available and emerging technologies to transform the curriculum.

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invite questions around what in education terms now constitutes effective teaching and learning strategies in the new millennium. For many in higher education, this new world now upends many traditional models that have defined the roles and relationships of teachers and learners.

This shift from static print media to the new media of the Internet has also redefined our broader relationship with *text*, *time* and *place*. With much of our information, knowledge and communication transduced through web-enabled technologies, our concept of *text* no longer implies linearity or singular authorship. Following the rise of applications in blogging, for example, online authorship is in now in the hands of millions, irrespective of geopolitical boundaries, publishing house protocols or government censorship. In many higher education contexts, teachers and students are interconnected through a wide range of media and information is now being communicated in ways that supplant the traditional lecture. Mobile devices such as smartphones and tablets have ushered in a new kind of anywhere, anytime computing that opens up the potential for learning more readily situated in real-world contexts, redefining our relationship with *place*. Our understanding of *time* has changed, with much of our information relayed in real time across a wide range of media. Increasingly, our personal information and that of our students now resides in 'the Cloud', vast arrays of servers and networks around the world that seamlessly synchronise data between devices, enabling our digital world to travel with us wherever we go.

The democratisation of access to content creation and delivery platforms has challenged the traditional role of the teacher in higher education as both the curator and purveyor of knowledge. The 'wisdom of crowds' (Kittur & Kraut, 2008) is evidenced in the success of volunteer-driven, multiple-authored websites like *Wikipedia*—and the subsequent demise of counterpart print editions like *Encyclopedia Britannica* (ABC, 2012)—leading us to question underlying notions of authorship and authenticity. At the same time, principles that have culminated in near-universal access to the world's information are now being turned to business models construed around *Big Data*—including a wealth of information on users' habits, browsing and search histories, interests, 'likes' and friendship networks. At a time when data itself has become 'the currency of the Internet' (Cavoukian, 2000, p. 14), the decreasing relevance of old media is being eclipsed by the web, our interactions with it and with one another. Many of our interactions with others, regardless of location, now take place in real time, being collaborative, instant and 'always on'. Our collective understanding of these changing ways of interaction is only now emerging.

2.2 Rethinking Relationships: Trends and the Technological Change Continuum in Higher Education

In exploring this redefined knowledge landscape, much of the literature has examined technology trends that have shaped the Internet, not all these technologies have lived up to the expectations of higher education. For many, such trends have become key points of reference when exploring how pedagogies can adapt to the broader developments in technology. In addressing possible trends of the last few years, terms like *Web 2.0* (O'Reilly, 2005), *Cloud Computing* (Katzan, 2010) and *Big Data* (Haff, 2012) have been developed to explain the trends that mark differential points on the continuum of technological change. Terms like these have also been closely examined and adopted, in both research and practice, by many educators in their attempts to better understand the relationship between the educational affordances of emerging technologies, the skills needed for teachers and learners to properly employ them in education contexts and the extent to which such technologies disrupt and/or align with existing pedagogies. These and similar terms have also emerged in close relationship to preceding trends, being as much defined by what they *are not* as by what they *are*. In theory, trend-related concepts explored in this chapter are language constructs used to make sense of the enveloping technological change.

Understanding technology trends has, accordingly, become an important part of the milieu of higher education in the twenty-first century. One problem with attempts to understand trends is that they are social phenomena: fluid, dynamic and rarely fixed. They can diversely represent anything from recurrent themes, popular and influential buzzwords or ways of thinking, to common elements between what may otherwise be disparate concepts but which resonate with communities of people. Technology trends might, for example, be reflected in the uptake of a software service, the entertainment value of an Internet *meme* or online video which has 'gone viral', the projected product sales of a new piece of hardware, the number of times a particular news story has been broadcast through social media or the development of a relatively new 'game-changing' technology. Although this open-ended view of technology trends is difficult to consistently or accurately articulate, nonetheless it represents broader perspectives through which educators can positively interpret an exponential rate of change. In practice, therefore, we suggest that trends themselves represent viewpoints that exist within specified parameters (e.g. a set timeframe or particular set of technologies) on the continuum of technological change. Inasmuch as trends serve a purpose, helping educators to speak a 'common language', they also limit the extent to which we can view technology as generative, extensible and a catalyst for disruptive pedagogies.

More often than not, developments in educational technologies build on pre-existing structures and ideas. Current key trends like those indicated in *The Horizon Report* (Johnson, Adams, & Cummins, 2012) represent a kind of repurposing of the pre-existing trends that have shaped our understanding. The development of concepts to explain key differences in technology is a process of 'retrofitting' concepts onto the continuum of technological change not unlike the idea of grammar as a system of rules imposed on the continuum of language. For example, the Fig. 2.1 illustrates some of the key changes technology-assisted writing with the impact of personal computing, the Internet, Cloud infrastructure and mobile devices.

As Fig. 2.1 suggests, many of the hardware and software interfaces that we use when writing evolve from pre-existing ones. For example, the customisable, touch-based software keyboards that are widely common on many mobile devices build on

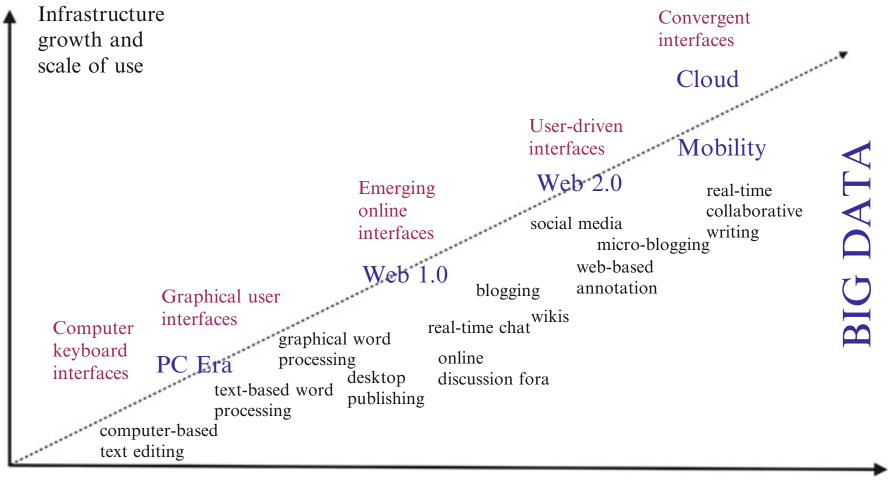

Fig. 2.1 Retrofitting trends and tools in technology-assisted writing

physical computer keyboard interfaces popularised during the PC era, while the kinds of graphical user interfaces that were developed by many Web 2.0 start-ups built on graphical user interfaces developed in early visual operating systems. Similarly, many tools are closely related and suggest a more evolutionary development in these technologies over time. For example, Cloud-based tools like *Zoho, Microsoft Live* and *Google Docs* all facilitate real-time collaboration between many writers in the same document, with the same real-time technology having been available in older tools like Internet Relay Chat (IRC). Likewise, online discussions and microblogging through social media widely incorporate the same technology that was used in older Web 1.0-style online discussion fora.

In all of these instances, the retrofitting of older technology interfaces and tools on newer technologies has, in spite of the evolutionary nature of these developments, been reflected in exponential growth in infrastructure and the scale of use. This is perhaps most clearly seen in the rise of Web 2.0, which built on Web 1.0 technologies at the same time as representing a trigger cause behind the 'read/write' web and the enormous growth in web-mediated participatory cultures. O'Reilly's (2005) articulated concept of *Web 2.0* incorporates a close discussion of what he at the same time termed 'Web 1.0'. This discussion incorporated a number of binaries to illustrate the relational differences between *Web 1.0* and *Web 2.0*, such as 'static' versus 'dynamic', or 'publishing' versus 'participation' (p. 1–2). By defining *Web 2.0* in close relation to 'Web 1.0', O'Reilly's two terms serve as key semantic identifiers that have considerably shaped much of the discourse in higher education in recent years. Of course, such identifiers exist not without being challenged, as web founder Tim Berners-Lee indicated shortly after *Web 2.0* became a part of the web lexicon:

> When asked if it's fair to say that the difference between the two might be fairly described as 'Web 1.0 is about connecting computers, while Web 2.0 is about connecting people', Berners-Lee replied, 'Totally not. Web 1.0 was all about connecting people. It was an interactive space, and I think Web 2.0 is of course a piece of jargon, nobody even knows what it means. If Web 2.0 for you is blogs and wikis, then that is people to people. But that was what the web was supposed to be all along. And in fact, you know, this 'Web 2.0', it means using the standards which have been produced by all these people working on Web 1.0'. (Anderson, 2006, p. 1).

These kinds of semantic arguments are important on a number of levels. As the literature reflects, *Web 2.0* as a term with an accompanying set of discourses (including the situated practices, expectations and shared understanding of the tools) has been embraced by many in higher education. For some, the concept serves as a paradigm that promotes 'accord between the design of technology and the student-centred and interactive approaches being advocated by contemporary educational leaders' (Bower, Hedberg, & Kuswara, 2009, p. 1153). Others have come to regard it as a necessary platform for twenty-first century civics and citizenship (Crocket, 2011), a set of tools for collaboratively engaging in spaces beyond the traditional classroom (McClure, 2010) or a vehicle for synchronous, real-time interaction which promotes more effective collaboration between learners (Hrastinski, 2008; Bradley, 2010; Conole & Alevizou, 2010; Kittle & Hicks, 2009). On examination of these recognised affordances and learning benefits, we can see that there is more of an overlap between 'Web 1.0' and 'Web 2.0' than may have been acknowledged within higher education. As Berners-Lee's argument above implies, student-centred learning, the development of online citizenship or use of real-time interaction were all *possible* with the early Internet. What has changed is our mindset towards using them, shaped by the discourses around us, along with the *time* and *place* in which we now live.

If we accept *Web 2.0* as a term denoting O'Reilly's concept of 'the read/write' web—a web fundamentally about 'people to people' connections—then we also place emphasis on *Web 1.0*, quasi-historically, an implied reference to the early developments of the Internet itself. For example, through the digitisation of print media resources, the standardisation of hypertext transfer protocols (HTTP) and hypertext markup language (HTML) and the rapid rise of Internet search engine start-ups, each success was clearly predicated on the open architecture and standards of the World Wide Web that Berners-Lee advocated. In other words, *Web 2.0* presupposes *Web 1.0* and both terms need to be understood in relation to one another. Of course, *Web 1.0* represents much more than the elements described here. In defence of Berners-Lee's argument, such a way of thinking is problematic when we consider that there is still much of the early web that remains unexplored in education; but when our mindset has shifted to a newer way of thinking ('Web 2.0'), we may fall into the trap of becoming more attached to trends and trend-related concepts than to the transformative and generative potential of the underlying technologies.

Technology trends like *Mobility* have, for example, very real implications to closing off many of the generative uses of technology that the open standards of the early Internet helped create. In terms of technology affordances, the *Web 1.0/Web 2.0* binary reminds us that technology affordances necessitate a technology-user relationship and our relationship with technology may be shaped as much by the discourses around us as by our own direct experiences with it.

The following table outlines some of the possible approaches to addressing five key trends that have been recognised in the way that they broadly describe the development of the Internet during the past decade: (1) *Web 1.0*, (2) *Web 2.0*, (3) *Cloud Computing,* (4) *Mobility* and (5) *Big Data*. These concepts can be loosely interpreted as follows through the lenses of *text, time* and *place.* Doing so sheds some light on how we understand our relationship with technology in the twenty-first century, including the key developments that we collectively regard as significant for educational discourse:

While the above table goes some way towards describing the narrative of the Internet in recent years and some of the many axioms and even broad generalisations we have come to accept in our discussions, what it does not show are the fundamental relationships among the so-called trends and the extent to which the boundaries between them can be both blurred and contested in a similar way to Berners-Lee's challenge to O'Reilly. Many of the current Cloud service offerings and their deployments in education institutions are highly effective enablers of many pre-existing *Web 2.0* applications and tools (Stevenson & Hedberg, 2011). An institution could, for instance, deploy *Google Apps for Education* at very low cost, scaling immediate access to applications like *Google Docs* and *Blogger* for teachers and learners within that institution. Therefore, while *Cloud Computing* introduces new services, standards and protocols, it also builds on pre-existing ones; what invariably changes is the scale, prevalence and context of use. Likewise, *Mobility* represents new hardware and software platforms, evidenced by the astronomical growth of smartphones and the proliferation of mobile apps. Many of these apps are simply repurposed versions of many pre-existing *Web 2.0* applications and tools such as *Facebook* or *Wordpress*—or, similarly, versions of Cloud storage services like *Dropbox* or *Google Drive.*

The relationships between the trends described in Table 2.1 are in some ways more important than the ideas informing our discussions of the trends themselves. Figure 2.2 illustrates the relational development among these trends, illustrating the continuum of technological change as more of an ongoing process of layered services and infrastructure rather than a series of mutually exclusive technology 'stages'. The horizontal axis indicates the linear development of these trends, showing rough points in time at which they emerge as recognised concepts (i.e. not necessarily when the technology itself becomes available). The vertical axis shows the scale of the technology in terms of participatory cultures (i.e. broadly speaking, the number of people using it) and the level of infrastructure implied by the prevalence of the technology.

As Fig. 2.2 suggests, the end point of the timeline indicates the present—a convergence of what we have so far called *Web 1.0*, *Web 2.0*, *Cloud Computing, Mobility* and, most recently, *Big Data*. What is perhaps most striking is the scale of development and use. While the standards of the early Internet through *Web 1.0* still

Table 2.1 Technology "Trends" of Text, Time and Place

Technology 'trend'	Text	Time	Place
Web 1.0	Web pages are largely the domain of enthusiasts. However, web page 'publication' doesn't require authorial vetting. This begins to open up changes in attitude to authenticity/authorship on a small scale. Early Internet protocols such as HTTP and HTML make it easy to semantically and technically link one page to another, thus building the networked nature of the web	Early, static web pages emphasise linearity; manually created and updated by tech-savvy enthusiasts. Web consumers begin to recognise that the early web is not fixed. For example, 'last accessed' in academic journals indicates acknowledgement that web pages are subject to unflagged change (unlike peer-reviewed, edition-stamped print media). Early forms of real-time interaction exist, e.g. IRC, but these are also the domain of enthusiasts	Web pages are globally accessible where there is connectivity and user access. *Place* begins to be less defined in terms of how people relate to information. Place is sometimes not defined at all—e.g. some web pages that appear to be in one place but exist in another
Web 2.0	The term *Web 2.0* is coined to reflect the 'read/write' web—which builds on many so-called Web 1.0 standards. *Web 2.0* sees a proliferation in web-enabled applications and tools that allow users of the Internet to participate and create. For example, blogs provide anyone with basic word-processing skills a platform to publish their ideas. Web 2.0 also encompasses multimodal forms of digital representation, e.g. the rise of YouTube and 'grassroots video'. In terms of authorship, we see democratisation of the generative processes—anyone can be an 'author'—and of course there is a backlash to this in schools and academia. Web pages also include material from multiple (sometimes thousands) of authors, e.g. Wikipedia	Web pages become much more multifaceted, including spaces with a range of media types and places for interaction, all of which mean that they become dynamic, updated all the time. Tools like RSS facilitate this, allowing content to be aggregated from other sources and updated in real time. The *immediacy* of the web is recognised as both an advantage (in terms of currency, relevancy, etc.) and disadvantage (in terms of authenticity, trustworthiness, etc.)	On a massive scale, for the first time, we realise that the web is really one global community. Terms like 'the blogosphere' reflect this—i.e. we talk about one place in an attempt to simplify what is very complex. Virtual worlds, e.g. *Second Life*, really come into being, and we have a strong sense that virtual reality *is* a reality and *place* refers as much to virtual as to physical

(continued)

Table 2.1 (continued)

Technology 'trend'	Text	Time	Place
Cloud	Cloud technologies scale Web 2.0 applications and tools across education institutions and enterprise. People begin to rely on these more and as we do, our data (at first trivial stuff and then large amounts of valuable, private, important stuff) shifts over to the Internet. Metaphors like 'the Cloud' become a way of simplifying the complexities. All sorts of texts are shared with others, e.g. collaborative documents—we become, to varying degrees, comfortable with the idea that so much of our stuff is 'out there'	There is increasing emphasis on '24/7' access to content. Very little on the web is seen as static or fixed. There is closing of websites like *Geocities* which prompts web communities of archivers to try and save the early web for posterity. We are now expecting everything to be 'in sync' much of the time. Thanks to developments in cellular and broadband, the concept of being online moves to '24/7', even when the user is not participating, consuming or generating content	*Place* is really difficult to fathom. We know that in physical terms, our data is in a multitude of countries on server racks in server farms but we wouldn't be able to pinpoint all of it. We become comfortable, to varying degrees, with these ambiguities. In terms of our own daily practices, we begin to expect that our data goes everywhere with us—this seems to be the trade-off against growing privacy and security concerns and the use of our data by third parties
Mobility	The concept of a 'web page' has to shift to meet mobile computing. Many web pages and websites have to be rewritten for mobile access. In part because this is such a difficult undertaking, we see the massive rise in apps and the 'appisation' of the Internet. Apps begin to represent *text* in a very different way—many apps are treated as texts themselves	Mobile computing opens up further points of real-time interaction between people. It is used to coordinate crisis management during disasters (e.g. the Haiti earthquake in 2011) and also for other humanitarian efforts (e.g. doctors relaying information to one another about the spread of waterborne disease in sub-Saharan Africa). No one expects any more that access to the Internet *has* to be on a traditional computer at set times. Note that the 'always on' feature of mobiles changes the way we use laptops, e.g. we now expect that laptops are 'instant on' or 'always on'	Mobile access to the Internet completely redefines our relationship with place. Most of the world's population access the Internet through a mobile (not laptop or desktop). The Internet goes where we do, it becomes more inextricably woven into our lives and the rather personal relationship many of us have with our mobiles reinforces this

Big Data	Growing numbers of businesses and other organisations recognise the value of data that is being generated through participatory cultures online. For example, businesses with financial interests understand that large amounts of user data can inform more effective product development, 'targeted' advertising and customer service	Big Data becomes an important part of how we understand key changes in *time*. For example, during the Arab Spring, the magnitude of change is reflected in the large number of real-time social media status updates from citizens of countries undergoing political upheaval. Many of these updates are 'harvested' by journalists and other media outlets	Location-based services become more insidious as many social media apps track the location of a user's phone and report this back to online servers for aggregation. More and more online data is geo-specific and this is used to inform much of what we view on the web

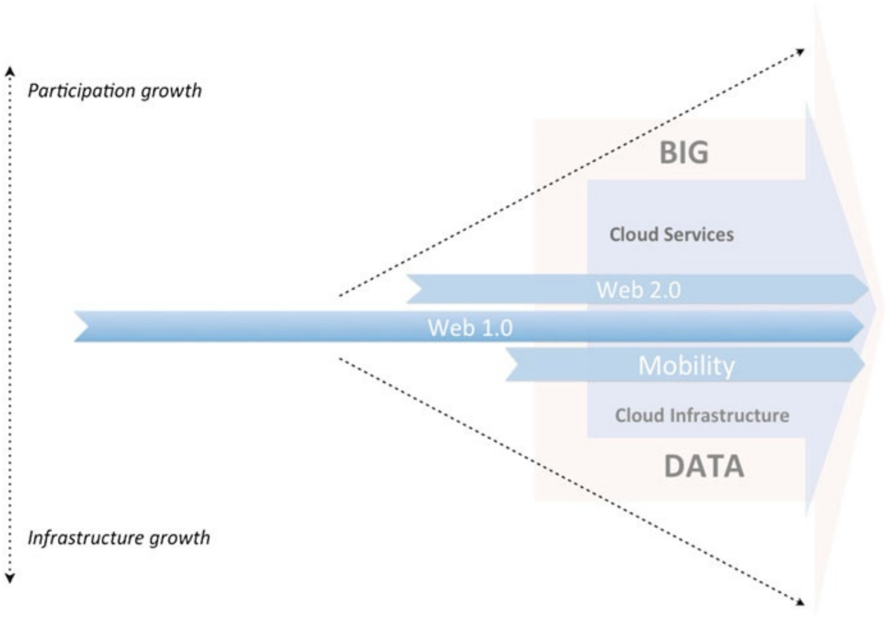

Fig. 2.2 Technology trends over time

underpin much of what currently defines the World Wide Web, it is *Web 2.0* and *Mobility* that have, through the scaling of Cloud services and infrastructure, led to our emerging understanding of *Big Data*—much of which includes the massive amounts of user-generated data in very recent years through Web 2.0- and Cloud-based platforms, but some of which still include data from the early years of the Internet. The nature of these trends as *convergent* means acknowledging their cumulative and relational value if we are to harness the technology tools around us, and this involves breaking away from any preconceived need to see such trends as mutually exclusive, self-contained or frozen in time.

2.3 New Media Literacies

As we have seen in the preceding section with its focus on technology trends, the present opportunely represents a point in time at which we can examine the juncture between any number of concepts making up the shifting global landscape of the twenty-first century. In furthering our attempts to make sense of these concepts as teachers and learners, much of the literature on web-enabled learning is increasingly exploring the growing number of new media literacies that reflect how web tools and content are used in teaching and learning. As newer forms of digital interaction and representation emerge, they open up new dimensions for both understanding and

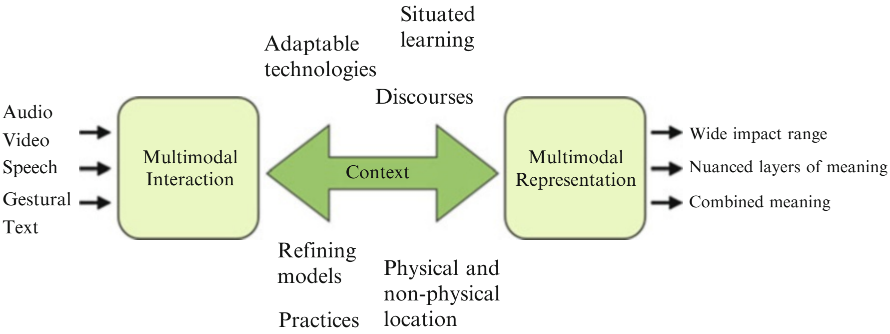

Fig. 2.3 Multimodal interaction and representation

representing *text*, *time* and *place*. Some have acknowledged that the pedagogies underpinning the relationship between multimodality and existing teaching and learning practices have given rise to many of the new 'digital' concepts explored here. In this light, the literature on new media literacies like 'collective intelligence' or 'transmedia navigation' (Hague & Payton, 2010) offers some important signposts for how web-informed pedagogies in higher education might be effectively leveraged to reshape institutional teaching and learning, including approaches to content creation and delivery, course structure and fostering a kind of learning that, ideally, moves beyond the institution itself. The increasing focus on these literacies likewise highlights their transubstantial, fluid and at times contestable nature. Figure 2.3 illustrates some of the broader relationships between multimodal interfaces and representation.

As Fig. 2.3 implies, many of the technology interfaces with which we now interact afford a much wider range of input types, including newer forms of gestural input, enhanced speech recognition and devices that enable 'grass roots video' (Johnson, Levine, Smith, & Stone, 2008). The context relationship between these interfaces represent opportunities for learners to adapt technologies to their own personal styles of learning, situate their learning in both physical and non-physical spaces and play a more defined role in shaping the discourses and practices that define their own learning.

Cazden et al. (1996) have argued that 'the multiplicity of communications channels and increasing cultural and linguistic diversity in the world today call for a much broader view of literacy than portrayed by traditional language-based approaches' (p. 60). In spite of this assertion, many in more recent years have suggested that education institutions have been slow to adapt to established and emerging forms of digital interaction and representation (Kennedy et al., 2008; Prensky, 2001, 2005; Williams, 2008). In their extensive review of *Web 2.0* in higher education, Conole and Alevizou (2010) note the 'dearth of evidence looking at the ways in which these new technologies are or could *change* learning and teaching *practice* [our emphasis]'. While such assertions echo longstanding arguments like Cuban (2001), maintaining that technology falls short of empowering learners where it is simply fashioned to fit existing practice, changes to practice fundamentally involve changes to *discourse*. In what they describe as a 'sociocultural approach to literacies', Lankshear and Knobel (2007) present a very broad perspective on both old and new literacies, suggesting that 'if we see literacy as "simply reading and writing"—whether in the sense of encoding and decoding print, as a tool, a set of skills, or a technology, or as some kind of psychological process—we cannot make sense of our literacy *experience*' (p. 2). By suggesting that experience plays a fundamental role in shaping our literacies—regardless of the type of media or context—this argument reinforces the need to incorporate a fuller understanding of multimodality in higher education teaching and learning practices. It also suggests that we need to be more aware of how our practices shape these discourses and the experiences of learning through multimodality.

Laurillard (2006) has also investigated technology learning processes in higher education, examining the need for the academic professional as teacher to move beyond learning experiences shaped by dominant knowledge acquisition discourses of 'reading, critiquing, interpreting and articulation' towards processes emerging from a better understanding of the adaptive and interactive potential of available technologies, noting:

> the power of the interactive computer to do a lot more than simply provide access to information. It makes the processing of that information possible, so that the interaction becomes a knowledge building exercise. Yet the excitement about information technology has been focused much more on the *access* than on the *processing* it offers (p. 7).

Technology devices can personalise the experience of learning to an extent not previously possible. Most notably, through the growing interest in Mobility, individuals now tailor specific learning experiences to their own needs through ubiquitous 3G and LTE access to Internet connectivity and the use of personalised apps on what are, essentially, very personal computers. As illustrated in Fig. 2.1, this technology builds on adaptive and interactive uses of earlier interfaces and tools, with implications for the scale of use and growth in infrastructure. Newer forms of gestural interaction with the device move the learner beyond the traditional input/output nature of the earlier interfaces. For the vast majority of smartphone users, most of these learning experiences are informal and *just in time*, largely unplanned, unsanctioned by educational discourse and beyond the immediate locus of institutional control. Nonetheless, through a better understanding of the interactive and adaptive potential of mobile devices, higher educators can begin to address many of the problems identified in the literature that stem from a more limited understanding of adaptability and learner interaction. The individual apps on smartphones provide possibilities for managing learning processes with an individual app supporting specific processes, such as capturing ideas and images, collecting evidence, organising and sequencing, producing a multimodal artefact and sharing any of the processes or resources with others.

When examining some of the multimodalities enabled by current technologies, much of the meaning made in digital and temporal sequences reflects layers of nuance. By contrast to the meanings often implied in print media—those associated with *singular* authorship, publication at a *fixed* point in time and tendency towards sense-making through *linearity*—these layers of meaning are often established more subtly through generative, often non-linear iterations emerging from diverse participatory cultures which are primarily collaborative in nature. There are nuanced layers of meaning with a wide range of Web 2.0- and Cloud-based applications and tools, learners can easily collaborate in real time, using multiple technologies and platforms to co-author their *text* in any number of ways. Further, the revision history snapshots available in web applications record the development of the document over time and enable collaborators to pinpoint key changes and roll back to earlier versions if needed. While learners in the same physical *place* might discuss their ideas face to face while collaborating in real time in the online space, learners in different locations can talk in real time as well as observing changes to the document near instantaneously. Similarly, services like *Diigo* and *Bounce* enable learners to annotate standard web pages, generating rich, multilayered discussions on key ideas, points of contention, or further ideas to be explored. By layering meaning on top of the original text, learners are able to more fully articulate their understanding of *text* through their experiences of multimodal representations over others texts, with far fewer constraints than those traditionally established by *time* and *place*.

One of the most interesting phenomena to have emerged into mainstream recognition is *transmedia storytelling*, 'the technique of telling a single story or story experience across multiple platforms and formats using current digital technologies' (Wikipedia contributors, 2012). Remixing material from movies, songs and other media to create new versions of popular narratives—*transmedia storytelling* has garnered considerable attention recently with the commercial rise of ebooks, ereaders and tablets and their associated online stores. These devices serve as tools for augmenting and reconfiguring *text* through the enabling of *time* and *place* beyond the constraints of traditional teaching and learning spaces. *Mobility* has also seen a movement away from the more traditional forms of computer user input such as the mouse and keyboard towards emerging forms of gestural input on the touch interfaces. Along with the increased prevalence of multimodal forms of representation in teaching and learning experiences or the media, these developing forms of gestural input are redefining the parameters of the digital world in which we participate, learn and teach online. Although the technology appears simple, tools like these open up potential for learners to become fully active participants in the way they make sense of *text* on the Internet, including older 'Web 1.0' static pages. Most importantly, these gestures underpin the learner's interaction with web content, enabling a much broader range of experiences in digital representation than previously imagined.

2.4 Frameworks Moving Forward

We have critically examined some of the technology trends and new media literacies informing current discourses in higher education and have suggested that by understanding the affordances of technologies that have characterised the shifting knowledge landscape from the time of the early Internet to the present, educators need to break away from the traditional knowledge constraints implied in our understanding of *text*, *time* and *place*. Most importantly, higher educators need to be aware of the fluid (and at times overlapping) relationship between traditional and emerging trends and concepts—to properly engage with the challenges presented to preconceived notions of teaching and learning. Sometimes, for example, this may involve experimenting with very new technologies when little might be known about how to effectively use them. Such experimentation is a vital part of 'tapping into' the experiences of learners engaging with the forms of digital representation described in this chapter. Fundamentally, higher educators themselves need to be actively learning in the digital world, incorporating their experiential understanding of phenomena like multimodality into what will be a continual re-evaluation of their teaching and learning practices, the values they place on *text* and their expectations about the learning *time* and *place*. The success of this multifaceted, evaluative approach to meaningful technology integration is informed by the recognition that while the broader knowledge landscape is shifting, each part of our digital world is made up of layers of nuance. Accordingly, our understanding of new media literacies needs to be both broad and flexible as we engage with the technologies.

Moving forward, what are some indicators of a workable *application* framework? Bower et al. describe the development of 'a Web 2.0-enabled learning design', proposing Anderson and Krathwohl's (2001) Taxonomy of Learning as a framework for this development. Such a learning design arguably represents a way of integrating both current and future Web 2.0 applications into curricula with a broader understanding of both the different knowledge dimensions (factual, conceptual, procedural and metacognitive) and a range of skills and cognitive process dimensions (remembering, understanding, applying, analysing, evaluating and creating) (2009, p. 1161). Further, in proposing this design, the authors draw attention to the importance of design *resilience*, suggesting that where technology is seen 'as only a mediator of pedagogy and content', it is possible for frameworks like these to align with both current and future technologies. Such discussions further highlight the need for framework and design flexibility both now and in the future.

Another framework oriented around flexibility has been explored by Goodyear and Ellis (2007), investigating differences between the instructor's designed learning task and students' actual learning experiences. Their study points out the problematic nature of technology-enabled teaching as design in tending towards one of two extremes: teacher directedness (e.g. in a heavily prescriptive task) or student centeredness (e.g. oriented around experiences in co-constructivist learning). While Bower et al. (2009) suggest that accord between student-centred learning and technologies like *Web 2.0* is now possible, the authors of this study remind us that such accord is often dependent on the task and the resulting learners' translation of it. Further, Goodyear and Ellis (2007) assert that tendencies to either teacher directedness or student centeredness need to be challenged in order to better understand 'the centrality of students' learning activities [sic]: that what matters most is what students actually *do*' (p. 340). In framing this argument, they address the importance of situatedness of learning and suggest that while 'a good task specification *affords* certain kinds of learning activity', teachers and students jointly shape the learning environment, culture and the experience of learning (p. 341). Knobel and Lankshear's (2006) argue for new media literacies as *experiences*, the notion of 'translation' explored here reinforces the view that effective learning task design should be informed by an understanding that moves beyond a limited view of technology trends into the multimodal experiences that embody the kinds of digital and temporal sequences now possible.

This chapter has considered the technological change continuum and shifting knowledge landscape through the collective lens of *text, time* and *place*. In so doing, we have suggested that understanding technological change in higher education necessitates a closer understanding of the relationship between the trends and constructs used to describe the rate, scale and nature of the changes around us. This process of 'retrofitting' concepts on top of change is essentially a sense-making process that is both useful and limiting—useful because it offers a common language for meaningful technology integration and limiting because of what such language struggles to fully articulate in a time where the rate of change is exponential. In recognising that many of the trends referred to in the literature are not mutually exclusive and that there is often considerable overlap between concepts, stages and the kinds of technologies available, we argue that higher educators need to make sense of trends as *convergent*. Further, by addressing the new media literacies as tools that help articulate our *experiences* of learning in a web-mediated world, sense-making is as much about exploring layers of nuance in digital and temporal sequences as it is about understanding the broader trends. These two viewpoints—the micro and macro—are, likewise, important for higher educators to consider when looking back at past achievements and looking forward to future possibilities. The Internet and the world that it has become, present formidable challenges and opportunities to higher education. While effective knowledge and application of emerging trends and new media literacies require so-called twenty-first century skill sets like collective intelligence, transmedia navigation and real-time collaboration, many of these skills simply define good learning practices regardless of technology use. Higher educators need, therefore, to think strategically about the kinds of learning now possible in the twenty-first century when searching for the right tool for the right job. Developing application frameworks that incorporate flexibility, experience, generativity and, most importantly, openness will ultimately ensure that the scale of learning possibilities keeps pace with the scale of change well into the new millennium.

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3.1 Introduction

Although online learning is now accepted as a convenient option for accessing educational materials and associated instruction, most web-based learning environments rely on relatively traditional methods of instructional design, delivered through proprietary learning management systems (LMS). Despite the eloquent rhetoric of vendors and institutions alike, LMS do not, of themselves, promote pedagogical diversity and innovation. Indeed, in many cases, the combination of institutional structures, along with the traditional assumptions designed into LMS, and the general conservatism of university educators means that online learning is often an impediment to the changes and improvements needed for higher education to produce creative, independent thinkers.

University students are rarely offered the tools to organise their online activities to accommodate their individual needs and circumstances; online collaborative problem-solving activities and group projects seldom provide satisfactory learning experiences; and seamless integration with online communities of practice is often not permitted or, at least, made difficult by the closed nature of many interdependent systems and the assumptions about how they should be used.

When thinking more generally about the Internet, as opposed to LMS, people have a much wider array of social sharing and learning opportunities, with a strong emphasis on user-generated content and ongoing networked conversation. While in recent years LMS have adjusted to include some of the new ways that the Internet promotes information and communication, for example including within these systems such popular platforms as wikis, blogs, and the like, they remain ‘closed’ to the outside world and therefore do not properly emulate the online environment. Furthermore, many other opportunities exist online for creative knowledge work and collaboration which are not present in LMS at all, ranging from simple web applications for data visualisation, presentation, mind-mapping, web publishing, and so on through to complex environments like Second Life. The Internet continually offers new tools to support such activities, but most contemporary learning management platforms do not fully encompass them and, even when included, such services are usually far more difficult to use than those found in the ‘real’ Internet. Finally, and most importantly, key online services like Twitter and Facebook are now very widely used and have become the main way for people to share information and forge and maintain social networks. The way people use the Internet through these services is completely different to the traditional approach taken in LMS. A mismatch is evident between what people are doing on the Internet and the online provisions of universities (Liber, 2004, pp. 137–138; Allen & Long, 2009).

This chapter examines, in contrast, how the learning experience can be enhanced through the provision of virtual collaborative learning (VCL) environments that utilise so-called Web 2.0 technologies to produce learning networks. Such learning networks are innovative and more effective because the open and participatory nature of the technologies that sustain them relocate the practices and power of learning within and across the network itself rather than to a central source from which learning is transacted. VCL environments disperse learning into the connections that form the network as opposed to serving to transfer knowledge from one point to another. They also more closely emulate the everyday behaviour of most Internet users and enable a greater development of informal learning *through* the networks thus formed. While in theory LMS might promote such activity, in fact they do not, because of the combination of institutional strictures and traditional assumptions noted above. The more that the Internet generally changes character away from its origins, which also give birth to the LMS in the 1990s, so the disparity between the everyday networked experience and the study-bound LMS experience grows and inhibits students from learning effectively when limited to the latter. While in its early days, e-learning moved away from traditions of instruction and transfer of knowledge, as it has become systematised within institutions, these traditions have largely re-asserted themselves and become culturally encoded into LMS use.

The educational arguments in favour of learning in such environments are straightforward and reflect several years of observing the relative successes and failures of current approaches to e-learning. First, whenever learning involves collaborative discourse, concepts, notions, or ideas are refined and transformed during collective exchange where participants contribute their ideas to an online community network and 'build on' the contributions of others. Second, conceptual change is an intentional and reflective cognitive process leading to higher order learning that arises through the efforts of individuals and collaborative groups (Campos, 2004, p. 10) and such groups form online as much as in physical spaces. Indeed new knowledge and ideas emerge whenever an individual or a group of individuals engages in discourse and interaction with other individuals and groups.

When correctly managed, networked online collaborations can proceed more efficiently than through past practices in knowledge exchange transactions. This efficiency stems from the fact that the raw material through which the networking process occurs—information displayed on a screen—can be rapidly transmitted, altered, developed, and refined, often in direct collaboration via that screen. The informatic and communicative aspects of the collaborative process converge, collapsing the time between initiation and completion of a learning activity, and thus enhance the interactions among the human participants. Further, as they are in digital form, these informational transactions can be stored, reused, analysed, and redeveloped with significantly less cost when compared to other mediums.

The purpose of this chapter is not, however, to argue the need for VCL—the literature abounds with positive endorsement for such environments. Instead, the focus is on understanding the curriculum design factors and strategies that inform the educationally effective deployment of VCL environments. We begin by examining how technology can support successful learning outcomes in the online environment.

3.2 Online Collaboration: Coordinating Technology and People

It is emphasised from the outset that the Internet is not a learning technology in the traditional sense. It is a socially widespread technology for knowledge work—through which knowledge networking has become far more prevalent (Allen & Long, 2009). The Internet is used by people in many ways to produce 'learning' regardless of whether they actively think of themselves as learners or students. In this nonphysical world of social interaction and virtual collaboration people are afforded the freedom to

- Communicate and interact with other people in ways that reduce the consequences of spatial separation and varying time-zones.
- Search for and acquire information that meets their immediate and longer-terms needs in developing knowledge to solve problems, make decisions, and become better informed about the world.
- Organise information via virtual libraries, bibliographies, tagging, or otherwise cataloguing their material and ideas.
- Organise collaborative online activities such as decision-making, shared information spaces, and website maintenance.
- Transact business processes in ways that save time and money by exchanging data and information in digital form without the need for more costly physical interactions.
- Publish and share content for other interested users through web-publishing services such as blogs, wikis, and discussion forums.
- Create textual and audio-visual resources and content, both distributing them online and forming interactive communities around them.

These activities occur separately throughout the Internet without the benefit of a single, task-specific, purpose-built digital environment in which all activities are fully harmonised. As a result, it is often the case that specific tasks are segregated according to the Internet function that generated them. For example, all emails are stored as emails, rather than as part of an overall task or project; website favourites are organised and stored as individual resources and not for group access. Although the emerging forms of Web 2.0 technologies are built upon collaboration and the coordinated activity of 'networked individuals', there is evidence that the majority of Internet users are still largely engaged in individual pursuits or interact with the spaces of collaboration (such as Wikipedia) only as observers, audiences, and readers.

The fact that technologies for collaboration exist and have so for several years suggest that there is more to online collaboration than *just* the technology. Fragmented private internet use no longer seems to be the preferred norm of technologies such as blogging, tagging, social media, and the like (Bruns, 2008; Howard, 2008), yet the uses are quite low or very narrow. Perhaps it is difficult to collaborate and simultaneously share a commitment to the ongoing maintenance of collaborative online endeavour.

Successful collaborative online behaviour is not inherently formed from the technologies, but is fundamentally social in its orientation, depending on the people involved as well as their computers and code. Three factors are crucial (Bruns & Bahnisch, 2009; Jones & Issroff, 2005):

1. Members of the network must be motivated to become involved and participate fully: such motivation is both intrinsic (in that the process of networking is engaging and enjoyable) and extrinsic (networking produces a realisable benefit for themselves and their community); further the activities of the network must themselves produce ongoing motivation and not serve or create demotivating concerns (for example, too much time required; lack of apparent success).
2. The rights and responsibilities of participants must be actively facilitated, not only in the early stages of the network's formation, but also in ways that enable the network to grow and adapt over time; in this respect a network is not a community—communities have more tightly defined boundaries, whereas networks extend and intertwine themselves far more through the active acquisition of additional nodes.
3. Participants are most successfully engaged and facilitated because they are the primary 'authors' and 'developers' of the network and, while members of the network can play several roles, they are all encouraged and capable of producing, not just receiving the information and communication flows within the network.

Put simply, successful collaborative networks attract membership, engage those members, and encourage ownership of the network. Moreover, network systems that enable human interaction must be useable in ways preferred by members. This requirement does not mean that the technologies must always be of a particular type or provide a specific function, but rather that the needs and imagination of the users should align with the capabilities of the applied technologies. Therefore, virtual collaborative networks are only successful when the needs and expectations of the participants align with the capabilities and affordances of the available technologies (that is, the chosen technologies must be adaptable to human needs (Oblinger & Oblinger, 2005, pp. 14–15)).

Users of virtual networks can be encouraged and supported to learn, refine, and filter content through communal opinion (whether or not a consensus is reached), discussion, and research to identify and interpret the meaningful relationships that exist between objects, phenomena, and human minds. It is the combination of information and computer technologies (ICT) along with advances in exploiting communal intelligence and conceptual understandings to build self-organising, adaptive online spaces that ultimately support innovation, creativity, and the generation of new ideas.

In effect, such spaces represent a framework for integrating various online technologies, offline spaces, human and technology-based support systems, and the thinking processes, methods, and strategies that give rise to learning. The construction of this framework requires design principles tailored to manage the complexities that occur as a result of the convergence of 'real-world' interactions between people and information, and the more abstract development of concepts, ideas, creativity, and learning.

The key to designing educationally effective online collaborations is to extend the individual's knowledge construction skills to embrace multi-levelled, interconnected, social learning systems that expose learners to a diverse array of perspectives, practices, interests, and the idiosyncrasies of the targeted knowledge domain. Collaboration among individuals and networks of individuals (groups) are fundamental to the sustained generation of new ideas, the refinement of accepted ideas derived through the efficient dissemination of information, and to the subsequent creation and application of knowledge. In this model, the learner is encouraged to negotiate pathways (either preset or self-determined) through divergent contexts while simultaneously being 'monitored' by community members who analyse and provide feedback on the strategies employed during the learning process. In this way, learning capability is enhanced for both the individual and the community.

However, any new model of learning for constructing educationally effective VCL environments that incorporate technology as an aid to the learning process must strive to connect people to people—not people to machines. With this goal in mind, a number of questions arise in determining how learning can be facilitated in the online environment. The questions that guide the present discussion are:

- How does learning emerge in a network environment?
- What are the strategies for producing collaborative learning in such environments?
- How to identify and provide automated support for the learning needs of a networked community of learners?

3.3 Learning in a Network Environment

In the physical world, social networks operate on the relatively simple principle that whenever people, groups, systems, nodes, organisations, resources, and other entities are connected, a 'greater than the whole' effect emerges as a result. Changes that occur within any of the components that make up the network produce an effect throughout the entire system. When such a network environment is used for education, learning occurs most effectively via the creation and strategic use of connections and relationships between nodes in this network. Nodes include information, ideas, individuals, and communities of interest. The likelihood that a new or unknown concept will become evident to the learner is dependent on how well it is linked to supporting nodes of information and to other supporting resources. As learners are exposed to more opportunities to identify and recognise the available nodes, the resultant increase in their depth of understanding eventually leads to cross-pollination of ideas and concepts communicated within the immediate learning community.

In effect, a social learning network is a structure within which a coordinated set of resources and activities are offered to provide opportunities for learning that are designed to empower the learner to create and evolve a range of experiences among people, places, and information. The learner is actively engaged in shaping the learning environment to support his or her individual learning. Such networks contain *both* information and identity nodes—things to learn and learners—and the network sustains motivation to learn, learning activities, and the reflections by which learning is known to have occurred.

Networking as described above can inform online learning design and accordingly enable the transition from a centralised, institution-based education system that requires conformity to an inflexible, standards-based top-down structure, to a decentralised, bottom-up system of knowledge creation and sharing that is formed around informal structures and standards. The design and structure of a networked learning environment should not be limited to technological application and interface design, nor should it be confined to the provision of curricula and learning materials. Instead, learning networks can be thought of as environments that encompass the social and environmental aspects of human experience.

Human learning networks are analogous in their nature to ecological systems. That is, they are 'alive', in that they display properties characteristic of dynamic, vibrant, interactive, and evolving environments. They are also grounded in interdependence: no element of the ecology can flourish without others. From a learning perspective, the design elements of a collaborative educational environment should provide:

- A means of organising individual input and experience.
- A mechanism for putting that experience into context.
- A means of creating knowledge and becoming part of other individual's or group experiences.

The capacity to prompt learners to structure, integrate, and interconnect new ideas with their existing knowledge and prior experiences facilitated by tools that enable them to rearrange, synthesise, and restructure information in their efforts to expand their personal knowledge base, means in effect that ICT provides a useful aid for teaching the complex tasks of thinking, problem solving, and learning (Candy, 2004, p. 230). The focus of learning becomes the learner's active identification and creation of relationships among data and information, married to or assisted by the formation of relations between people within the network.

For many years, the Internet has provided a familiar example of how relationships can lead to the creation of meaning and knowledge, as well as a working environment for such learning networks. It is also a medium that can provide a pedagogically sound foundation, conducive to active learning, knowledge construction, and discursive interactivity (Geer, 2000, p. 1). Connections made via Internet networking enable the emergence of unusual 'nodes' of information or activity and support and thereby intensify existing group activities. The amplification of learning, knowledge, and understanding through the conscious extension of a personal network is, ideally, an epitome of connectivism in that it provides valuable insights into the learning skills and activities that empower learners to create new knowledge (Siemens, 2004, p. 4). The networked connections are constantly changing, dynamic, responding to interest, experience, and new understandings and thus are continually adapted and expanded as more is learned and the volume of accumulated knowledge increases. In essence, a connectivist approach to learning environment design presents a model that acknowledges the act of learning is much more than an individualistic and hence, internalised process.

In recent years, the Internet has become far more capable of sustaining effective knowledge networks that enable learning. This change is both technological and social. Not only are many new kinds of online tools readily available for participation in knowledge networking (normally termed 'Web 2.0', but also understood as social media or the read/write web), but the cultures of use of the Internet have changed to make more and more people already part of social networks whose substance is formed by knowledgeable interactions. Thus, it is reasonable to conclude that while the Internet has always held potential for forms of learning based in social networks, it is only in the past 3 years that this potential has become operational. At this time, therefore, universities that have built structures and systems better suited to earlier ties are now facing many challenges to adapt to the epistemological shifts of Web 2.0 (Allen & Long, 2009).

3.4 Strategies for Collaborative Learning

It is natural to assume that knowledge resides in the minds of individuals, but when tacit knowledge is considered, especially as related to actual practice, it becomes apparent that there is much more to learn than what is already known and understood. However, complications arise when considering the broader epistemological topology as a whole in that both tacit and explicit knowledge apply not just to the individual, but also to the social network that is often referred to as a 'community of practice' (Fitzgerald & Steele, 2008; Greenhow & Robelia, 2009; Waters & Gasson, 2007). Furthermore, much of what is described as 'knowing' is made more authentic through active participation in the world and through interactions with other people where the focus is directed toward solving practical problems. More specifically, a great deal of an individual's 'knowing' or 'know-how' derives from active participation within a social network of learners. We might label this state 'constructivism' but it is more than that: the network of relations within which people 'know' is itself involved. A learning network is not just a space within which knowledge is constructed by individuals, but a fundamental collaborator in its own right: the network has agency and identity as much as its individual nodes.

Knowledge, therefore, is not derived from the individual alone, or from individuals in concert: it derives from the architecture and affordances of the network that those individuals form, along with their knowledge. The network particularly enables clarifications from and between individuals so that acquired understandings can be consolidated from deep expertise (Candy, 2004, p. 231). Such cognitive activities are increasingly being performed in 'virtual' networked contexts where the co-creation of knowledge is achieved through networked technologies. The key concept underpinning such online activity is that through active collaboration in the

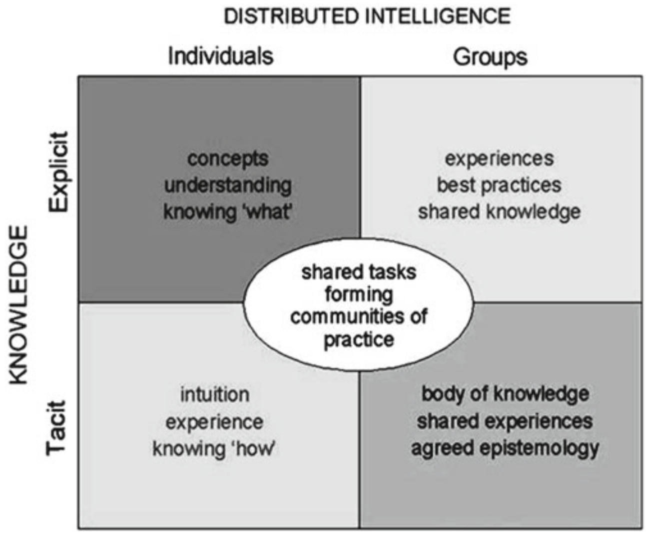

Fig. 3.1 Distribution of intelligence across a community of practice

production, creation, improvement, and innovation of knowledge, a community can accomplish much more than the contributions of individual. Campos (2004, p. 3) adds further weight to these views:

"Knowledge communities that develop within a networked cognitive communication process follow a path in which formal individual structures blend with collectively shared content. Knowledge building represents a collaborative process in which conceptual change and innovation are apparent. Therefore, both conceptual change and innovation are indicators of collaborative learning".

New knowledge emerges whenever an individual or a group of individuals engages in some form of discourse and interaction with one or more additional participants within an identifiable community of practice (or interest). When individuals collaborate, concepts, notions, or ideas are refined or transformed in a collective exchange as may occur in synchronous 'real-time' discussions or as a result of asynchronous activities such as the exchange of ideas through a bulletin board. If the shared aim of a community of learners is to enable knowledge building, then a detailed understanding of how intelligence is distributed across a broader matrix of learning (see Fig. 3.1) is critical (Brown, 2002, p. 7).

It is during collaborative, networked discourse that participants 'build on' the contributions of others. The outcome of this exchange is that participants reassess and reflect on new knowledge, and in the process, reconstruct previously held concepts, notions, or ideas. Collaborative learning is achieved when conceptual change is explicitly affirmed and redirected during the sequence of discussions with a view to transforming the shared thinking into new concepts and idea. However, any change in concepts, notions, and ideas derived through networked argumentation that become more or less established (stable) during discourse (thus, collaborative learning) is not automatically valid evidence of knowledge building (Campos, 2004, p. 10). Whereas the resulting outcome may be in the form of knowledge that arises from any change in concepts, notions, and ideas that have stabilised through group consensus (thus, collaborative learning), knowledge that is clearly unique and could not be achieved by the individual alone is in effect the collective result of many interconnected minds. Therefore, networked learning presents opportunities for learners to access pedagogically rich environments that exhibit several fundamental elements of effective learning: the active construction of knowledge; positive interpersonal relationships; and discursive interactivity.

In terms of learning effectiveness, there are sound educational reasons for engaging students in collaborative activities. As students learn from each other and benefit from the need to articulate their knowledge and understanding to their peers, group work becomes conducive to cultivating cognitive development. Where most students are concerned, the authenticity of the collaborative activity or task is crucial to determining their willingness to participate. Tasks perceived to be trivial or superficial run the risk of students being unwilling to commit. However, students respect those tasks that they perceive to be ‘real’ and suggest a strong connection to the practical application of their knowledge and skills to creative endeavours. They also demonstrate a keen desire to test their abilities in a group environment and to take the opportunity to compare their work with their peers. In addition, well-designed collaborative learning environments may encourage the enhancement of highly valued generic skills that are considered necessary for successful engagement in an information-dominated future (James, Mcinnis, & Devlin, 2002, p. 48):

- Teamwork skills as related to understanding team dynamics and fostering leadership skills.
- Analytical and cognitive skills involving task analysis, effective questioning, critical interpretation of materials, and peer evaluation.
- Collaborative skills in as applied to conflict management and resolution; and acceptance of intellectual criticism, negotiation, and a capacity to compromise.
- Organisational and time-management skills.

3.5 Supporting the Learning Needs of Communities of Learners

Regardless of the desired outcomes, research studies that focus on the application of ICT to online learning design should demonstrate learning advantages for all affiliates including the learner, the lecturer/tutor, and the learning institution. The benefits to the learner should include: an increased capacity to acquire and generate knowledge; identifiable social benefits in terms of collaborative and team participation skills; enhanced personal motivation and lifelong learning skills; and advanced learning and problem-solving strategies.

For the teacher, administrative workloads must be noticeably reduced, thus freeing up valuable time to focus on their primary role, that of facilitating the learning process. The main outcomes should include: the capacity to access high-quality resources for reuse in other learning contexts; provision of automated assessment tools; and the assistance of software systems that respond directly to learners' immediate needs and deliver customised assemblies of teaching resources tailored to diverse learning styles and generational preferences. Finally, the benefits to the learning institution apply to: a measurable increase in learners' knowledge and their eventual suitability for employment; calculable cost advantages and procedural efficiencies; the levels of contribution to organisational goals; and the status derived through the delivery of innovative teaching solutions in relation to world best practice.

Therefore, where VCL is concerned, it is important to recognise that in the absence of systematic planning and design to determine a suitable structured environment it is unwise to assume collaborative activities will automatically result in quality learning outcomes. Campos (2004, pp. 9–10) raises three crucial questions in relation to the learning effectiveness of collaborative environments that assist in devising a viable learning model:

- How to assess collaborative conceptual change and learning?
- How to assess collaborative conceptual (or notional or idea) change and (higher order) learning in online discourse when these processes follow one another?
- How to assess knowledge building?

In answering the first question, Campos emphasises there is a marked difference between successfully performing an action and understanding what has been achieved. Whereas an individual may succeed in identifying a problem and then structure it through language or the written word, in order to really understand a problem requires the capacity to reflect on the problem at hand, formulate hypotheses, and reconstruct prior logical conclusions (logical reasoning). It is during the process of applying logic to solve problems that inferences are made, a tacit learning process where the learner moves from meaning to meaning to draw valid relationships and refine their individual meaning system (natural logic). Conceptual change is an intentional and reflective cognitive process leading to higher order learning as opposed to lower order learning which is mainly automatic (such as learning instinctively or making unconscious decisions). Conceptual change can occur individually or in collaboration with others (collectively). When it is collaborative, concepts, notions, or ideas are changed or transformed in a collective exchange, as in the case of web-enabled asynchronous activities.

The distinction made here between succeeding and understanding points to the difference between cognitive and metacognitive behaviour, where metacognition refers to the individual's awareness of their own cognitive processes, or the thinking steps required to transform a concept, a notion, or an idea. Thus, metacognition is thinking about thinking as well as knowing 'what is known' and 'what is not known'.

The basic metacognitive strategies to be observed when designing a collaborative learning model are (Blakley & Spence, 1990, pp. 11–14):

- Connecting new information to former knowledge.
- Selecting thinking strategies deliberately.
- Planning, monitoring, and evaluating thinking processes (Dirkes, 1985).

In considering the implications of the second question, Campos instructs the learner to identify concepts, notions, or ideas that are both at the centre and are a result of a hypothetical collaborative process of networked argumentation. In this process, community participants 'build on' the contributions of others using a 'if this, then that' strategy to apply explicit or implicit conditionals that correspondingly lead to hypotheses formulation and inferencing. The result of this exchange is that participants reassess and reflect on knowledge and rebuild previously held concepts, notions, or ideas. When collaborative conceptual change occurs, then collaborative learning is also likely to take place. However, it should be noted that collaborative learning can only be achieved if there is evidence in the sequence of exchanges that conceptual change was clearly incorporated in the renewed discourse, either by affirming it or by re-transforming it to create renewed concepts, notions, or ideas.

Where question three is concerned, Campos advises that any change in knowledge must be profound. That is, the resulting knowledge must be unique and a truly collective result of the many asynchronously interconnected minds, something that could not be achieved by the individual alone.

3.6 Designing a Virtual Collaborative Learning Environment

VCL design does not mean 'building a website' or writing code, or even using a learning management system (LMS). Designing a VCL refers to the curriculum design strategies by which teachers can create, using web technologies, *experiences* for collaboration that involve networking. Such design must, in the first instance, be informed by the principles that underpin the attainment of metacognition: the design of a VCL needs to ensure that students have metacognitive awareness of their interactions and practices within it (Blakley & Spence, 1990, pp. 11–14). As Tay and Allen (2011) argue, curriculum design for technology-based learning must also identify and create effective social affordances, and not just rely on the technological affordances.

Students begin a learning activity through a conscious process of identifying 'what is known' and 'what is not known'. As they engage in a learning activity, students are required to verify, clarify, and expand or replace their prior knowledge and understandings with more accurate information. In essence, a metacognitive learning environment should be designed to encourage students to be aware of their own thinking. Therefore teachers need to monitor and apply their personal knowledge, deliberately modelling their individual metacognitive behaviour to assist students develop an understanding of how to structure their own thinking processes. In other words, the teacher is as active within the VCL network as the students. Problem-solving and research activities provide additional opportunities for developing metacognitive strategies. To be successful, teachers need to focus student attention on how tasks are accomplished. Process goals, in addition to content goals, must be established and evaluated with students so they discover that understanding and transferring thinking processes lead to improved learning.

The substantive point here is that the learning network does not require code to do this type of work: rather, for it to be a learning network, there has to be a designed process—carried out using any relevant technology (blogging, discussion, wikis, chat, or more)—through which metacognition is made *present* within the interactions of individuals. Essentially, through the teacher's intervention, metacognition becomes a node in itself.

There are a number of useful models for gauging the learning effectiveness of collaborative activity in which it is understood that the goal of computer-mediated communicative interaction is the production of new knowledge or the understanding of meanings (Campos, 2004, pp. 4–6). He describes several models of which two are selected as typical examples of how collaborative learning environments may be designed and structured. The first draws directly on grounded theory principles to propose a five phase evolution of negotiation leading to the co-construction of knowledge: sharing and comparing information; the discovery and exploration of dissonance or inconsistency among ideals, concepts, or statements; negotiation of meaning and construction of knowledge; testing and modification of proposed synthesis or co-construction; and agreement on the applications of newly constructed meanings. A second model employs three methods. The first defines discussions as being vertical (seeking answers on a given subject matter), or horizontal (interacting with other participants to co-construct) in order to classify them as the simple assimilation of information or knowledge construction. The second method advocates the need for critical thinking and participation. The third classifies discourse according to vertical questioning, horizontal questioning, statements, reflections, and scaffolding.

An innovative example of how an online learning network may be structured to support learners in their efforts to construct and assimilate new knowledge is provided by Slotta and Linn (2000, pp. 4–5) who devised a set of design principles they refer to as the Scaffolded Knowledge Integration Framework. Within this framework, students become engaged in sorting out unfamiliar ideas and determining a predictive set of models. Students are also encouraged to develop personal criteria for linking ideas and expectations about what it means to explain and what it means to understand. Ultimately, the goal is to structure autonomous learning in a way that promotes the ability to integrate diverse sources of information and to judiciously critique the credibility of their findings.

To achieve such outcomes, cognitive, social, and epistemological factors provide the basis for devising the four major principles that underpin this framework, which we will now outline.

1. New goals for learning are required in order to shift students (and teachers) away from their traditional focus on rote memorisation and performance measurements against standardised tests. What is needed is a curriculum that emphasises opportunities for students to evaluate new information in accordance with personal understanding, to articulate their own theories and explanations, and to actively participate in principled design. Students must also assume a high degree of independence when engaged in the process of solving complex problems. This approach encourages students to seek out and explore connections and to test the validity of the connections they have made. In turn, they are able to develop greater autonomy in evaluating connections and seeking out disconnected information. The importance of connecting ideas in the Scaffolded Knowledge Integration framework is supported by the notion of 'making thinking visible'. Most noteworthy is the way connections are made and how relationships are defined to form new conceptual understandings that in principle is similar to systems thinking.
2. It is important to assist students to utilise their own repertoire of learning models by providing the tools and opportunities to represent their own thinking. This strategy allows students to develop more sophisticated as well as more diverse models of thinking, particularly if structured within a framework of cognitive, procedural, and metacognitive supports. To have any real effect however, it is essential students receive constructive feedback on the relevance and efficacy of their current thinking models.
3. There is a need to emphasise autonomous student activities that connect to students' concerns and engage them in sustained reasoning. Design or critique projects that require students to form opinions or explanations about the available evidence or to make principled design decisions assist to encourage autonomous learning. To make such projects authentic, it is essential to draw on students' existing knowledge and to incorporate information that is directly relevant to their individual interests.
4. Social supports for learning can assist students to develop valuable collaborative skills, and in the process, gain new insights from their peers. For example, listening to ideas from peers, validating each other's ideas, and asking questions of peers all foster the formation of links and connections among ideas. However, opportunities for discourse succeed best when structured into the curriculum, so that students are actively encouraged to share opinions, offer feedback to others, and to reflect on the mix of ideas.

Thus, designing an effective social context for learning also involves guiding the process of social interaction. Well-designed learning environments not only promote collaborative activity, but also provide an efficient means of teaching students to learn how others connect ideas.

3.7 Curriculum Design as Applied to Virtual Collaborative Learning Practice

How might these four principles be put into practice to create an effective VCL? To answer this question we must first of all appreciate that there is no single software solution, no packaged learning system or similar options. While LMS such as Blackboard, Moodle, Sakai, Desire2Learn, and others are very prominent in online learning and could play a significant part of the production of VCLs, they are not, of themselves, the answer. Rather, the four principles just outlined provide us with the ability to create an interwoven mix of technologies, practices, and learning design which gives effect to the VCL through the digital ecology of the network: the interaction of people, ideas, and activities that can be experienced through many technological forms.

Here is one way to use existing online knowledge work technologies to give effect to these principles.

The first principle, put simply, requires students to be active in their learning: to *do* something, rather than simply receive and attempt to internalise information. While learning is not solely about the inherent generation of knowledge from nothing, learning will only be effective, for the majority of students, when it involves working *with* prior knowledge, transforming it, appropriating it, and representing it. The Internet provides a very powerful array of technologies to enable such an approach. Wikis, whether in their more traditional form (for example, maintained through services like http://wikispaces.com, http://wikidot.com or http://pbworks.com) or in more sophisticated ways (http://springnote.com), are one such technology.

A wiki is a space that depending on the way it might be designed and prepared by a teacher is a more or less open, collaborative writing/media production environment, which more than any other online technology embodies the principles of the read/write web. Knowledge is received, considered, and also produced all in the same place. Quite literally, the space of reading is also the space of writing. Although difficult to use in practice, wikis produce the kind of active engagement that is essential within a VCL. There are alternatives, as well. To pick one example, http://slinkset.com enables any Internet user to create a private or public shared space that mimics the rolling stream of links and comments found in services like digg.com and reddit.com. VCL development requires educators to find these 'open' writeable spaces and then encode them with the scaffolding necessary for students to use them as a place for conducting knowledge work online.

The second principle demands that students have tools to represent, reflect on, and improve their own thinking. The Internet, particularly in the guise of Web 2.0 applications and services, has provided significant opportunities for students in this respect. Mind-mapping software (for example http://mind42.com; but also http://www.wisemapping.com, http://www.glinkr.net and http://bubbl.us) is a very useful technology by which the thinking process can be externalised, often shared with other students and teachers, even used as the basis for a fully finished piece of knowledge work (rather than being a precursor to a traditional written form of presentation). While not commonly thought of as a tool for thinking representation, a blog (powered for example, by http://wordpress.com, http://blogger.com, or http://posterous.com) is a tool that can track thinking over time, with the particular value of the social understanding of the blog as a narrative developed over a period of time, rather than an edited, re-edited, and then finalised single piece of work. Visualisation services such as http://wordle.net or http://chartle.net can enable students to translate words into images that investigate the meaning of those words and the logical relationships within them. Services like http://xtimeline.com or http://www.preceden.com allow students to create timelines, which serve as another way of externalising the logical relationships involved in narratives that emerge over time.

The third principle emphasises autonomous student activity by which they take external, conceptual knowledge and link it to their own world, their own understandings and make sense of that conceptual knowledge. VCLs will work when they create specific tasks that students must complete to enable this linking to occur. These tasks should, however, involve the production of an outcome, not just the reception of knowledge. Many new services are emerging that give students the creative tools to work independently in this way, for an audience. Where knowledge is best understood and represented through images, http://flickr.com allows students to present knowledge as images; a service such as http://slideshare.com promotes the public sharing of powerpoint-style presentations; and http://hubpages.com or http://scribd.com can allow the creation of autonomous publication of written material.

VCLs need also to engage with technologies that create new forms of presentation—http://prezi.com is a significantly different form of presentation software; http://quizlet.com enables students to create flashcards which, instead of being a personal study aid, become a public representation of their understanding of the knowledge being learned. http://delicious.com and http://diigo.com enable students to work on the production of annotated literature reviews in the form of tagged web resources. In all cases, however, what makes these services useful for a VCL is that they all enable and often demand collaboration, commentary, and public reception.

Social support for learning through the networked conversations of learners that can be more or less directed towards specific learning outcomes can now take place in many ways. Traditionally, it has been assumed that such conversations between learners took place in 'designed' places, within the learning environment (discussion boards, chat rooms and the like within Blackboard or a similar system). Now, increasingly, learners utilise their own forms of networked conversation through Facebook, Twitter, MSN, and the like regardless of what is arranged for them; indeed these forms, which are more personal and affectively connected to students, are likely to provide more effective social support than formalised discussion forums. A VCL therefore needs to both recognise and accept this entirely unscripted, unprompted, and uncontrolled social learning, while also building on these approaches to create interconnections between formal, teacher-managed conversations and those that students are experiencing on their own. Twitter can provide such a mechanism, but in this respect the software is less important than the recognition that there is a continuum between entirely informal, student-dominated conversations and very structured, 'learning focused' conversations. Thus, an educationally effective VCL will promote the use of a variety of technologies that students already use or may need to discover and then use, to create overlapping networks of more or less formal communication between students and teachers.

The recent enthusiasm developing within higher education for massive open online courses (MOOC) presents now a further challenge for educators seeking to generate highly active student learning within knowledge environments. MOOCs, while valuable in many ways, emphasise again individual learning in response to didactic instruction—while this is not the only model by which a MOOC could work, it does seem to be the emerging norm.

Ultimately, a VCL will emerge in different ways, for different purposes, depending on the students and teachers involved and the subject matter to be learned. There is no single model which can be adopted reliably in all situations. However, as evidenced from the examples above, a VCL needs to deploy a range of technologies that have, in common, the linking together of people, with ideas, and through these technologies interactions between people and ideas are brought to the fore of the learning experience. This chapter demonstrates that there is still significant research to be conducted in this field, directly addressing the questions of how might such interactive environments be realised in higher education, given the overwhelming focus on the traditional LMS.

3.8 Conclusion

While many educational institutions throughout the world have introduced online learning as a delivery option, there is mixed evidence about the concurrent development of curriculum models that advance pedagogical diversity and learning effectiveness. Aside from some innovative exceptions and a general tendency towards technology-oriented experimentation, the design of most online learning experiences is structured around the conventional instructional model, which inherently does not afford the flexibility required to take full advantage of the socialising and information sharing potential of the Internet as it now exists, with nearly a decade of Web 2.0 and social media development.

In many universities, online learners are not equipped with the tools required to organise their work, group learning is not always readily available, team-focussed problem-based learning activities are not easily supported and managed, and productive engagement with the wider community is not always feasible. There is little systemic attention paid to the importance of the pre-existing social networks of students, mostly enabled by Facebook and Twitter, nor their own social media habits (encompassing such newer services as Tumblr and Pinterest). Moreover, the power of these networks, and the way educators might intersect with them is not widely understood as the key challenge for curriculum design.

The Internet continually offers new tools to support such activities, but there is an obvious disparity between what people experience on the Internet and what university online delivery platforms provide. Bridging this gap is only part of the solution as there is also the unrealised potential of students' web 2.0 expertise to consider. There is something incongruous in the notion of applying web 2.0 technologies to learning and teaching without enlisting the support of the very audience that by and large have been the drivers of web 2.0 innovations.

For students to learn effectively in the increasingly complex online systems available, teachers will need to create from the raw material of web 2.0 technologies, as well as any formal learning systems, an environment for virtual collaboration. In such a VCL, students will learn much more than the 'know what' (explicit knowledge). They will also experience and understand the 'know how' (innate knowledge) that is gained through personal and active involvement in applying what they already know, through networking with other recipients of that knowledge, practitioners, and so on. At the interplay between innate and explicit knowledge lies deep expertise, where the learner is required not just to assimilate the explicit knowledge of a given subject area, but also apply that knowledge through active engagement and contribution to relevant communities of interest (Brown, 2002).

Considered as a whole, the factors and strategies raised in this chapter point to the need to not only rethink the purpose of the curriculum models that inform the design and function of virtual collaborative environments, but also to devise more adaptive, educationally focussed teaching and learning strategies. What is missing are the technologies that promote the generation of ideas and support the communal filtering processes that lead to innovative thinking and deep learning. For such technologies to be successful, an analysis of the innate social processes that characterise human collaboration is required. This chapter begins the exploration of how these processes can be supported by the 'version 2' web revolution, which appropriately should be further enhanced and sustained through the active mobilisation of a strong student voice in the design and application of web 2.0 technologies.

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Chapter 4
Open Educational Curricula Interpreted Through the Māori Concept of Ako

Stephen Marshall

Abstract The idea of open educational resources has been growing in popularity over the last decade, particularly in response to the initiatives of large institutions such as Massachusetts Institute of Technology and the UK Open University and the work of organizations such as UNESCO. In essence, this concept promotes ideas originally developed in the context of software which state that genuine freedom requires the ability to change and share any tool. Traditional models of curriculum development can be seen as embodying many of the undesirable aspects of closed systems, with control remaining in the hands of teachers. Truly Open Curricula would allow the same freedom of modification that currently exists for content. The Māori concept of Ako describes the relationship that exists between learners and teachers and recognizes that an educational experience influences both through their shared experience. This useful idea is used to explore the reality of an Open Curriculum and to suggest a model for open education that is defined less by technology and more by the structured social experience of education.

Keywords Open education • OER • Open curriculum • Ako

4.1 Introduction

Every month it seems a new university is announcing its entry into the Massive Open Online Courses (MOOC) market. Much is being made in the media of the experience of former Stanford artificial intelligence researcher and academic Sebastian Thrun's experience (Hsu, 2012; Murray, 2012) culminating in his departure from Stanford and the formation of a company to build on that success (Udacity;

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http://www.udacity.com). The Open University, Massachusetts Institute of Technology (MIT), Harvard, Stanford and a range of other institutions are all experimenting in the Open Educational Resources (OER) space and releasing large amounts of content for use by students anywhere in the world. This international largesse has not escaped the notice of the United Nations with UNESCO working in partnership with a consortium of international institutions to explore the concept of an OER university (Mackintosh, 2011). These initiatives appear to be being driven by a range of factors. Individual teachers are being motivated to address a widely perceived failure of higher education to provide cost-effective education to everyone and to improve the quality of learning and teaching. Open approaches are also seen as providing a response to the monopoly on knowledge being developed by commercial publishers and also supporting lifelong learning (McGill, Currier, Duncan, & Douglas, 2008; OECD, 2007; Yuan, MacNeill, & Kraan, 2008).

At the heart of the current activity, there appear to be two key ideas. The first is the concept of openness. Originally an almost nostalgic view on the development of software, the open ideal is now an active political philosophy that combines ideas of democracy with a Marxist perspective on the common ownership of society (Lane & Van Dorp, 2011; Unsworth, 2004; Vest, 2006). The second is what (Batson, Paharia, & Kumar, 2008) describes as the consequence of the pedagogy of abundance. Digital technologies and the Internet have created a world where the cost of creating and accessing information has dropped substantially and the role of educational institutions as repositories of scarce knowledge is no longer assured. Thomas Carlyle stated that “The true University of these days is a Collection of Books” (Carlyle, 1885, p386) in response to the explosion of books following the invention of the printing press. Technology now means that most people, at least in theory, can carry the university with them wherever they are.

These ideas, and the projects they have stimulated, suggest that the world is about to experience a shift in how higher education is accessed and valued by our societies. However, significant challenges confront those engaging in open education. The most obvious one is that of sustaining the creation and delivery of the “open” resources. Researchers in the field of open education are starting to see a change in focus from the creation of content to an examination of how that content is used to support learning (Ehlers, 2011; Lane & Van Dorp, 2011; Stacey, 2010). This focus on use suggests two main issues. The first is the mundane question of who pays? The experience of the content industries (music, television, movies, books, and news) suggests that sustainable business models embracing digital media are challenging. Many of the current open education initiatives are dependent on charitable funding from educational foundations and struggle to demonstrate sustainable financial independence (Baraniuk, 2008; Stacey, 2010).

The second main issue is that of the curriculum. Current activity in open education is predominantly framed within a model of teacher-driven courses. Many of the open resources being developed for educational use are being created for use by other teachers and within the existing model of formal education and qualifications. This raises the question, is it possible to meaningfully describe an “Open Curriculum,” an educational experience able to be reshaped usefully by a learner outside of the necessary control of a teacher? And if so, is there still a role for a teacher and how do the two roles engage effectively with each other? This chapter explores these questions and whether a conception of education expressed by the New Zealand Maori term “Ako” might be useful in defining one possible direction for higher education.

4.2 Ako

The Māori people of New Zealand have the concept of “Ako.” Commonly the word is used to mean “education,” but it has a more complex etymology. Ako embodies the idea that teachers and learners are inescapably entwined in a synergistic experience of learning. The act of learning teaches others who in teaching you become learners themselves (Hemara, 2000). This concept of education as a relationship has a number of attractive features consistent with the ideas of active education, social constructivism, and the use of discussion and communication technologies to support learning (Bishop, Berryman, & Richardson, 2002; McDonald, 2011).

To understand Ako, it is important also to be aware of the respect for experience and knowledge within Māori culture. The two roles of teacher and student are not equivalent and Ako does not mean that learning arises from the interaction of peers. A successful Ako relationship will reflect mutual respect and awareness of each other’s strengths and needs, framed within a shared desire and interest in the object of the learning. Epistemologically, Ako is also framed traditionally by tikanga, the worldview, customs, and rules of the Māori culture. Tikanga sets limits on many aspects of daily life including that of learning and forms a normally invisible framework constraining, sustaining, and defining the actions of both the learner and the teacher. At this point, it is also worth emphasizing this view of Ako is a modern description of education quite distinct from the practices of learning sacred knowledge within Māori communities prior to European settlement in New Zealand (Mead, 2003).

Educationally, the key concepts of Ako that can be used to frame the work of teachers and learners more generally can be summarized as follows:

1. The design of education in the form of relationships between people who are not equals but treat each other with respect.
2. The work of the participants is structured by a set of implicit and explicit cultural norms and expectations independent of the subject being studied.
3. Learning is active, and the act of learning stimulates and provokes a pedagogical response from the teacher that facilitates deeper learning by both the learner and the teacher.
4. The learner and the teacher are participants in a larger community that supports and sustains them and which values both of their contributions to the life of that community.

These ideas form a coherent set of values, or tikanga, that can be used to frame education in many contexts and which will be used below to suggest a model for open education that is defined less by technology and more by the structured social experience of education.

4.3 Open

The idea of "Open," a far newer cultural concept than Ako, draws on two main strands of modern thought. The first is embodied by the Open University in the United Kingdom and similar "Open" education institutions internationally. These institutions are guided by a philosophy of education that accepts anyone as a student irrespective of their prior performance. Teaching materials produced by open institutions are often made available publicly as well, in order to promote wider access to learning materials.

The second sense of openness is derived from the field of software. Open source software describes the practice of sharing the source code of software as well as the compiled or runnable application. The emergence of the modern consumer computer business has seen this replaced with commercial software which is merely used and which cannot easily be modified by users.

Many within the research computer community have strong reservations about the implications of the lack of access to the source code of software. These concerns led people such as Richard Stallman to explore the concept of openness through the idea of free software (Stallman, 2002). These ideas, expressed as a set of four freedoms (Table 4.1), were not just a statement of practical concerns about the ability to modify software but are a strongly expressed political position on the role software could play in society: "When users don't control the program, the program controls the users. The developer controls the program, and through it controls the users. This nonfree or 'proprietary' program is therefore an instrument of unjust power" (http://www.gnu.org/philosophy/free-sw.html).

A successful open source software project is often seen through the continuous refinement and improvement undertaken by a large number of contributors. Importantly, there are two major types of participants in these projects, the architects or leads who define the major goals and structure of the software and who validate the contributions made by others and those who work within that structure to

Table 4.1 Richard Stallman's four freedoms (http://www.gnu.org/philosophy/free-sw.html)

The freedom to run the program, for any purpose (freedom 0)
The freedom to study how the program works and change it to make it do what you wish (freedom 1). Access to the source code is a precondition for this
The freedom to redistribute copies so you can help your neighbor (freedom 2)
The freedom to distribute copies of your modified versions to others (freedom 3). Access to the source code is a precondition for this

improve the software's capabilities. In many projects the boundary between these two groups is fluid and users actively participate in discussions about the architecture and feature set of the software they are collectively creating and using. A key feature of this community is that all of the members are active users of the software they create.

David Wiley recognized (Wiley & Nelson, 1998) the potential impact the ideas of the open or free software movement could have in education and coined in 1998 the concept of "open content." He suggested that this would see the creation of a mechanism for free and simple access to learning materials and support a culture of educational innovation and collaboration (Wiley, 2002). Building on the ideas of open content, UNESCO hosted a forum in 2002 (UNESCO, 2002), which defined the concept of OERs. Extending beyond content, OERs were defined as "educational resources, enabled by information and communication technologies, for consultation, use and adaptation by a community of users for non-commercial purposes" (UNESCO, 2002, p24).

The two strands of openness started to merge in 1999 when the Open University collaborated with the British Broadcasting Corporation to create a website of open content (http://open2.net/). This website provided a range of freely accessible online educational content complemented by online and public collaboration and contribution facilities (Lane, 2012). The materials produced however remained under copyright and thus fail the test of the four freedoms outlined above.

Subsequently, the Open University partnered in 2006 with the William and Flora Hewlett Foundation in the module-based Open Content Initiative (OCI now known as OpenLearn, http://openlearn.open.ac.uk/). The OpenLearn materials are also copyright, but licensed through a Creative Commons License (Bissell, 2009) that allows personal noncommercial use, provided that such use acknowledges the source of the material and that any changes are covered by the same license terms. Again this fails the test of the four freedoms outlined above. Similarly, in 2001 the MIT started making course materials publicly available on the Internet (Goldberg, 2001). As with the Open University, these remained owned by MIT and were structured in courses reflecting the degree model at MIT.

The work of these initial innovating institutions is now being complemented by a number of collaborations as more institutions explore the concept of open education. The Higher Education Academy (HEA) and the Joint Information Systems Committee (JISC) are promoting and supporting the use of OERs through a national programme (JISC, 2012). This describes (JISC, n.d.) OERs as "Open educational resources are learning and teaching materials made freely available online for anyone to use. Examples include full courses, course modules, lectures, games, teaching materials and assignments. They can take the form of text, images, audio and video, and may even be interactive." The edX consortium of MIT and Harvard and the Coursera initiative partnering with Stanford, Princeton, University of Michigan, and the University of Pennsylvania are rapidly moving a large quantity of courses online for students to access for free. Moving well beyond content, these initiatives are providing full courses with assessments and collaborative environments. The one thing they do not offer is a qualification; instead students receive a "letter of achievement" that the terms of use make clear is not any form of qualification from the partner institutions.

MIT, Harvard, and the other institutions experimenting with free courses online clearly have to maintain a tight balance between the reputational benefits of being seen to be socially responsible and innovative, while also protecting the reputation of their existing qualifications. It has been suggested that beyond the possible reputational benefits, these initiatives might potentially attract students into the full-fee programmes (Hanna & Wood, 2011). Coursera, despite being a for-profit enterprise, has not indicated how it intends to make money from its free courses, but it seems inevitable that some form of premium service will be offered at some point and this might provide a pathway to an accredited qualification (or a Pearson validation acting as a proxy for accreditation).

There is also, however, a strategic dimension to these initiatives when viewed from the perspective of the successful high-profile and high-quality institutions engaging in them. By giving away free online courses, they are essentially lifting the expectations of society for all online providers. Existing online providers will have to demonstrate how they are offering sufficient value over and above the free courses to justify their fees. These free initiatives are a textbook case of Christensen's low-end disruption (Christensen, Anthony, & Roth, 2004) with the twist that the disruption is being done by the established institutions. Potentially this will make it very much harder for any other organizations engaging in low-end disruption that might challenge the current incumbents in the future.

MOOCs are the high-profile modern face of open education, but it is important not to be distracted by their hype and scale and to consequently miss the fact that they are not truly open as defined by the four freedoms. Free software advocates make the distinction between free as "free beer" and as "free speech." The course initiatives described above are all "free beer," they provide access to course experiences and content, but they control the conditions and outcomes. The structure of the courses are defined by instructors, the content remains covered by copyright and only available for personal noncommercial use, and there is certainly no hint that the students might remix the courses for their own ends. In reality, much of the material released as "open" content is commonly provided for use by individuals but remains under the control of the creator and cannot be modified, amended, and reused by others without their permission. The perception by many academics is that the audience for open resources is not students, but rather other academics teaching similar courses who will simply use it as provided (Brent, Gibbs, & Gruszczynska, 2012).

This latter point perhaps explains one of the key ways in which open education differs from open software (Mackie, 2008). Open source software projects typically operate as a community of practice with all of the members actively collaborating on the software being developed. Initiatives such as edX and Coursera in contrast are not creating communities of active participants "hacking" their courses, they are rather establishing new communities of learners in very much the same form as that of a traditional university (and just changing how that is paid for).

Taking these reservations regarding many supposedly "open" educational initiatives into account, what are the key concepts of openness that can be used to guide the creation of a completely open education?

1. Open technologies prevent the exertion of "unjust" power on the users, providing the users with options that are not controlled by the developer of the software.
2. The freedom to modify for personal reasons exists within a community of sharing experiences of that modification and use, which encourage further development and use of the software.
3. People engaging in open projects will naturally adopt different roles depending on their knowledge, skills, and available resources (including their own time) with many people happy to work to a plan defined by others providing that it is clear and it addresses their needs.

4.4 Using Ako to Create a Philosophy for Open Curricula

In part at least, the difference between open source software projects and open education may be a consequence of how they are experienced and used. Software is commonly seen as being a tool, while education can be seen as a series of experiences within a larger process, which may be described as a curriculum, often resulting in the achievement of a qualification.

Curriculum is a complex concept. It can apply to the student's experience in a specific class, a programme of study usually resulting in a qualification, or a national qualification framework. Curriculum can be scoped over short periods of time, e.g., a single module, or it can be applied to several years of study. It can refer to the content, the teacher's intentions or plans, the structure of learning activities and assessment, the relationships between those activities and formally defined graduate and learning outcomes, or the change in skill, knowledge, and capability experienced by the student (Doll, 2008; Lynch, 2008; Niculescu, 2009). Importantly, although we can distinguish between the formally designed curriculum and the perceived curricula experienced by staff and students (Niculescu, 2009), students remain motivated significantly by the assessment component of their curricula and the associated feedback ultimately resulting in their being qualified (Nicol, 2009). Generalizing assessment activities to make them relevant in multiple curricula contexts is recognized as a challenge for existing OERs (Lynch, 2008). Those operating educational repositories are addressing the need to complement educational resources with information on the pedagogical uses of the material; however, these uses are still being framed with the expectation that the structure of the curriculum is being created by a teacher in an institutional context (Carey & Hanley, 2008).

In terms of the current analysis, curricula can perhaps be best understood as the structured relationships between learning activities experienced by the student. Traditionally curricula are seen as the responsibility of the teacher and institution, with any flexibility to tailor the experience and personalize it for students in the hands of the teacher, not the student (Lynch, 2008). Clearly, students do not know what they do not know and so are wise to be guided by more experienced people. Complete freedom to choose to learn anything in any order seems to be a recipe for chaos or at least inefficiency with a risk that much student time will be spent drifting aimlessly through the ever-growing body of human knowledge such that nothing tangible can be achieved. In this regard, simply having OERs available for students is clearly insufficient in itself for many people to be able to learn (Lane & Van Dorp, 2011).

Analogously, open source software, even that which meets all of the freedoms discussed earlier, benefits from some constraints and structure. Software must be able to be executed by a computer as a series of logical and purposeful instructions. Computers are very effective at providing summative feedback to people writing code; software either compiles or it doesn't. Beyond that basic constraint, software normally is created to achieve a specific purpose, and the people using it and creating it are able to quickly determine whether it meets their needs. Often this will include the ability of software to operate effectively in conjunction with other software systems. Beyond these basics, however, many software products contain subtle bugs or misbehaviors that only occur when the software is used in specific contexts. Much of the work of software developers is spent analyzing these subtle faults and identifying the causes.

Curricula can be seen as helpfully providing structures and constraints supporting the user experience of learning. The need to place educational materials within a specific context can be seen complicating the learner's attempts to evaluate materials for themselves (Mackie, 2008). Consequently, the approach of traditional "closed" learning is to place the evaluative and structural responsibility in the hands of the teacher and institution. Even when describing the consequence of open, student created and driven education writers still impose traditional models of degrees with "someone" responsible for selecting and structuring the resources used to support student learning (Batson et al., 2008). As discussed earlier, many ostensibly open educational initiatives have thus remained closed rather than open or "free" for learners to control for themselves even when they are operating outside of formal qualification frameworks.

Using the key concepts of openness drawn from the software world and those of Ako identified earlier as a guide, what might an Open Curriculum look like? A key feature in common with both philosophies is the need for community and the roles of participants within that community. Beyond the existence of the community, there is also an awareness of the values of that community, the means by which participants demonstrate respect for others. There is the mechanism used to identify the different goals of the participants and the incorporation of those goals within the shared activity of the group. Finally, there is the achievement of outcomes valued by the individual participants, with the same activity leading to a variety of outcomes depending on the goals and roles of the individuals.

An Open Curriculum needs to allow learners the ability to define their own objectives within the framework established by the community they are participating within. It would then provide a mechanism for explicit summative feedback on whether the learner is successful in achieving the key steps to that goal (equivalent to the process of compilation and execution of software) as well as formative guidance on the quality of achievement and progress towards the larger objectives (equivalent to the discussion by the community of people developing software as well as the outcome of using the software).

Some of the participants in the curriculum processes would be in teaching roles, setting the scope, shape, and structure of the overall experience but always collaborating with others who might contribute components of that structure. All of the participants would also be active members of a larger community of learners using the curriculum to support the achievement of their own goals, just as the open source software developers are themselves users of their tools. This community conception of learning is very consistent with modern ideas of the evolution of the web into the idea of "web 2.0" where value is created through the collective actions of community members who learn to "be" through a social and creative process (Seely Brown, 2008).

It is also important to emphasize that this community model depends on collective ownership and an acceptance of a loss of complete control by those who create the affordances of the community (Norman, 2004). Any attempt by a few to own any aspect of the whole is incompatible with the community dynamic. Accordingly, it needs to be legally open as well, unencumbered by copyright.

Combining these ideas of pedagogical freedom and the experience of open source communities of practice, an Open Curriculum imbued with the concept of Ako can be seen as embodying the following elements:

1. An openness of the curriculum itself, where the representation of the pedagogical model, the resources supporting its application, and the support needed to engage with it are all provided in ways that enable learners to access all parts of the curriculum, reuse these, remix them, modify them, and freely share them with others.
2. The existence of a community around the curriculum, with participants adopting different roles and responsibilities within a commonly held cultural framework. All members can participate actively in the defining the structure of the curriculum (including the designed goals or outcomes intended), contributing to the creation and development of supporting resources, and, most importantly using the curriculum and the materials to enhance their own learning.

4.5 The Challenges of an Open Curriculum

Richard Stallman's four freedoms were a response to a proliferation of ideas about openness and form a robust critique of different models of open software. Similarly others have also engaged with the ideas of open education and started the process of stating key ideas intrinsic to openness that can be used to evaluate different initiatives.

Mackintosh (2011) describes the basic components of an OER through the three dimensions of educational values, pedagogical utility, and technology enabling. These capture the need for resources to be both legally and practically used, copied, remixed, and redistributed. Ehlers (2011) defined a hierarchy of pedagogical levels of freedom or openness. Low degrees of openness reflect transmission models of education where the teacher "knows" what the learner has to learn and focuses on transferring their knowledge. Medium degrees of freedom exist where the outcomes are predetermined, but the pedagogy is open and determined collaboratively by learners. High degrees of freedom exist when the objectives and the methods are determined by the learners, who are then facilitated by teachers who scaffold experiences.

Kahle (2008, p30) identified five principles for open educational design: "(1) Design for access. (2) Design for agency. (3) Design for ownership. (4) Design for participation. (5) Design for experience." Access describes not only the ability to acquire educational resources but also the ability for a wide variety of people to effectively learn with them. Agency reflects the control the learner has over the resources and their ability to modify them to suit their local circumstances. Ownership describes the key aspect of the open philosophy that resources are intended to be owned by future users who incorporate them in new forms and manners into new resources; as implied in Stallman's four freedoms, if you can't modify something you don't own it. Participation refers to the need for learning to occur within a social context as well as the community of practice that generates and sustains the creation of learning resources. Finally, design for experience captures the need for the affordances (Norman, 2004) of a learning resource to be clearly apparent to users and able to support their effective use of the entirety of the knowledge available to them.

The Open Curriculum infused with the ideas of Ako described above would demonstrate high degrees of freedom under Ehlers (2011) model and is very compatible with Kahle's five principles (Kahle, 2008) and those of Mackintosh (2011). Beyond these it emphasizes the importance that the social dimension plays in complex human endeavors. This is potentially a strength of the Open Curriculum but also a significant challenge.

The Open Curriculum hinges entirely on the need for current roles of teacher and learner to blur. This is challenging for people who define themselves strongly in either role. Teachers, particularly at universities, are used to roles of responsibility, authority, and accountability as well the status of being an academic. Academic roles are very much states of being, intimately entangled with individual senses of identity and purpose.

Harley (2008) reported that the biggest single factor preventing the use of OERs was the need for the resource to fit into the model defined by the academic. In particular they found that humanities and social science academics particularly were disinclined to use resources that structured learning. Others (Coughlan & Perryman, 2011; Walsh, 2011) have also described the inconsistency in uptake of OERs apparent between disciplines. Much of the current body of OER work supports learning of generic study skills, professionally applicable topics, and basic knowledge in the disciplines of science and mathematics. A number of factors may be responsible for this, including the ease with which basic science and study concepts can be embodied in OERs, but it also likely that many academics in the humanities and social sciences are unable (or unwilling) to see their teaching embodied as an OER (Coughlan & Perryman, 2011), in essence to shed some of their control over the learner.

Learners are often unused to taking personal responsibility for their own learning, not only in managing the tasks that need completion, but in defining what tasks are needed, their scope and extent. Experiences with systems that provide students with the ability to take control of their learning suggest that very few actually will do so (Aczel et al., 2011). Beyond this, consider the impact of being one student amongst 150,000. Maintaining a sense of purpose and focus while caught up in communities of this scale suggests that learners need significant resilience and motivation. Learners (by definition) don't know what they don't know and lack the skills and knowledge often to initiate productive learning and need to be given some form of context or map to start the process of knowing (Matkin, 2011).

The systems within which education occurs are perhaps the most significant challenge to Open Curriculum embodying Ako. Academics often refer to their freedom, but in reality a complex web of regulations, laws, precedent, and societal expectations controls the tertiary education systems of all countries. Much as open source projects have benefited from systems that support and structure their existence, Open Curricula need systems that enable their creation, development, and use (Aczel et al., 2011; Marshall, 2012). Traditionally these systems are seen as qualifications, accreditation frameworks, and institutions of higher education. The absence of any model of social acceptance of open qualifications is notable in the current MOOC initiatives with institutions like Stanford clearly challenged by the risks of associations with Udacity. The need for clarity in the social and cultural place of different models has lead in New Zealand to the development of separate Māori adult educational providers, known as Wānanga. These institutions operate within the legal framework of New Zealand education but otherwise pursue a model of education defined by āhuatanga Māori according to tikanga Māori (Mead, 2003).

A key feature of the systems of formal education is their certification or documentation of the achievements of learners. A major challenge facing the Open Curriculum is how participants can communicate their learning effectively and efficiently to others. Experience with MOOCs is already highlighting the problem of various types of cheating or fraud, and the experience of e-commerce has shown that once something has extrinsic value there will be extensive attempts to subvert the integrity of the associated systems. The community model of Open Curricula may represent at least a partial solution here if the audience assessing and validating student achievement are active participants in the community. This suggests an attractive idea for those concerned about the divide between education and economic life.

Inevitably, the ultimate success of Open Curricula as a model of education will depend on a receptive social context, including the commercial world. Where the Open Curricula are successful, the scale and success of the supporting community will be a powerful argument supporting the significance of learning arising from their use. As an analogy, consider the status of the Linux operating system. Linux in its many forms is now a significant part of the information technology infrastructure underpinning the web and many people depend on their knowledge of Linux for their jobs.

This success, however, also illustrates the likely consequence of success for Open Curricula, which is the increasing involvement and dominance of commercial interests. While these interests can't directly control open projects, they can dominate them through the scale of investment they make in the project. Companies such as Pearson are clearly seeing opportunities to develop new business models building on open education initiatives. Linux has been able to maintain its integrity and independence through a combination of having gifted leadership and a committed community determined to resist corporate control. Open Curricula need a similar strength that will be harder to sustain as each community is likely to be much smaller than that for Linux.

Scale presents major challenges for the Open Curriculum as well. Early experience with MOOCS suggests that popular subjects are likely to attract interest from hundreds of thousands of people, far too many to credibly engage in any effective community without significant effort in structuring their participation. Inevitably, this suggests that communities will have to be formed continuously, building from the original "parent" community in a process analogous to the "forking" of open source projects. This then introduces inevitable inefficiencies as changes can't easily be shared between different communities.

A related challenge, shared with open source software projects, is the scarcity of expertise. To function well, each community needs its own participating "experts" capable of leading the experience of the group. The scarcity of expertise needs to be respected, and experts, even redefined as advanced learners, need to be supported and their skills and knowledge used wisely. All too easily the communities can fall back into a pattern of subordination to a small group of leaders, and the Ako principles of engagement and community participation are lost. One way in which this problem could be minimized would be through the development of a formal statement of values, a tikanga, for the Open Curriculum that would encourage participants to behave in ways that sustain the Ako model, rather than a teacher domination model. A key factor facilitating this would be the lack of any ownership of any aspect of the Open Curriculum, enabling people to take resources freely from failing communities in order to sustain successful ones.

The Open Curriculum model presented here is the result of experience with technological systems and reflects a modern understanding of education and the role that technology can play in it. The specific technologies that can be used have not been defined and this represents an area where there are many opportunities for entrepreneurial involvement. The absence of qualifications and support from existing formal systems of education means that Open Curricula communities will depend on a web of services, many of which could be offered commercially without compromising the experience of the participants. It is not difficult to imagine Open Curricula projects succeeding in existing collaboration platforms like Facebook and the various Google tools, but it is also not hard to see how new providers could establish the infrastructure needed to host Open Curricula much as wikis and blogs have been enabled previously.

4.6 Conclusion

An Open Curriculum ultimately is defined by the state of learning, the desire to actively seek new knowledge. The disposition to engage with other people learning from their experience in related endeavors, and to both learn from them and support the learning they experience, to be part of a process of Ako within a community. This primacy of a tikanga of learning distinguishes the Open Curriculum from models of "open" education that retain the authority of the teacher, that are limited to resources or content, or which are functioning more as communities of practice (Wenger, 1998). Requiring an active community using a shared tikanga has the advantage of automatically creating a model of support and engagement that will help many students learn effectively.

The challenges outlined above are real, and interestingly many also apply to the wave of MOOCs and other OER initiatives already underway. Clearly if these different models do lead to new forms of education, we will have to experience a difficult transition. People supporting open philosophies can easily be confused with anarchists and it is clear that widespread open education will be anarchic for a period, possibly even destructive to old orders and systems of education. The Open Curriculum model described here is not free of all constraints and the focus on community may well provide stability sufficient to weather the anarchy.

The Open Curriculum is not a model for scaling education without any concern for the costs. It will not support a YouTube model of education where content is simply dumped online in the hope that someone will find it useful. It requires commitment and ownership on the part of those participating in it. Ako requires all participants respect each other, respect the systems that sustain their learning, and explicitly participate in a community of shared endeavor. Inevitably, this will be hard to achieve in the chaos of the modern Internet. Much as with any open source project, it is likely that any single attempt to implement the model will fail, hopefully these failures will also help us learn. The few successes will be all the more valued for their genuine openness and potential for demonstrating a model of education for the future free of the hierarchies and limitations of our current formal education system.

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From its first foundation, universities spread across the globe with first universities in America in the sixteenth century and Australia, Asia, as well as Africa in the nineteenth century.

Despite numerous reforms, the successful integration of information and communication technologies (ICT), and recently established fully online universities, one thesis for the twenty-first century university remains almost unchanged: the oppositional view of teaching and research at university (Clark, 1997). Brew (2010) argues the necessity for change proposing that the twenty-first century calls for the placement of scholarship at centre stage in higher education and for research, scholarship, teaching, and learning to be viewed as part of one seamless whole.

> New understandings of the concept of scholarship and the role of scholarly work are important not only to the development of academic knowledge but also to the development of knowledge about the institutions and situations in which we work, and they are critical to the development, by students, of the skills needed to cope with professional life in the twenty-first century (Brew, 2010, p. 107).

The increasing demand for Universities to graduate students with higher order problem-solving and critical and creative thinking skills that bridge the theory practice divide lends weight to the importance of integrating the development of higher order capability into the curriculum (Barrie, 2004; Bosanquet, 2011). One approach to achieving this is through research-based learning.

Given the thesis of reconceptualising scholarship to address the tension between teaching and research at university level, this chapter presents a theoretical insight into research-based learning (RBL) and teaching which integrates learning, teaching, and research. Further, a curriculum for descriptive and inferential statistics at undergraduate level using the RBL and teaching approach is introduced. The chapter wraps up with reflections on further implementation of RBL and teaching, including the adoption of new technologies to assist this important mode of university education.

5.2 Research-Based Learning

In the nineteenth century, Wilhelm von Humboldt echoed in 1809 the concept of combining research, teaching, and learning as follows: “The university teacher is no teacher anymore and the student is no learner anymore, but rather the student is conducting research while the professor is leading the research and assisting the students’ research activities [translated from German]” (Humboldt, 1984, p. 71). Hence, the central idea of RBL is to actively involved students in ongoing research activities and let them develop their own research interests and questions (Huber, 2009).

RBL is a multifaceted approach for orchestrating a variety of learning and teaching strategies in order to connect research and instruction. Accordingly, the research

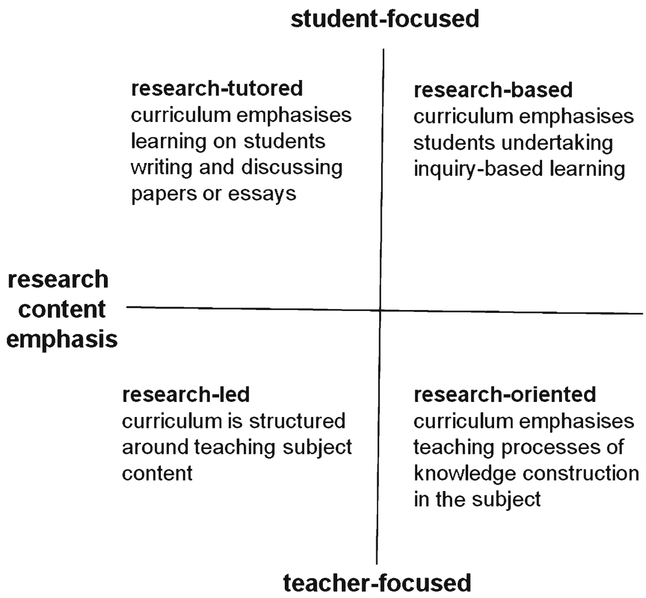

Fig. 5.1 Curriculum design using research-based learning approach (adopted from Healey, 2005)

activity is regarded as an important tool for teaching and learning (Clark, 1997). This involves (1) an active involvement of students in research projects, (2) the application of adequate research tools, (3) inclusive research approaches, and (4) research outcomes informing the (re-)design of the curriculum (Blackmore & Fraser, 2007).

Healey (2005) introduced a matrix which identifies various possibilities of curriculum design using the RBL approach (see Fig. 5.1). The horizontal axis represents the emphasis on research content/processes, and the vertical axis represents the level of student engagement. The four categories represent conceptual models. In practice, a curriculum may combine different perspectives.

A *research-led* curriculum is highlighting content informed by contemporary research and selected by the course instructor. This type of curriculum emphasis mainly information sharing. A *research-tutored* curriculum features student-produced research essays and discussion of research papers in working groups. A *research-oriented* curriculum emphasises the research process rather than only the research outcomes. Hence, researchers/instructors identify how research problems are approached by utilising various research methods and how scientific knowledge is constructed. A *research-based* curriculum involves the student in active research projects enabling them to learn as researchers, while the division of roles between researcher/instructor and student is minimised.

Table 5.1 Principles for integrating research-based learning

RBL principle	Detailed description
Personal research focus	Focus on current research projects
	Illustrate problems to be solved in research projects
	Provide insights into theoretical and methodological dilemmas of conducting research
Research overview	Provide historical insights into theoretical concepts and methodological approaches
	Critically reflect on current findings
	Link current research with past research outcomes
Active student participation	Involve students as research assistants in current research projects
	Let students conduct self-guided research in selected parts of larger projects
	Provide access to laboratories and venues of research
Contemporary research focus	Identify up-to-date research problems
	Analyse current scientific publications and critically reflect the theoretical and methodological arguments presented
Research methods, skills, techniques	Identify methods, skills, and techniques needed to solve research problems
	Apply research methodology to current research problems
Research activities as assignments and assessment	Provide students data of existing research and let them reflect the research approach analyses
	Involve students in micro-assignments guiding them step by step through the research process cycle
	Offer larger assignments focussing on conducting a complete research project
Research culture	Provide an overview about ongoing research projects
	Invite guests presenting and discussing their current research
	Encourage active participation at workshops and conferences
	Assist students in organising student-centred workshops and conferences
Values of scientific research	Model the ethical and scientific values of the discipline
	Illustrate the research dissemination process (e.g. conference presentations, journal publications)

5.2.1 Principles of RBL

In general, effective curriculum design involves determining the objectives of the course, choosing adequate anchors, providing relevant information in an appropriate way and deciding which activity facilitates student understanding (Beck & Krapp, 2006; Bosch, 2006). Additionally, the integration of RBL approach into curriculum may follow specific principles as shown in Table 5.1 (Baldwin, 2005; Blackmore & Fraser, 2007).

All principles for integrating RBL into curriculum presented in Table 5.1 may be tailored with regard to the subject domain, student's expertise, and context of the institution. Still, they provide various options for effective curriculum design involving RBL (Clark, 1997).

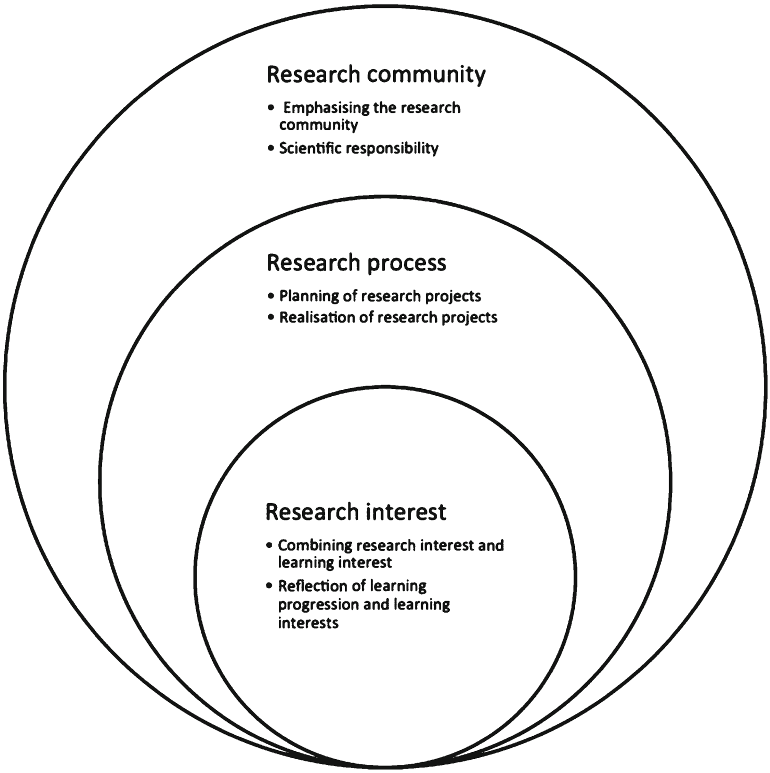

Fig. 5.2 Typology of research-based learning

5.2.2 Typology of RBL

RBL can be integrated into the curriculum in various ways. A typology of RBL identifies three major types (Ludwig, 2011): (1) research interest, (2) research process, and (3) research community (see Fig. 5.2). The first type of RBL focuses on *research interest* combining research interests and learning interests of students in order to identify research questions. Accordingly, students receive scaffolds for critically reflecting on their individual learning progression and learning interests (Ifenthaler, 2012b; Ifenthaler & Lehmann, 2012). The curriculum will be guided by the interest of students that is reflected in their research and learning interests. The second type of RBL focuses on the *research process* by expanding the research and learning interests to the planning and realisation of research projects. The third type of RBL is the most comprehensive by emphasising the *research community*. It includes not only the research interests, research problems, and research process, but rather it includes the scientific community into the research process. This may include philosophy of science, research methodologies, and individual research identity. Hence, the students are encouraged to build their own research identity and getting actively involved in the scientific network. This may lead to a critical reflection of the scientific fundamentals and acceptance of scientific responsibility (Huber, 2009).

5.3 Realising Research-Based Learning

This section explores a curriculum where a new approach to RBL was implemented in an undergraduate statistics module focussing on descriptive and inferential statistics. The implemented curriculum is based on the RBL approach (Baldwin, 2005; Blackmore & Fraser, 2007; Clark, 1997; Healey, 2005), however, it has been adapted to meet particular institutional needs and available technologies.

5.3.1 Setting

Descriptive and inferential statistics are relevant to students in educational science and is increasingly taught as part of the educational curriculum. However, courses focussing on statistics and mathematics are often disliked, and students tend to underperform in such courses compared to other courses (Freeman, Collier, Staniforth, & Smith, 2008; Windish, Huot, & Green, 2007). Additionally, students often do not see the link between the application of statistical procedures and their primary study interest which is the driver for enrolling in a university programme (Kossack & Ludwig, 2010).

The curriculum "Introduction to Quantitative Research Methods" including descriptive and inferential statistics at the University of Freiburg is taught over two semesters for undergraduate students enrolled in instructional design, educational science, and teacher education. Prior to implementing the RBL approach, the course was taught as a traditional 2-h lecture followed by a 2-h tutorial each week. The cohort was comprised of approximately 80–100 students with the majority studying in the instructional design programme. The lectures were delivered by a lecturer, and tutorial classes (comprising approximately 30 students each) were delivered by teaching assistants. Prior to the RBL approach, tutorials focussed on review of the lecture and preparation of the final exam. Table 5.2 shows the two-semester curriculum including lecture and tutorial topics.

Overall, evaluation of the lectures and tutorials showed that students complained about redundant content delivered in lectures and tutorials. Additionally, students were not able to apply the statistical procedures in their future studies. This was evident when students were asked to design a research study for their thesis. Still, they were trained well in calculating statistical procedures; however, the transfer to their own research projects and interpreting empirical studies reported in journal publications were insufficient. Therefore, the curriculum was redesigned and implemented in 2008 by applying a RBL approach by the first author of this chapter.

Table 5.2 Curriculum "introduction to quantitative research methods" before RBL approach

Semester and week	Lecture topic	Tutorial topic
1.01	Empirical educational research	Research database introduction
1.02	Construction of questionnaires part 1	Review of questionnaires
1.03	Construction of questionnaires part 2	Review of questionnaires
1.04	Frequencies part 1	Exercise
1.05	Frequencies part 2	Exercise
1.06	Types of average: mode, median, mean part 1	Exercise
1.07	Types of average: mode, median, mean part 2	Exercise
1.08	Measures of dispersion part 1	Exercise
1.09	Measures of dispersion part 2	Exercise
1.10	Contingency table part 1	Exercise
1.11	Contingency table part 2	Exercise
1.12	Correlations part 1	Exercise
1.13	Correlations part 2	Exercise
1.14	Mock exam	Written exam preparation
1.15	Written exam	–
1.16	Wrap-up session	–
2.01	Empirical educational research	Statistics software introduction
2.02	Hypotheses	Exercise
2.03	Chi-square test	Exercise
2.04	*t*-Test	Exercise
2.05	Analysis of variance	Exercise
2.06	Correlations part 1	Exercise
2.07	Correlations part 2	Exercise
2.08	Linear regression part 1	Exercise
2.09	Linear regression part 2	Exercise
2.10	Logics of statistical testing	Exercise
2.11	Objectivity	Exercise
2.12	Reliability	Exercise
2.13	Validity	Exercise
2.14	Mock exam	Written exam preparation
2.15	Written exam	–
2.16	Wrap-up session	–

5.3.2 RBL Curriculum Design and Realisation

In the light of the theoretical assumptions of RBL and results of previous course evaluations, the curriculum "Introduction to Quantitative Research Methods" was redesigned and implemented at the University of Freiburg in 2008. However, the increasing student numbers and limited capacity of teaching staff did not allow for dividing the student cohort of approximately 80–100 students into smaller groups. Accordingly, the lecture was kept as a central part of the curriculum. Figure 5.3 illustrates the constituents of the curriculum.

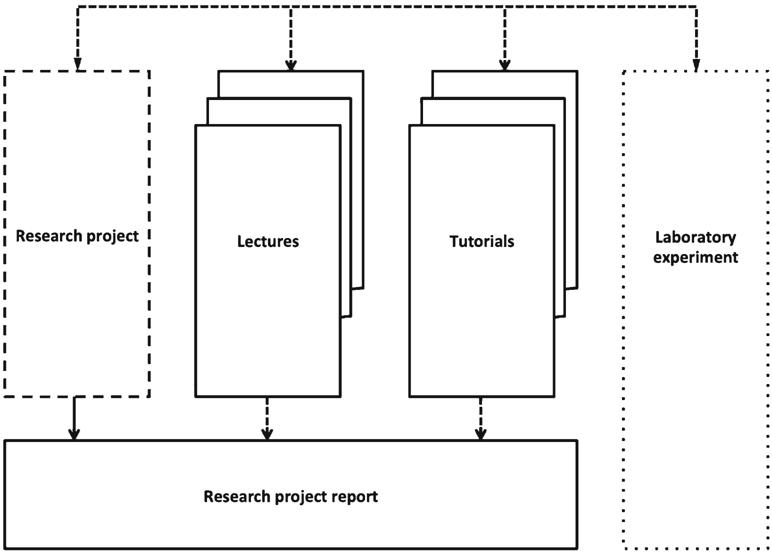

Fig. 5.3 Constituents of the RBL curriculum

The weekly 2-h *lecture* introduced a new topic each week of the semester and addressed open questions posted in the learning management system (LMS; Moodle) and issues raised in the tutorials and research project. Additionally, the lecture informed students about the laboratory experiment and the research project. Every 20 min, a student activity was included in the lecture in order to increase student engagement (Rocca, 2010). These activities were in line with the principles of RBL outlined in Table 5.1, e.g. formulation of research questions and hypotheses, reflection of applied research methods, comparison of historical research outcomes or calculation of statistical procedures. Results of these activities were discussed in student groups or reported and discussed further in the tutorials and the course LMS. Table 5.3 shows the lecture topics of the redesigned curriculum.

The weekly 2-h *tutorials* (comprising maximum 12 students each) were delivered by teaching assistants. The tutorials were held in the university's SMARTroom, i.e. a computer laboratory with high-level hard- and software technology (Blumschein, Ifenthaler, & Pirnay-Dummer, 2007). Open questions from the lecture were addressed, and additional reading materials were reflected in the tutorials. Additionally, statistical software applications were introduced, e.g. SPSS and r Statistics. Each tutorial offered students the opportunity to develop their expertise in areas of particular interest—so-called expertise areas. These expertise areas are reflected in the steps of the research process cycle (see Fig. 5.4). Accordingly, in each tutorial, at least three students developed their expertise in theory building and hypotheses formulation, three students focussed on research methodology, three students concentrated on data analysis, and three students focussed on reporting of research projects. The student experts took over a specific lead role in the research project.

Table 5.3 Curriculum "introduction to quantitative research methods" with RBL approach

Semester and week	Lecture topic	Tutorial topic	Research project focus
1.01	Philosophy of science	Research culture at university	Theoretical foundation
1.02	Logics of educational research	Values of scientific research	Theoretical foundation
1.03	Quantitative and qualitative research	Research management	Research methodology
1.04	Operationalisation	Construction of questionnaires	Research methodology
1.05	*Research project reflection*	*Research project reflection*	Research methodology
1.06	Measurement and scaling	Construction of questionnaires	Data collection
1.07	Frequencies	Using SPSS and r Statistics	Data collection
1.08	Types of average	Using SPSS and r Statistics	Data collection
1.09	Measures of dispersion	Using SPSS and r Statistics	Data analysis
1.10	Contingency tables	Using SPSS and r Statistics	Data analysis
1.11	Correlation analysis	Using SPSS and r Statistics	Data analysis
1.12	*Research project reflection*	*Research project reflection*	Data analysis
1.13	Research quality criteria	APA guidelines	Research publication
1.14	Mock exam	Written exam preparation	–
1.15	Written exam	–	–
1.16	*Research project poster session*	–	Research publication
2.01	Logics of inferential statistics	Research culture at university	Theoretical foundation
2.02	Probability	Ethics of scientific research	Theoretical foundation
2.03	Distributions	Experiments and quasi-experiments	Research methodology
2.04	Parametric and non-parametric statistics	Research quality criteria	Research methodology
2.05	*Research project reflection*	*Research project reflection*	Research methodology
2.06	Chi-square test	Application of research instruments	Data collection
2.07	Paired samples *t*-test	Using SPSS and r Statistics	Data collection
2.08	Independent *t*-test	Using SPSS and r Statistics	Data collection
2.09	Analysis of variance	Using SPSS and r Statistics	Data analysis
2.10	Post hoc analysis	Using SPSS and r Statistics	Data analysis
2.11	Effect size	Using SPSS and r Statistics	Data analysis
2.12	*Research project reflection*	*Research project reflection*	Data analysis
2.13	Regression analysis	APA guidelines	Research publication
2.14	Mock exam	Written exam preparation	–
2.15	Written exam	–	–
2.16	*Research project poster session*	–	Research publication

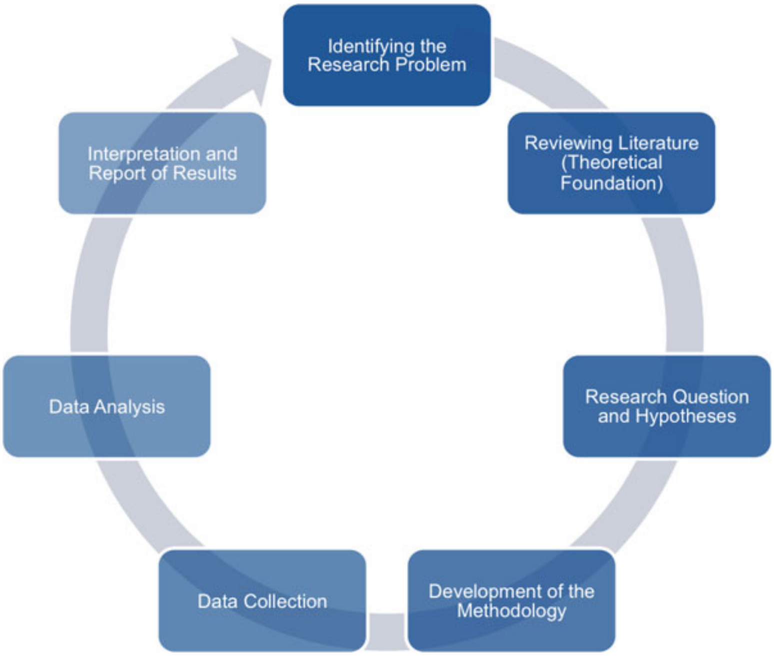

Fig. 5.4 Research process cycle

The *research project* was the driver of the overall course and was sequenced in order to follow the research process cycle (see Fig. 5.4). The lecturer introduced a current research problem (e.g. teacher's perception of school development) at the beginning of each semester, and students were asked to form small research groups (approximately four students per group). After a self-guided in-depth literature review, students were asked to identify research problems within the larger context of the research project (e.g. what factors hinder teachers from active participation in school development?). In a next step, students developed the research methodology including instruments and procedures. Depending on the status of the overall research project, instruments were provided by the lecturer or were developed as pilot instruments by the students. The lecturer and teaching assistants helped in organising the sample for the data collection (e.g., necessary permissions, make contact to stakeholders, provide infrastrucure). The data analysis was performed within groups in the tutorials, while problems and outcomes were addressed in the lectures to enable students to develop a broader understanding of the issues emerging across all the projects. As a final outcome of the course, students produced a research project report following scientific guidelines, e.g. APA (American Psychological Association, 2010).

The *laboratory experiments* introduced students to experimental research through active participation. Accordingly, students participated in a laboratory experiment during the initial weeks of the semester. Later, students were introduced to the research questions, hypotheses, design, materials, and procedure of the laboratory experiment. Hence, a critical reflection of the research was possible from different perspectives (participant and researcher).

Table 5.3 shows the redesigned two-semester curriculum including lecture and tutorial topics as well as research-based project activities. Web 2.0 technology was omnipresent in the overall curriculum design, e.g. LMS, discussion boards, file sharing, and groupware.

5.3.3 Course Evaluation

Over eight semesters, a total of 487 students enrolled in the course. Students were predominantly female (383 females, 104 males). 291 students (215 females, 76 males) volunteered to participate in the course evaluations. Their average age was 21.52 years ($SD=3.49$).

The *Heidelberg Inventory for Course Evaluation* (*HILVE*), a standardised questionnaire for the evaluation of courses, was administered at the end of each semester (Rindermann & Amelang, 1994). Overall, HILVE is a widely used instrument for course evaluation in German-speaking countries including high reliability, with Cronbach's alpha ranging from $r=0.74$ to $r=0.88$ (Rindermann & Amelang, 1994). Twelve items focussing on *interest* and *learning* in the course were answered on a four-point Likert scale (0 = totally disagree, 1 = disagree, 2 = agree, 3 = totally agree). The results of the subscales *interest* and *learning* are reported in this chapter. Additionally, the student performance was measured by the result of the written exam of each course. The analysis includes two courses before the redesign of the curriculum (DS 2007, IS 2008) and six courses with the redesigned curriculum including the RBL approach (DS 2008, IS 2009, DS 2009, IS 2010, DS 2010, IS 2011).

Student assessment was based on a written exam at the end of the semester and on a research project report. The written exam and research project report results (German grades, i.e. 5 = fail, 4 = sufficient, 3 = satisfactory, 2 = good, 1 = very good) indicate that the grades significantly changed over the eight semesters, $\chi(7)=135.92$, $p<0.001$. Figure 5.5 shows the progression of grades indicating that students performed significantly better in the redesigned curriculum. Interestingly, students also performed significantly better in their second course, i.e. the inferential statistics course (see Table 5.4).

Consistent with the improvements in the grades, students evaluated their learning and their interest in the course significantly higher after the redesign (see Fig. 5.6). Accordingly, students believed they learned more in courses with the RBL approach. Additionally, students reported a higher interest in courses with the RBL approach.

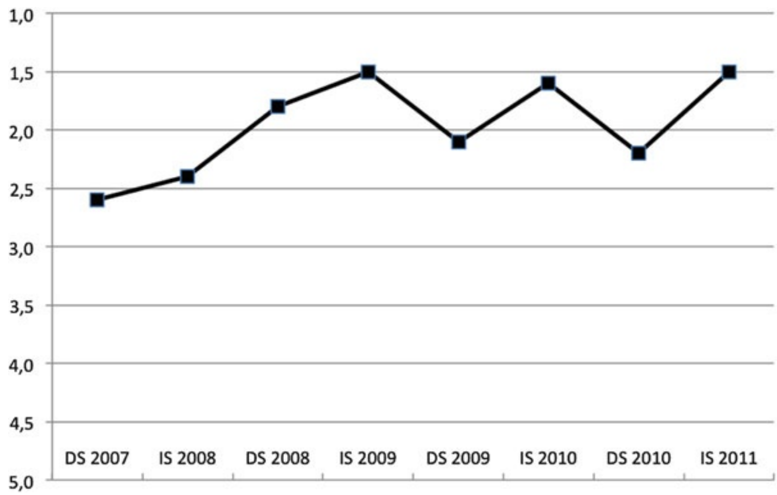

Fig. 5.5 Progression of written exam grades (DS = descriptive statistics, IS = inferential statistics)

Table 5.4 Test statistics of Wilcoxon test

Course comparison	*Z*	*p*
DS 2007—IS 2008	−1.000	0.317
IS 2008—DS 2008	−3.781	<0.001
DS 2008—IS 2009	−3.617	<0.001
IS 2009—DS 2009	−3.617	<0.001
DS 2009—IS 2010	−4.082	<0.001
IS 2010—DS 2010	−4.153	<0.001
DS 2010—IS 2011	−4.142	<0.001

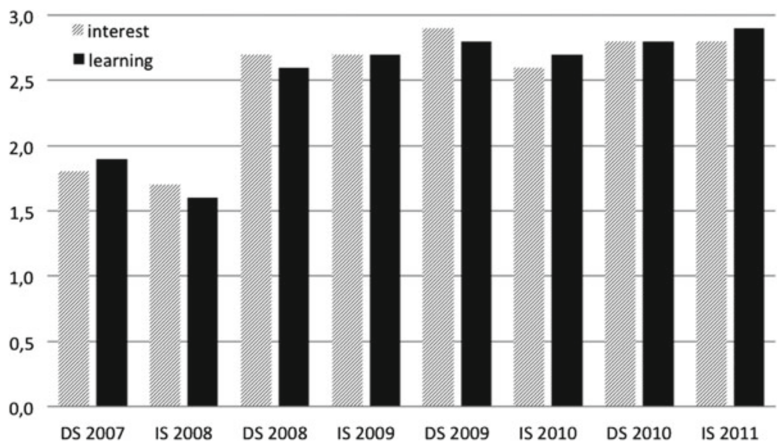

Fig. 5.6 Student evaluation of the courses focussing on interest and learning

5.4 Discussion

Requirements of a curriculum do of course need to correspond to the skill level of the learners (Pirnay-Dummer, Ifenthaler, & Seel, 2012) as their prior knowledge and experience will influence both their level of engagement and the outcomes attained. We know that as learners develop over time they are better able to interpret and organise the knowledge, make use of more complex strategies, contemplate a wider range of alternatives, and make better use of metacognitive skills (Ericsson & Lehmann, 1996; Ericsson & Smith, 1991; Ifenthaler, 2012b; Ifenthaler & Lehmann, 2012). Hence, a novice learner with low levels of knowledge and skills may just find out about some dependencies of the subject domain and come to an initial understanding of the overall complexity. A more experienced learner may be able to gain some theory-driven insight into parts of the subject domain, while a very well-trained expert may gain a system-analytical understanding of the subject domain using the available theories (Ifenthaler & Seel, 2011; Pirnay-Dummer et al., 2012).

To evaluate the success of students and set the expectations right from the beginning of the curriculum with differently skilled learners, the following general framework helps to identify levels of complexity (Pirnay-Dummer et al., 2012, p. 83; see Fig. 5.7).

Accordingly, when designing curriculum including the RBL approach, the student's prior knowledge and skills need to be taken into account. Students might only be able to paraphrase a specific research project. More advanced students might be

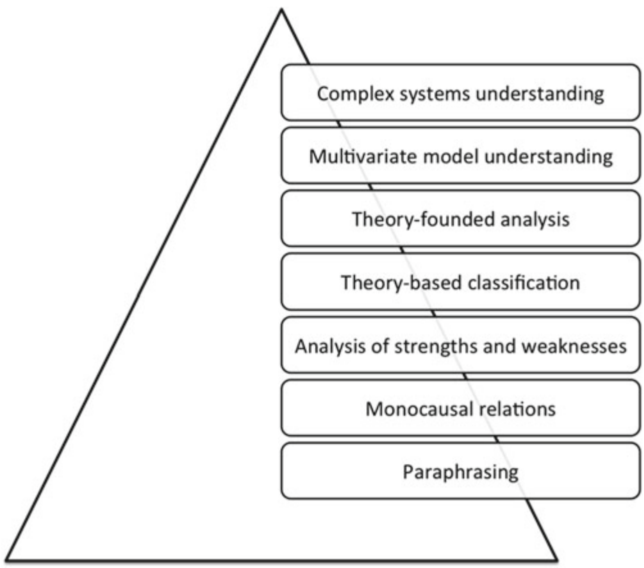

Fig. 5.7 Framework identifying levels of complexity

able to identify monocausal relations, e.g. learner motivation is linked to learner performance. At a next level, students reflect and are able to create pro-con lists or analysis of strengths and weaknesses. On the level of theory-based classifications, students are able to use their theoretical knowledge to create typical research. The theoretically grounded analysis improves on this level by turning the reasoning around: Instead of looking for fitting theories from the perspective of the research project, theories are consulted that explain in themselves what may be found in the research project. The next level combines the use of theories on a multivariate level. It involves understanding on the multiplicity of interactions between different parts of the research project. The last assessable level is a system understanding which includes the prior levels and adds an understanding about effects, delays of effects, cycles, and other between- or within-construct changes. Even experts do not always reach or need this level of understanding (Pirnay-Dummer et al., 2012).

Designing and creating successful curricula that scaffold the progression of students from novices to experts in a particular domain is not an easy task. Certainly this cannot be achieved in one semester with one unit of study as this can take up to 10 years of cumulative learning (Ericsson & Lehmann, 1996; Ericsson & Smith, 1991) A whole of programme approach is suggested to ensure students gain the necessary building blocks at the base of the learning pyramid to enable them to progress to higher levels of learning (Fig. 5.7).

One model that holds promise for guiding the progression towards expertise is the MAPLET Framework (Gosper, 2011; Ifenthaler & Gosper, under review). It is based on a three-phased approach to intellectual skill acquisition whereby the first phase is focussed on the development of foundational knowledge and skills. The second extends and refines knowledge and understanding through the development of increasingly complex schemas comprised of conceptual procedural and organisational knowledge. The final phase focuses on developing speed, accuracy, and transferability. Limited space precludes a detailed discussion of the phases; however, it should be noted that progression through the phases reflects the cognitive hierarchies typically represented by taxonomies of learning outcomes Bloom's Revised Taxonomy (Anderson et al., 2001) and the SOLO Taxonomy (Biggs, 2003). Furthermore the framework encapsulates the three principles identified by Bransford, Brown, and Cocking (2000) which are fundamental to placing students on a pathway towards expertise, namely, the learner through their prior knowledge and experience has the power to shape the learning that takes place; achieving competence involves the development of foundational knowledge, conceptual frameworks, and organisational structures that facilitate retrieval, application, and transfer; and metacognitive skills are necessary to enable the learner to define goals and monitor progress towards their achievement. If we are to produce graduates with critical and creative capability, then a careful mapping of the curriculum using tools such as MAPLET can assist in ensuring the necessary structures, and supports are in place to achieve this.

Web-based systems designed to optimise curricula are cropping up everywhere. The rapid pace of these technological developments makes it nearly impossible to integrate them into comprehensive systems (Ifenthaler, 2012a). Therefore, so-called personal learning systems (PLS) are being designed to enable students to select various Web applications individually to meet specific learning goals (Ifenthaler, 2010; Seel & Ifenthaler, 2009). The requirements and features for designing PLS for RBL and teaching are:

Portal: Rather than an isolated island, a PLS is an open portal to the Internet which is connected with various applications and collects and structures information from other sources. The content can be created by both learners and teachers/researchers using simple authoring tools.

Potential for integration: Information is offered in standard formats which learners can subscribe to and synchronise with their desktop applications. In this way, the learning environment is integrated into the user's daily working environment and connected to it.

Neutrality of tools: Tasks in the RBL environment are designed in such a way that the learners themselves can choose which application they wish to use to work on them. The portal can make recommendations and provide support. The media competence acquired in this manner can also be useful in research and everyday life.

Symbiosis: Instead of creating new spaces, a PLS uses existing resources. The portal works with existing free social networks, wikis, blogs, etc.

All in all, PLS require increased personal responsibility, both from the learner and from the researcher/teacher. At the same time, however, they offer more freedom for individual learning in RBL environments. Yet, no empirical studies are available which account for the efficiency of PLS for RBL and teaching. Hence, much research is needed in near future to investigate the strength and weaknesses of these newly designed curricula.

5.5 Conclusion

The RBL approach presented in this study is one way of combining research, scholarship, teaching, and learning in a holistic way. It has taken into account the needs and preference of the learner by enabling choice of projects and opportunities to choose the research skills they wish to pursue in more depth. The staged introduction of research skills in tutorials takes account of the cognitive complexities inherent in the research process. Importantly, the alignment of skill development with the natural progression of the research project enables students to directly relate theory to practice. Such an approach might help to leverage students' learning experiences in ways that will equip students with the capabilities that have been identified for working twenty-first century. Still, empirical evidence is needed to support the successfulness of curricula using the RBL approach.

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is a more flexible, learner-centric paradigm that, among other things, instills in individuals the habit of being self-directed lifelong learners. The proposed approach to addressing the changing needs of engineering education is based on mass customization. In this chapter, the development of this approach over the last decade is traced. Other foundational principles in this approach include focusing on competency-based learning rather than one-size-fits-all content delivery, shifting the role of the instructors to orchestrators of learning, shifting the role of students to active learners, shifting the focus from the lower cognitive levels of learning to the upper levels, creating learning communities, embedding flexibility in courses, leveraging diversity, making students aware of the learning process, scaffolding, and enabling students to make decisions where all information may not be available. In this chapter, an overview of the implementation of this approach in graduate-level engineering design courses is presented for courses offered in three different settings, (a) mass customization of content within a single course, (b) mass collaboration of students in distributed settings, and (c) jointly offered cross-institutional courses with distance learning students. The implementation details include technical themes for the different courses, the course architecture (activities and their interdependencies), the assignments, learning modules, team formation, end-of-semester deliverables, and self-assessment.

Keywords Personalized learning • Competency-based education • Mass customization • Design education • Learning organizations • Continuous learning • Active learning

6.1 Frame of Reference

The rapid progress of globalization has led to many unprecedented changes in the world in which students are educated and in which graduates will practice (Friedman, 2006). As Friedman puts it, "Globalization has collapsed time and distance and raised the notion that someone anywhere on earth can do your job more cheaply. Can Americans rise to the challenge on this leveled playing field?" In 2004, the National Academy of Engineering published a report summarizing visions of what the engineering profession might be like in the year 2020 (National Academy of Engineering, 2004). A follow-up report (National Academy of Engineering, 2005) on how to educate the engineer of 2020 was released a year later. The key message gleaned is that engineering education must be adapted to the challenges of globalization. Course and curriculum redesign must better address and constructively align "what" is to be learned and "why" those target outcomes are needed. Then, building on the "what" and "why", it should present clearly the "how" or strategies used to achieve them. We know that current engineering students will be tomorrow's engineering workforce and that they will have to face and address challenges and dilemmas that are very different from the problems and tasks they were exposed to as students. The nature of those challenges will require them to take on open-ended ill-defined problems and unforeseen issues, understand system-level challenges, and respond to them with innovations. If they have not experienced creative challenges that require innovative responses in their engineering classes, they will not be prepared to do so in their professional careers.

The "how" of developing this type of skills and expertise in analysis, evaluation, and creative production for unforeseen needs requires authentic experience in tasks that require students to exercise these skills. There are various ways to provide practice in creative problem-solving and innovation. One way to provide this experience is experiential learning. If designed well, experiential learning not only offers authentic opportunity but also supports self-determined motivation and regulation. Further, it can be structured to enable adaptive interaction among those with various types of expertise, sharing in a professional community, and experience building both competence and community. This involves balancing structure and autonomy, supporting both team and individual effort, and valuing error that leads to deeper learning and skill refinement. Related to these outcomes is the power of metacognition, reflection on task process and products, both during and after experiences. Metacognition is directly linked to the process skills of analysis and evaluation and, within a discipline, divides legitimately creative experts from those whose skills are limited to doing the same thing, albeit doing it well, over and over again (Ericsson, 2006).

Innovation and independent problem solving are marks of domain expertise in applied fields (Feltovich, Prietula, & Ericsson, 2006). Experts have defined innovation as, "A novel idea, put into practice that offers value to customers and/or society" (Fisher, Biviji, & Nair, 2011). Innovation is supported by both cognitive and affective/motivational factors which, in turn, are informed by learning theory and research (Ericsson, Charness, Feltovich, & Hoffman, 2009). Cognitive characteristics to support expertise development and innovation include depth of domain knowledge and skill, awareness of the situational factors that influence choices, and knowledge of adaptive task characteristics that may transfer to the current challenge (Ericsson, 2006). Motivational and affective characteristics that support expertise development and innovation include self-efficacy (Bandura, 1997), self-determination (Ryan & Deci, 2000), and self-regulation (Zimmerman, 2006). Together they comprise an integrative framework to investigate, understand, and promote innovation, learning to learn and learning to create.

In this chapter, the longitudinal development of a graduate-level engineering design course to encourage students to engage in higher levels of cognitive activities including analysis, synthesis, and evaluation is presented (Bloom, 1956).

6.2 Competencies and Meta-competencies for Twenty-First-Century Engineers

There are two levels of competencies in any professional field: field-specific task competencies and generalized skill sets or meta-competencies. The task-specific competencies are benchmarks for graduates in a given field (Allan & Chisholm, 2008; Earnest & Hills, 2005). The general meta-competencies are skill sets that enable graduates to function globally, e.g., working with others, producing complex systems, meeting organizational demands, and transferring task-specific skills to new challenges or tasks they have not encountered before (Radcliffe, 2005; Wulf & Fisher, 2002; Wulf & Fisher, 2002).

The competencies and meta-competencies required of a successful engineer today and tomorrow are different from those needed in earlier eras because the nature of innovation is changing. The raw production of ideas alone is no longer sufficient for accomplishing innovation. The problems that we are facing today are global and complex, where engineers need to manage dilemmas among economic, social, ecological, and intellectual capital (Ahmed, Xiao, Panchal, Allen, & Mistree, 2012; Bertus, Khosrojerdi, Panchal, Allen, & Mistree, 2012; Hawthorne, Sha, Panchal, & Mistree, 2012). The competencies required by twenty-first century engineers will have to support innovations that go beyond the current models which are often limited to economic considerations. Innovators of the future will need to be equipped with more than just skills in their specialties (Christensen & Raynor, 2003; Downey et al., 2006; Warnick, 2011).

In this chapter the focus is on the development of meta-competencies to support innovation and collaboration, with the understanding that technical competencies are prerequisite. A combined list of meta-competencies that need to be developed by future engineers to support innovation has been compiled by various educators and researchers (Allan & Chisholm, 2008; Radcliffe, 2005), and is the starting point for the work proposed here. It is summarized in Table 6.1.

In the context of an innovation economy, critical thinking provides the foundation for developing these competencies and meta-competencies. Levels of accomplishment of these competencies and meta-competencies are evaluated using Bloom's taxonomy of learning. While there are many other taxonomies of learning, Bloom's taxonomy (Bloom, 1956) has been chosen as a framework within which to orchestrate student's learning, because, based on experience, engineering students find it easy to understand. Bloom identified six levels of learning within the cognitive domain; these six levels are (1) knowledge, (2) comprehension, (3) application, (4) analysis, (5) synthesis, and (6) evaluation. They can be used to define curriculum objectives prescribing the level that a student should attain. In addition, Bloom's taxonomy provides a powerful means to assess students' performance, justify associated grades, and provide students feedback as to how to improve their performance. The focus of the course is to offer students the opportunity to learn skills related to the higher levels of Bloom's taxonomy—analysis, synthesis, and evaluation.

Table 6.1 Meta-competencies required of twenty-first-century engineers that support innovation

Ability to manage information
- Ability to gather, interpret, validate, and use information
- Understand and use quantitative and qualitative information
- Discard useless information

Ability to manage thinking
- Identify and manage dilemmas associated with the realization of complex, sustainable, societal-technological-economic systems
- Ability to think across disciplines
- Holistic thinking
- Conceptual thinking
- Think in a local and global context
- Ability to speculate and to identify research topics worthy of investigation
- Ability to use both divergent and convergent thinking
- Ability to engage in critical discussion
- Ability to identify opportunities for developing breakthrough products, services, or systems
- Ability to think strategically by using both theory and methods

Ability to manage collaboration
- Ability to manage the collaboration process in local and global setting
- Ability to create new knowledge collaboratively in a diverse team
- Competence in negotiation
- Teamwork competence
- Ability to manage learning
- Ability to identify the competencies and meta-competencies needed to create value in a culturally diverse, distributed engineering world
- Ability to self-instruct and self-monitor
- Ability to interact with multiple modes of learning

Ability to manage attitude
- Ability to self-motivate
- Ability to cope with chaos
- Ability to identify and acknowledge mistakes and unproductive paths
- Ability to assess and manage risk taking

6.3 An Educational Approach to Support Innovation in an Interconnected World

The approach to support innovation in an interconnected world is to create personalized learning environments within classrooms where each individual can focus on different competencies while working in a group. The concepts of mass customization from the product design domain have been incorporated into the domain of engineering education. In the product development domain, mass customization refers to the ability *to customize products quickly for individual customers or for niche markets at a cost*, *efficiency, and speed close to those of mass production*, *relying on limited forecasts and inventory* (Pine, 1992). In a world in which change is the order of the day, it no longer makes sense to offer a one-size-fits-all education (Bransford, Brown, & Cocking, 1999; Gibbs, 1981; Halperin, 1994; Rugarcia, Felder, Woods, & Stice, 2000). The competencies required in the workforce of the near tomorrow vary significantly from one individual to another.

Table 6.2 Differences between this approach and traditional approaches to engineering education

Traditional concepts in engineering education	Foundations of our approach
Instructors deliver course content	Shift from instructor to an orchestrator who creates opportunities to learn
Students are passive learners	Students are active learners, i.e., take charge of their own learning
Learning goals are fixed by the instructor	Learning goals are defined by the students in collaboration with the orchestrator
Focus on lower levels of learning	Focus on higher levels of learning
Individual learning	Learning communities
Rigid course structure	Embed flexibility in the course including multiple opportunities for learning from various experiences
Ignore diversity	Leverage diversity
Learning process unclear to the students	Make students aware of the learning process and scaffold student learning

The emphasis is to encourage students to take charge of their education. Students develop competencies by using a method which fosters "learning how to learn." In Table 6.2, the fundamental differences between the course discussed in this chapter and traditional courses found in many engineering programs are shown.

6.3.1 Foundations of the Approach

In order to accomplish the changes discussed in Table 6.2, the foundational principles in our approach include shifting the role of the instructors to orchestrators of learning, shifting the role of students to active learners, providing opportunities to learn, creating learning communities, embedding flexibility in courses, leveraging diversity, making students aware of the learning process, scaffolding, enabling students to make decisions where all information may not be available, and shifting the focus from the lower levels to the upper levels of learning as described by Bloom's taxonomy. Our techniques to scaffold the learning activities in a distributed classroom are based on systems thinking, personal mastery, mental models, a shared vision, and team learning (Hawthorne et al., 2012; Siddique, Panchal, Schaefer, Allen, & Mistree, 2012):

Shift in the role of the instructor: Shifting the role of the instructor to become an orchestrator of learning who creates opportunities for students to learn (both individually and collectively).

Shift in the role of students: The students become active learners and play a significant role in the learning process. They define their own learning goals (in consultation with the orchestrators) and are responsible for directing their efforts to achieve their goals. Students are also presented with a variety of decision-making methods and tools, and students are given opportunities to make decisions and evaluate the consequences.

Shift the focus from the lower levels to the upper levels of learning: Traditionally, the focus has been on the knowledge of core concepts and their application to technical systems, namely, competencies. The focus here is on higher-level learning such as the gaining the abilities to analyze, synthesize, and to evaluate.

Embed flexibility in the course: Flexibility is embedded in the course by having guest lectures on diverse topics, by asking the students to define their own goals, and letting the students adapt various parts of the course to suit their learning needs. This includes adding discussion sessions, self-study time, virtual collaboration, providing the opportunity to create new knowledge with a collaborative group project, reflective practice, and self- and peer evaluation.

Leverage diversity: One of the approaches for leveraging diversity is to share students' unique work with the rest of the class. This is achieved by identifying, distributing, and discussing "best practice" submissions, those outstanding submissions from other students which can be used as exemplars. This enables collective learning; students learn from and about each other, get inspired and build on the work of others to generate new knowledge.

Create learning communities: An underlying principle for achieving successful mass customization in engineering education is "sharing to gain," which is achieved by fostering learning communities (Senge, 1990). The paradigm of a learning organization has proven to be an effective mean of helping students to understand how to develop learning communities. According to Senge (1990), a learning organization is "an organization that facilitates the learning of all its members and consciously transforms itself and its context." A learning organization exhibits five main characteristics: (1) systems thinking, (2) personal mastery, (3) mental models, (4) a shared vision, and (5) team learning. The paradigm of the learning organization (LO) was initially developed for companies, based on the business models and practices of the 1990s. To extend the concept of learning organization to educational settings, we analyze the original model of the LO and augment it to better fit the learning needs of the students and the characteristics of the globalized world.

Make students aware of the learning process: In this approach, the students are made aware of the learning process so that they can understand the role of each activity that they undertake and the relationship of these activities to their learning. Scaffolding is provided to help students achieve their individual and collective goals and help them understand more about the learning process. This scaffolding is accomplished using the observe-reflect-articulate (ORA) construct (Williams & Mistree, 2006). *Observation* involves absorbing information and ideas from a variety of sources. *Reflection* involves using the background knowledge and prior experiences to generate new ideas and connections. Finally, the *articulation* step involves documenting observations and reflections and explaining new conclusions and lessons learned. Through the use of this construct, students become conscious of their learning and are empowered to provide customization at their own level and further, the professors gain a better understanding of individual students

Table 6.3 Constructs to facilitate development of meta-competencies identified in Table 6.1

Ability to manage information

- The observe-reflect-articulate paradigm is given to the students with a series of tools for managing qualitative information and decision-making strategies
- A smorgasbord of information is available—the students must select that which is of value to them. They are continually advised to focus on relevant information

Ability to manage thinking

- Concept generation techniques and strategies for evaluation are presented
- Early in the course, the focus is on understanding the current state of the literature. Students are given an assignment on thoughtful reading and evaluation and are presented a discussion on identifying a "gap" that may be filled by research
- Students are presented with the observe-reflect-articulate construct
- Multiple opportunities are presented for critical discussion during the lectures
- Ability to think strategically by using both theory and methods

Ability to manage collaboration

- As the teams are formed, students are invited to develop a team contract which acquaints all members of the team with the individual strengths and desired learning outcomes
- Lectures are presented about the structure of learning organization

Ability to manage learning

- At the end of each lecture, students are asked to evaluate what they have learned as a result of that lecture. Further they are asked for "learning essays." In these learning essays, students are asked to evaluate what they have learned and to compare this with their learning objectives (Mistree, Panchal, & Schaefer, 2012)

Ability to manage attitude

- A great deal of information is presented relatively quickly to the students. Initially it seems like chaos and students have to cope with it

Systems thinking is achieved by posing a high-level question for the students which is to be addressed by scaffolding activities and assignments throughout the semester. The question is the question for the semester (Q4S). Team learning and shared vision are achieved through the process of collectively completing the assignments and answering the Q4S.

In Table 6.3 a summary of the constructs used to help students learn how to attain the meta-competencies presented in Table 6.1 is presented. In the following section, a typical pattern of assignments used in implementing the course is given. These assignments offer students the opportunity of working both individually and in collaborative groups of different sizes, both face to face and in a distributed environment.

6.3.2 Implementation of the Approach

Over the last decade, the generic architecture of the semester-long courses has evolved. It is designed to provide personalized learning experiences in a group setting. The key components of this architecture are as follows:

Question for the semester is a common thread to tie the components of the course together.
Assignment 0 helps students identify learning goals and meta-competencies.
Learning essays and *feedback* to provide both personalized guidance to individual students and group feedback.
Best practices enable collective learning by providing exemplars of high-quality student work.
Assignment A0-end of the semester (*A0-EOS*) for reflection and self-assessment.

The relationships between these components are discussed in the following sections and summarized in Table 6.3.

6.3.2.1 The Question for the Semester

The question for the semester is used to align the efforts of all the students while providing enough flexibility to the students to explore the topics that are particularly interesting to them. The question for the semester is presented during the first lecture. Every student must answer this question individually by the end of the semester. In consultation with the orchestrators, the students are allowed to particularize this question according to their personal semester goals.

6.3.2.2 Assignment 0

The first step is to let the students identify their personal goals for the semester. This is achieved in Assignment 0, which is given during the first class. In this assignment, the students' task is to identify the goals that they want to achieve. These goals specify the learning objectives and competencies that each student wants to achieve during the semester. Competencies are achieved by integrative learning experiences in which skills, abilities, and knowledge interact to form bundles that have currency in relation to the task for which they are assembled (National Postsecondary Education Cooperative, 2002). Learning objectives are generic skills that students wish to accomplish and are expressed in terms of the six levels of learning defined in Bloom's taxonomy.

6.3.2.3 Learning Essays

Learning essays are weekly submissions in which the students usually review and explore topics from the lectures in the context of their personal semester goals. To guide the students, at the end of each lecture, specific guiding questions are offered to help them to better relate the lecture content to the big picture of the course. The students also have the freedom to choose other course-related themes for their learning essays. A core aspect of the learning essays is that the students learn how to create new knowledge and enhance their critical thinking skills. Furthermore students learn how to evaluate their work and document their progress towards their personal goals from Assignment 0. The structure of a learning essay involves observation-reflection-articulation.

The students are then requested to evaluate the value of the new knowledge gained by considering the utility of this knowledge in attaining their individual learning objectives in relation to the time invested. At the end of the semester, the students reflect on their learning in the Semester Learning Essay. Here, the students can show their progression in achieving their personal semester goals outlined in Assignment 0.

6.3.2.4 Individual and Group Feedback

No grades are given until the end of the semester. Hence, the students concentrate only on their progress towards achieving their personal semester goals. To ensure that the students are and remain on the right track, the orchestrators facilitate self-assessment and provide regular feedback to the individual and the group through formative assessment of all submissions throughout the semester.

6.3.2.5 Project: Answering the Question for the Semester

The project is an avenue for collaborative learning experience; typically it is done in groups of two to four students. All students answer the same question for the semester, although there is considerable flexibility and their answers may differ substantially. In the project, the students are expected to validate a part of their answer to the Q4S. Validation is an important aspect of the course because it helps students to learn how to critically evaluate their proposed answer to the Q4S. This relates to the highest level in the Bloom's taxonomy and increases the depth of learning through group learning and discussions.

Learning essays and assignments that have the potential to add value to the learning of others become "best practices" and are shared with the entire class. Often "best practices" from former students of the course are also discussed in class or presented on the course website. This aspect of the presented approach enables collective learning; students learn from and about each other, get inspired and can build on the work of others to develop new knowledge. A positive side effect is also an additional incentive to become author of a "best practice" and the experience that an individual's work is taken seriously by others.

6.3.2.6 A0-End of the Semester (A0-EOS) and Self-Grading

At the end of the semester, students are called on to evaluate what each individual has learned—to what extent has each person achieved the competencies and the

Table 6.4 Tools of mass customization used to implement this approach (Mistree et al., 2012)

Traditional challenges in engineering education	Foundations of the approach	Tools used in the course
Instructor delivers course content	Shift from instructor to an orchestrator who creates opportunities to learn	Assignment 0, question for the semester, learning essays, project
Students are passive learners	Students are active learners, i.e., take charge of their own learning	Assignment 0, question for the semester, learning essays, project
Learning goals are fixed by the instructor	Learning goals are defined by the students in collaboration with the orchestrator	Assignment 0
Focus on lower levels of learning	Focus on higher levels of learning	Bloom's taxonomy
Individual learning	Learning communities	Learning organizations
Rigid course structure	Embed flexibility in the course	Assignment 0, core and optional modules, ability to adapt the learning tools
Ignore diversity	Leverage diversity	Best practices, collective learning
Learning process unclear to students	Making students aware of the learning process	Observe-reflect-articulate construct Question for the semester (Q4S)

associated learning objectives proposed in A0 and refined through the semester. The students revisit their submissions, reflect on the feedback and take stock of how much each of the learning activities throughout the semester have actually helped them to meet the corresponding learning objectives. To what level of Bloom's taxonomy have they managed to climb and to what degree have they learned how to learn? In addition to revisiting the questions of A0, the students are called on to reflect on their learning process. Based upon this self-reflection, the students are asked to propose a grading scheme for evaluating their own work as well as that of their peers. This includes developing a comprehensive assessment rubric showing the categories of work to be assessed along with justifications for the various degrees of achievement, as well as the articulation of the specific grades they believe they have earned.

A summary of the way the tools of mass customization are used to implement our approach is presented in Table 6.4.

6.4 Implementation of the Approach in Different Settings

During the past decade, these foundations and techniques have been used in a number of graduate-level engineering design courses (Mistree et al., 2012; Schaefer, Panchal, Thames, Haroon, & Mistree, 2012; Williams & Mistree, 2006); typically these courses were taught to 10–25 graduate engineering students. Although most students were students of mechanical engineering, also biomedical engineers, business majors, and civil engineers have found this a useful course. In this section an overview of the implementation of the course in three settings is presented: (a) mass customization of content within a single course, (b) mass collaboration of students in distributed settings, and (c) courses jointly offered across universities with distance learning students. ME6102: *Designing Open Engineering Systems* was offered at Georgia Institute of Technology and is an example of mass customization of content within a single course. This course is further described by Williams and Mistree (2006). This course provides a baseline model on which to explore the use of technology in collaborative design.

While answering the question for the semester, the students work in a mass-collaborative manner which gives them the opportunity to create new knowledge by combining the diverse knowledge from the personalized section of the course. The key for providing personalized learning experience in a group setting is an intensive two-way communication between students and the orchestrators and also among students.

6.4.1 Technology Enhances Mass Collaboration of Students in Distributed Settings

The approach has been extended using emerging methods for collaboration. In Rippel, Schaefer, Mistree, and Panchal (2009), an implementation of the approach to create a mass-collaborative learning environment between students within the classroom and distance learning students through the use of Web 2.0 technologies is presented. Web 2.0 presents a significant potential to support the mass customization paradigm of education. It offers users and providers a platform to gather, share, and enrich knowledge. It promotes the transformation of learning experiences into personally usable, practical knowledge and helps learners to present results of this transformation to others. Web 2.0 applications support the ubiquity of communication and knowledge production, qualities that are essential for globally distributed education for the twenty-first century (Harkins & Moravec, 2008). Well-known examples of Web 2.0 technologies that can be used to generate and distribute knowledge include wikis, repositories, blogs, social networking tools, shared workspaces, and podcasts.

This approach is presented in the context of a graduate-level course ME 6102—Designing Open Engineering Systems offered by the authors at Georgia Institute of Technology in 2008. ME6102 was taken by students at different Georgia Tech campuses—Atlanta, Savannah, and Lorraine (France)— and also by distance learning students who were located all over the world. The course was orchestrated by a team of two faculty members, one located in Atlanta and the other faculty member in Savannah. Each lecture was given by one of the faculty members—either in Atlanta or Savannah. To reach all students, synchronous and asynchronous education techniques were incorporated. Atlanta- and Savannah-based students attended the in-class lectures via videoconferencing; if the lecture was given in Atlanta, the students in Savannah connected through a videoconference technology and vice versa. The lectures were recorded and uploaded to an online content management system so that all students could access them online at any time. Besides in-class interactions, the students were encouraged to communicate with the course orchestrators via e-mail, telephone, videoconference, or on an online forum on the course website which also enabled communication analogous to social networking websites such as Facebook and LinkedIn.

The question for the semester assigned to the students in spring semester 2008 was:

Imagine that you are operating a product creation enterprise in the era of Globalization 3.0 (Friedman, 2006). Your task is to define your company and develop a business plan. This includes answering the following key questions:

- How do you envision the world of 2020 in such an environment?
- How do you see yourself and your company operating in this world of 2020? Please take into account your engineering expertise and your passions.
- What are the *competencies* that you would require to be successful in such an environment? Please identify the drivers and metrics for success.
- What would your strategy for product development be in the world of 2020? What kind of products/processes do you plan to offer? How would you structure your design and manufacturing process? What kind of collaborations with other companies do you envision? What kind of supply chains do you envision your company to be involved in? How would you utilize the intellectual capital available throughout the world?
- What would the IT framework for collaborative product realization in 2020 look like?
- What kind of a product realization method is necessary for your world of 2020? Please provide phases and steps.

The answer to the Q4S was developed collaboratively by all students by combining and refining their individual answers. Without a collaborative part, earlier efforts on infusing mass customization in courses such as the one presented in (Williams & Mistree, 2006) resulted in a set of diverse work from the students. A wiki-style homepage was provided for the students to work together on the collaborative answer to the Q4S. All were encouraged to contribute with their individual competencies and knowledge to generate a detailed and comprehensive answer to the Q4S. In this exercise, the students had the opportunity to learn several things. First, they learned from each other's knowledge. Second, they learned with each other by collaborating on the overall fit and consistency of the document. Third, they learned about mass collaboration; they have the chance to experience the opportunities and the challenges of mass collaboration. Although students have the possibility to learn from the work of others, they are responsible for their own learning and contribution.

Students also worked on their personal semester goals and concentrated on different topics. However, the integration of diverse expertise was missing. The diversity of the knowledge created in the customized part of the course was not used for collective learning. In order to innovate and to create breakthrough designs, future engineers must take one further step and analyze a variety of results in order to synthesize them and thus derive new knowledge.

The implementation was further updated in 2009 by asking the students to identify and analyze existing Web 2.0 technologies with regard to their appropriateness for professional mass-collaborative work. In an assignment, the students were to look into mass collaboration for product development. This included an analysis with regard to the following phases: (1) idea generation, (2) idea screening, (3) concept development and testing, (4) business analysis, (5) beta testing and market testing, (6) technical implementation, and (7) commercialization. The students were asked to think about using mass collaboration in virtual product realization environments and the utilization of simulation-based design and they were also asked to collaboratively write a complete book in which each chapter was dedicated to one of the assignments. The difficult task here was to tie everything together to create a coherent train of thought. Technological advances in the future could focus on tools that help collaborators develop a single coherent product built on extensive diverse input.

6.4.2 Courses Jointly Offered Across Universities with Distance Learning Students

During fall 2011, the preceding methods were used in a graduate-level course jointly offered at the University of Oklahoma, Norman, and Washington State University, Pullman. The details of the course, AME5740 *Designing for Open Innovation*/ ME503 *Systems Design Approaches for Sustainability*, are presented by Hawthorne and coauthors (Hawthorne et al., 2012; Siddique et al., 2012). The Q4S was a two-part question and was stated as follows:

Bridging fuels: What are the technology, policy, and communication dilemmas associated with utilizing natural gas as bridging fuel for the next 25 years, while minimizing the adverse impact on quality of life?

Policies for distributed generation technologies: What are the technology, policy, and communication dilemmas associated with implementing the feed-in-tariff (FIT) policy while maximizing the adoption of distributed generation technologies? (Couture, Cory, Kreycik, & Williams, 2010)

6.4.2.1 Scaffolding the Team Using Individual, Group, and Team Assignments

The uniqueness of this course was the collaborative structure in which students worked in group settings in order to answer the Q4S. This class contained four assignments in addition to the Assignment 0. These assignments built on one another and integrated the collective approach of this course. Each assignment had an element that was designed to help answer the question for the semester. Although Assignment 0 and Assignment 1 were completed individually, these assignments ensured that students had determined what competencies and learning objectives they wished to develop individually. Assignment 2 introduced the concept of collaborative learning by having students form groups within each university to complete this assignment. Assignment 3 was unique because it started as an individual assignment and then had students combine this assignment in their university groups which were already formed. Based on the submissions of this combined work, groups were paired with groups from the opposing university. Each AME5740/ME503 team then had the task of combining the two groups' assignments before submission. After submitting Assignment 3, the AME5740/ME503 teams were to work collaboratively on Assignment 4. This allowed each member to give their input directly as opposed to the scaffolding technique introduced in Assignment 3. To ensure that each member of the group contributed equally, group contracts were introduced. The assignments were as follows:

Assignment 0—Self-evaluation: The first step was to let the students identify their personal goals for the semester, as discussed in Sect. 6.3.2.

Assignment 1—Define the world of 2030 through deep reading, *ORA, and critical thinking*: This assignment was completed individually. In this assignment, the students were asked to deep read and critically evaluate two articles from Friedman (2005, 2008). Some of the questions that the students were asked to answer after reading the articles were the following: (1) What are the key issues facing the world of 2030 as highlighted by the author? (2) How are these issues related to the three aspects of sustainability (social, economic, and environmental)? (3) What are the interdependencies between the issues identified by the author? and (4) What are the relationships between globalization and the issues identified above? The students were also asked to take a first step towards identifying the dilemmas associated with energy policy. The expected outcomes of this assignment were (1) having the students focus on a vision for the engineering world of 2030 and (2) having them focus on a vision of the energy infrastructure in the world of 2030 and (3) refined student competencies and learning objectives in the context of the world of 2030.

Assignment 2—Collaborative and collective learning: This assignment was completed collaboratively within the students' own universities and had two primary objectives: The first objective was to experience using a virtual environment to collaborate in a globalized mass-collaborative environment. The second objective was to gain an understanding of the efficacy and limitations inherent in Senge's learning organization, Sect. 6.3.1. As a part of the team vision, the students are asked to identify (1) the goals they would like to achieve as a team, (2) the tasks that the team needs to carry out, and (3) the assignment of responsibilities for completing the tasks. At the end of this assignment, the students develop a team contract that outlines the tasks, responsibilities, and overall team outcomes.

Assignment 3—Dilemmas in energy policy design: This assignment had three parts: First, the assignment was completed individually. Second, the assignment was compiled together in groups formed within each university. Lastly, the assignment was compiled collaboratively from groups at both universities. The objective in this assignment was to understand how to analyze the impacts of different energy policies from a sustainability standpoint (engineering, environmental, economic, and social objectives). The outcomes of this assignment included the following: (1) an understating of the different types of policy tools used for increasing the adoption of renewable energy technologies; (2) an appreciation of the scope, benefits, and challenges associated with designing energy policy; and (3) an understanding of the dilemmas associated with the analysis of FIT policy and energy policy in general. This assignment also helped the students understand the benefits and disadvantages of collaboration.

Assignment 4—Dilemmas in bridging fuels: This assignment was completed collaboratively with groups from both universities. The objective was to understand how to determine the suitability of bridging fuels from a sustainability standpoint (engineering, environmental, economic, and social objectives). The outcomes of this assignment included (1) an understating of the requirements and dilemmas associated with the choice of the bridging fuels and (2) an understanding of the suitability of natural gas and/or other fuels as sustainable bridging fuels.

6.4.2.2 End-of-Semester Deliverables

At the end of the semester there were three deliverables that each student had to submit to the instructors. These included the answer to the Q4S and the Assignment 0-End of Semester (EOS).

Answer to the Question for the Semester: Assignments 3 and 4 were completed collectively with AME5740/ME503 teams. The compilation of these two assignments was used to answer the Q4S. This required AME5740/ME503 teams to work together one last time in order to combine these documents and make a final submission of their work.

Assignment 0-End of Semester (EOS): At the end of the semester, the students were required to revisit their submissions, reflect on the feedback provided, and take stock of how much each of the learning activities throughout the semester had actually helped them to attain the desired competencies and meet the corresponding learning objectives. To what level of Bloom's taxonomy had they managed to climb and to what degree have they learned how to learn? This process of reflective practice is presented to the students by means of A0-EOS, an extended end-of-semester version of the original Assignment 0. A fragment of the A0-EOS is presented in Table 6.5.

Following the A0-EOS, the students reflected on their learning process, the quality of their contributions to the various assignments, the value gained with respect to attaining their individual learning objectives and competencies, and the value added to the learning organization. Finally, based upon this self-reflection, the students were asked to grade themselves.

Table 6.5 Fragment of Assignment 0—end of semester (A0-EOS) (Mistree et al., 2012)

Assignment 0—end of semester
A0 completion—individual
10. Revisit value = utility/time invested
Summarize …
Assignment 1: Summarize Part VI
Assignment 2: Summarize Part IV
Assignments 3 through 6: Summarize Part III
11. In tabular form, in the context of a learning organization, outline the strategy that you followed in defining your "mental model" for Assignments 2 through 6 and your contributions to the collaborative assignment
12. In tabular form, summarize your contributions to Assignments 2 through 6 under the following headings:
a. Themes/ideas proposed by *you* and adopted by the team
b. Themes/ideas proposed by *others* that were adopted by the team
c. Rate the contribution of others[1]: AA, above average; A, average; BA, below average. You are encouraged to use + and − for the grades you assign. Justify
d. In the context of 12c, rate your own contribution: AA, above average; A, average; BA, below average. Justify
13. In tabular form, please convey how you progressed in attaining your competencies and learning objectives throughout the semester
14. In graphical format, please convey the degree to which you attained the identified competencies and learning objectives
15. Analyze what you have written in Steps 10 through 14. Then, critically evaluate your performance (in terms of competencies and learning objectives) throughout the semester; be sure to use action words from Bloom's taxonomy. Comment on the level of attainment in Step 14, what you would do differently if you had to do it over, and plans for the future
Grade for A0 end of semester
16. Reflect on your performance in this class throughout the semester. In tabular form, please suggest a grade for yourself in the following categories and justify[2]:
a. Contribution to the collective question for the semester. Justify
b. Degree to which you attained your competencies and learning objectives and why
c. Degree to which you learned what you would do differently and why
17. Overall grade you award yourself for this submission. Not all items are equally important to determine your grade for the course. You may weight items 16a through 16c as shown below
• 16a–30 to 50 %
• 16b–30 to 50 %
• 16c–10 to 20 %

[1] A(4.3). A(4.0). A(3.7). B(3.3). B(3.0). B(2.7). C(2.3). C(2.0). C(1.7). D(1.0). F(0)
[2] Be sure to reference elements of your responses to items 10 through 15

6.5 Closing Comments

A number of insights were gained by the instructors as a result of offering this course. The key is to foster learning how to learn (see Hawthorne et al., 2012; Siddique et al., 2012). As a result of offering this course, the instructors realized that two of the core competencies required for success in a dynamically changing workplace are the competencies to first identify and then to manage dilemmas (see Ahmed et al., 2012; Bertus et al., 2012). The instructors found that instead of completely free-form collaboration between students across different universities, it is better to scaffold the team formation using principles from the learning organization. By letting the students define their own learning goals first, and then abstracting group level goals, the students are able to relate what they want to achieve with what other students in the group want to achieve. This ensures that the students are motivated to achieve the group objectives while making progress towards their individual goals. This also helps in task allocation. The use of Bloom's taxonomy for formulating learning objectives is found to be particularly effective rather than letting the students define objectives in free form. Based on the instructors' experience, if the students are not given any structure for learning objectives, they tend to formulate objectives that are task oriented, as opposed to learning oriented.

Although this approach has many advantages over traditional courses, instructors should be aware that most students are unfamiliar with such a pedagogical approach. Most students are used to traditional content-focused courses where the lectures are meant to deliver technical information. Focusing more on the process can be a difficult challenge. There is potential for some students, particularly those who have just started a graduate program, to get discouraged when they find the instructors posing higher-level questions such as a question for the semester, rather than providing specific answers directly. Hence, instructors need to provide continuous encouragement to the students to think differently. It is important for instructors to repeatedly emphasize the importance of the process, in addition to the technical content.

Based on the instructors' experience, one of the most difficult tasks is self-grading. Most of the students who take the class are used to following evaluation schemes provided by their instructors. However, in this class students are asked to develop their own evaluation rubrics based on their personal learning objectives and competencies.

There were a number of recurring themes in the students' feedback. For example, by taking the course, the students became conscious of the process of learning and realized the importance of setting learning objectives. The students learned the value of being able to see the broader view of globalization and the importance of being able to speculate the future. They also gained the understanding that complex systems do not have optimum solutions, but are often associated with dilemmas that need to be managed. The students realized the importance of being able to identify and filter information from diverse sources that are currently available on the Internet and gained some experience with it. Finally, the students were able to identify challenges associated with collaboration among individuals with different goals especially when collaboration was across multiple sites.

Engineering students in the twenty-first century should be able to receive degrees that are tailored to their personal needs and the professional career path they wish to pursue, whether it is in industry, entrepreneurship, or academia. This necessitates the adoption of both the appropriate technology and a game-changing pedagogy—one that embodies competency-based engineering education anchored in the mass customization of the engineering curriculum!

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Chapter 7
Creating Curriculum Within the Context of an Enterprise

Ana-Paula Correia

Abstract Curricula of the twenty first century promote the development of critical skills, content knowledge, expertise, and literacies for the twenty-one-century learner. Creativity, critical thinking, problem solving, communication and collaboration, initiative and self-direction, social and cross-cultural skills, and leadership and responsibility are among the most critical elements a contemporary curriculum should embrace. This chapter provides insights on how to create and sustain an enterprise-based curriculum as an alternative curricular model for educating the twenty-one-century instructional designer. Alternative teaching approaches to instructional design and the experiential learning framework are discussed, as well as the rise of entrepreneurism in education. The chapter concludes with a comprehensive discussion of a case of an enterprise-based curriculum implementation that resulted in the creation of a self-sustaining instructional design consulting organization.

Keywords Instructional design • Entrepreneurism • Experiential learning

7.1 Introduction

As higher education is coming under attack by the widespread concept of *edupunk*, a Do It Yourself (DIY) attitude, and the Open Source movement, it is time to conceptualize alternative curricular models that respond to new needs and demands of learning. Personal learning networks and paths, learning that blends experiential and digital approaches, and free and open-source educational models are the future of higher education (Kamenetz, 2010). As new market needs force career lifecycles

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to shorten and work environments to quickly evolve, the twenty-one-century learner needs to develop critical skills, content knowledge, literacies, and expertise in order to succeed. A technology revolution combined with globalization and the crossing of cultural frontiers must force higher education to rethink curricula. Employers demand work-ready graduates who can think critically, solve problems, show initiative—and who are entrepreneurial, flexible, and adaptive. Prospective students demand educational programs that offer flexibility plus relevant and applicable content. Thus, contemporary curricular perspectives in higher education need to meet these evolving educational needs. Learning and innovation skills (e.g., creativity, critical thinking, problem solving, communication, and collaboration), information, media/technology, and life/career skills (e.g., initiative and self-direction, social and cross-cultural skills, leadership, and responsibility) are at the heart of such a curriculum reconfiguration (The Partnership for 21st Century Skills, 2011). Emerging conceptions of curricula should take into consideration this plethora of demands as a way to face, understand, and evaluate an incessantly changing world.

This chapter discusses the case of an enterprise-based curriculum implementation in higher education that uses an experiential learning framework and provides a step beyond traditional forms of experience-based education. As Kolb (1984) argues, learning from experience is the process whereby human development occurs, "an increasing occupation for us all; for in every aspect of our life and work, to stay abreast of events and to keep our skills up to the 'state of the art' requires more and more of our time and energy" (p. 2). As Dewey (1938), the intellectual predecessor of experiential learning in higher education, describes it, there is an acute need for an "intimate and necessary relation between the processes of actual experience and education" (p. 19–20).

A logical development of applying experiential learning in higher education is the rise of entrepreneurism. Even though the field of education has not traditionally stressed entrepreneurship, it is imperative, in light of current economic challenges and shrinking global job markets, to ensure that students are adequately prepared to face the challenges ahead. Wagner (2008) identifies the gap between "what our *best* suburban, urban, and rural public schools are teaching and testing versus what *all* students will need to succeed as learners, workers, and citizens in today's global knowledge economy" (p. 8). Among seven survival skills for the twenty-one century, Wagner (2008) highlights "initiative and entrepreneurialism" as ways to pursue new opportunities, ideas, and strategies for improvement. Organizations are looking for highly adaptable employees who can produce creative solutions to complex problems. As social change takes over every dimension of people's lives, schools reveal themselves as too conservative and "lagging behind change" instead of helping students "understanding and living with social change" (Ornstein & Hunkins, 2008, p. 151). Along these same lines, Zhao (2012) makes a strong and evidence-based argument that schools need to educate students to be creative, entrepreneurial, world-class learners who can move with ease across cultures and perspectives.

The following sections of this chapter discuss in detail the case of an enterprise-based curricular model to support the education of instructional designers as up-and-coming entrepreneurs in education (Correia, Wei, & Baran, 2010), or *edupreneurs*: self-motivated learners/members of an enterprise who can recognize opportunities and take action on complex educational problems while aiming to create social value, financial value, and/or social benefits.

7.2 Curricular Models and Instructional Design Education

A document that describes strategies for achieving desired goals or ends is a widely accepted definition of curriculum (Ornstein & Hunkins, 2008). However, in the context of this chapter, curriculum is viewed more as "dealing with the experiences of the learner" (Ornstein & Hunkins, 2008, p. 9). Everything that has been planned that happens in and out of school is considered part of the curriculum.

Models are mental pictures that help with the comprehension of something one cannot see or experience directly. Curricular models help designers map out the reasons for using particular teaching, learning, and assessment approaches. However, Ornstein and Hunkins (2008) warn that although curricular models are useful, they often leave out the human aspect of education. As they so eloquently put it:

> The curriculum must consider the smells and sounds of the classroom, the intuitive judgments and hunches of the teacher, and the needs and interests of the students that evolve and cannot always be planned by the student, teacher, or curriculum specialist. (p. 10)

Curricular models in higher education are often described in a contrasting yet practical way as both product models and process models—the first driven by objectives and outcomes, and the second by continuous development along with outcomes perceived as desirable processes. Curricular models may also be defined as subject-centered and learner-centered designs, since they describe elements of a curriculum such as: (1) philosophies and learning theories, and (2) one's "basic beliefs concerning people, what they should learn and how they should learn" (Ornstein & Hunkins, 2008, p. 232).

Subject-centered design is similar to the product curricular model since it stresses the curriculum as a plan or blueprint with pre-defined objectives and an emphasis on efficiency. Learner-centered design equates to the process model in its humanist approach, which stresses the personal, subjective, and aesthetic nature of the curriculum.

The most important aspect of the learner-centered curriculum is not the content per se, or learning goals, but the learner. Curricula that support experiential learning fall into this curricular design. In short, an organic curricular design offers learning experiences to support students' growth as creative and independent learners (Harris, Cullen, & Hill, 2012).

Much has been said on pedagogical methods for educating professionals in higher education, including those involved in the field of instructional design (Irlbeck, 2011). As Seels and Glasgow (1998, p. 1) explain, "instructional design is the process of solving instructional problems by systematic analysis of the conditions for learning" using a rigorous and systematic process of design. Extensive critical competencies are required of both the instructional design researcher and practitioner. These competencies range from questioning assumptions and critically analysing existing instructional theories to creating learning environments, messages, and systems. Professional instructional designers ought to make sound instructional decisions based on evidence regarding the educational problem at hand, critical content, learning objectives, instructional strategies, assessment procedures, user-centered design, media production, evaluation, and implementation (Seels & Glasgow, 1998).

Approaches to teaching instructional design, the experiential learning framework, and a discussion on entrepreneurship in education are presented below.

7.2.1 Teaching Instructional Design

The educational technology field in general and instructional design in particular have experienced significant pressure to change teaching approaches and learning strategies (Bichelmeyer, Boling, & Gibbons, 2006; Gordon & Zemke, 2000). One major critique relates to the rigid practices and processes taught to educational technologists, which focus more on instruction within various theoretical models, techniques, and tools than on human needs. More contemporary teaching approaches highlight the work process, or "how instructional design is carried out, what strategies and approaches work in various contexts, how designers should systematically practice their craft" (Campbell, Schwier, & Kenny, 2008, p. 1). Recently, more attention has been paid to educating instructional designers who are socially aware as well as technically competent in performing their jobs (Yusop & Correia, 2012). According to these authors, a civic-minded instructional designer is a professional "who has the public interest and a sense of civic responsibility at the forefront of his or her work. He or she is also attentive, responsible, and responsive to the emergent instructional needs of the members of the community. Most importantly, he or she utilizes knowledge and skills in instructional design and technology to improve learning and performance of others" (Yusop & Correia, 2012, p. 186).

Janusewski and Molenda (2008) make a call for change by stressing that today's learning goals need to be more ambitious. Knowledge and skills are to be applied actively and must be conducive to deep, rather than surface, learning. They define technology as "an application of knowledge for a practical purpose" (p. 225), which expands the instructional designer's zone of influence. "Technology," in this sense, includes both hard and soft technology. Hard technology equals physical products that result from research and development activities. Examples are computer hardware and software, video and audio recordings, mobile devices, and applications. Soft technology corresponds to the application of intellectual processes to solve educational problems. Examples are plans for teaching, instructional design operations, curriculum development projects, learning resources administration, media utilization strategies, and optimization of group processes, to mention just a few. Soft technology refers to a multitude of ways of thinking and solving problems using different theories of learning based on a systematic process of designing instruction. This broad definition of "technology" allows for innovative application of instructional design in an entrepreneurial manner, in any context (e.g., high or low tech), and to a multitude of audiences ranging from pre-schoolers to senior citizens.

At the same time, more attention is being paid to authentic approaches to teaching instructional design. Learning experiences are designed to represent real situations that students must handle as professional instructional designers. Current practices in the teaching of instructional design incorporate less traditional, more contextualized approaches that are inclusive and responsive to societal needs, such as studio-based approaches (Boling, 2008), cognitive apprenticeship (Ertmer & Cennamo, 1995), and community-related approaches (Wilson & Schwier, 2010). These contemporary methods typically utilize experience-based approaches where students work directly with community members, identify problems, and propose appropriate technological solutions based on in-depth analyses and consideration of resources.

7.2.2 Experiential Learning

Experiential learning theory provides a distinctive perspective on the learning process that has a wide application to higher education and adult learners. Kolb (1984) claims experience is the primary source of learning and development and introduces experiential education as a contemporary application of experiential learning theory. He argues that adult learners demand from higher education that their life and professional experiences (e.g., work-related activities, family responsibilities, and previous education) be incorporated into their learning. Adult learners want to know *why* they are learning, what they are learning, and see a clear relevance and application to their professions and life in general. More than communication skills and content knowledge, higher education should contribute to more advanced forms of intellectual development and permeate the multiple dimensions of human development demanded by today's globalization and digital revolution.

Experiential learning theory defines *learning* as "the process whereby knowledge is created through the transformation of experience" (Kolb, 1984, p. 38). The focus is on the process of adaptation and learning as opposed to content or outcomes. Knowledge is continuously created and recreated, "not an independent identity to be acquired or transmitted" (Kolb, 1984, p. 39).

The experiential learning cycle. Experiential learning is "a process of constructing knowledge that involves a creative tension among the four learning modes" (Kolb & Kolb, 2005, p. 194). The four learning modes—concrete experience, abstract conceptualization, reflective observation, and active experimentation—are organized into a cyclical pattern known as the experiential learning cycle (Fig. 7.1).

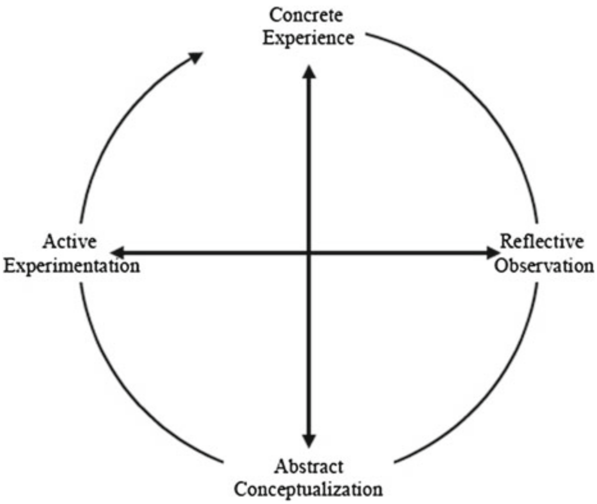

Fig. 7.1 Experiential learning cycle

Experiential learning in higher education is often approached through case analysis, role-playing, and live or computer simulations. These activities allow learners to apply what they are learning to new situations and to learn by doing. But they lack the messiness of reality because they neglect critical relationships that can only be encountered when working in real contexts.

Through concrete experience, one observes and feels the world around him or her, while reflective observation helps to make sense of that experience on a personal level. Abstract conceptualization allows one to think and generate new concepts, understandings, and strategies for action. Active experimentation gives opportunities to practice these concepts, understandings, and strategies in novel situations, which lead to the next concrete experience.

Kolb (1984) argues that learners need to be fully immersed in new learning experiences and embrace these experiences fully and openly by leaving behind their biases. Learners should expose themselves to different perspectives and reflect on their learning and growth as they go through these experiences. They must be able to relate to the new concepts and integrate their observations in theories and models that support them. Instructional decisions, then, are made and educational problems are solved based on these theories (Kolb, 1984).

7.2.3 Entrepreneurship in Education

As predicted by Bridges (1994), the idea of job security belongs to the past. Contemporary workers operate in a different paradigm in which they must view their career as an enterprise that requires a vision and careful planning. Following similar reasoning, Zhao (2012) defines an entrepreneur as "someone who creates a job or employment for him or herself" (p. 77). Globalization and the digital revolution have allowed people to engage in low-risk start-ups. College and university graduates are no longer expected to put all their time and effort toward moving up the corporate ladder in a single company during the span of their entire career. Much to the contrary, they are experiencing different career paths in different organizations including, in all likelihood, a company of their own.

As mentioned above, higher education has been the center of many criticisms. Critics argue that there is a need to create programs with extensive practical preparation intertwined with coursework (Darling-Hammond, 2000) and to "rethink the relationship between theory and practice" (Korthagen & Kessels, 1999, p. 4). It is further argued that bringing entrepreneurial skills and competencies (e.g., identify an opportunity, develop a business concept, assess the required resources, acquire the necessary resources, implement and manage, and harvest the venture) to higher education is one strategy for overcoming these criticisms.

Early writings on entrepreneurial mindset define entrepreneurship as "the process of creating value by bringing together a unique package of resources to exploit an opportunity" (Stevenson, Roberts, & Grousbeck, 1989, p. 28). Timmons (1989) defines entrepreneurship as "the ability to create and build something from practically nothing. It is initiating, doing, achieving, and building an enterprise or organization, rather than just watching, analyzing or describing one" (p. 1). Timmons (1989) goes further by explaining that entrepreneurs use failure as a tool for learning and trade perfection for effectiveness. They go after an opportunity independently of the resources they actually control. Entrepreneurs' approaches are often driven by minimum, rather than maximum, resources, driving them to be innovative when proposing solutions to problems.

Martin and Osberg (2007) explain that entrepreneurship "describes the combination of a context in which an opportunity is situated, a set of personal characteristics required to identify and pursue this opportunity, and the creation of a particular outcome" (p. 31). More simply, being entrepreneurial means recognizing an opportunity and taking conscious action to leverage that opportunity. A critical element of an entrepreneurial mindset is acting on ideas. Since entrepreneurism is a learned skill, universities should "play a vital role in encouraging and providing opportunities for enterprise to flourish" (Smith, 2008, p. 714).

Entrepreneurial capabilities. Morris' (1998) work is used to frame the entrepreneurial skills and competencies to be integrated into higher education in general and instructional design education in particular (Correia, Niehm, & Yusop, 2010). Here is the specific competency set selected for that:

- Opportunity recognition—the ability to perceive and act upon opportunities in the environment that others do not see; developing a set of skills that can be used to differentiate between an idea and an opportunity.
- Opportunity evaluation—the ability to use processes to evaluate an opportunity (e.g., feasibility analysis, market analysis) for the purpose of deciding whether to pursue the opportunity.

- Innovation—creating new or novel ideas, offerings, processes, in unique combinations.
- Creative problem solving—the ability to examine standard situations or problems in new ways.
- Mitigating risk—being a calculated risk-taker; managing risk.
- Thinking and acting as a guerrilla—taking unconventional approaches to examining problems and developing solutions.
- Resource leveraging—the ability to assess and acquire necessary resources and use them in a way that maximizes their value.
- Managing ambiguity and uncertainty—the ability to be comfortable addressing problems in loose and ambiguous contexts.
- Implementing change—the ability to create and manage change.
- Building a plan for an innovative concept—the capacity to create and build something from practically nothing.

Even though globalization and the digital revolution have allowed ordinary people to become entrepreneurs, the change to an entrepreneurial mindset is quite slow (Zhao, 2012). The rise of an entrepreneurial mindset, meaning "a critical mix of success-oriented attitudes of initiative, intelligent risk-taking, collaboration, and opportunity recognition" (Aspen Youth Entrepreneurship Strategy Group, 2008, p. 5), depends on better involving young people in their own education. Starting in elementary schools, students can strengthen connections among communities, businesses, and schools by involving their parents and taking initiatives to better their communities (e.g., leading a book drive or exhibiting their inventions/projects). Creating educational experiences that cultivate this entrepreneurial mindset will increase education's commitment to entrepreneurship and the development of entrepreneurial capabilities.

Entrepreneurial mindset and instructional design. When identifying instructional strategies to meet learners' needs, instructional designers often evaluate opportunities; they take risks, tap into networks, and expect a return on their time and effort by seeing learners' cognitive and affective growth. Novice instructional designers need to learn how to evaluate opportunities as they set out in an ill-structured and highly demanding profession. Being comfortable addressing problems in loose and ambiguous contexts is one of the most valuable lessons a new instructional designer can learn. Needless to say, the need to deal with change and solve problems creatively are constant demands in the instructional design field. This makes the field of instructional design an exceptional area in which to foster an entrepreneurial mindset. With this in mind, at Iowa State University, a service center named *Learning Design Solutions* (http://www.ctlt.iastate.edu/learnds) was created. This center was created as an "embedded enterprise," meaning an organization that is financially independent, but solidly rooted in the university and its entrepreneurial initiatives. *Learning Design Solutions* aims at developing entrepreneurial capabilities among its members and collaborators. For example, after an on-campus tornado threat, student consultants contacted the county's emergency management agency and proposed developing materials to educate college students to prepare, respond, and recover from a severe weather situation.

Other entrepreneurial experiences in instructional design have been reported in the U.S., such as those conducted at Indiana University. This institution has implemented a multitude of educational technology projects with real-world applications developed by the Instructional Systems Technology department. In addition, David Merrill's team at Utah State University has been working on educational materials targeting entrepreneurial education (e.g., Mendenhall et al., 2006). However, what makes the case of *Learning Design Solutions* unique is its self-sustaining nature and the conscious and active embedding of entrepreneurial principles and practices within its instructional design practices. When student members graduate and leave the organization, they are ready to explore a multitude of career paths that would not be recognized if they had not been exposed to the rich experiences provided by *Learning Design Solutions*.

Similar enterprises have also been identified across the U.S., mainly among students in business and management (e.g., Valdosta State University) (Plumly et al., 2008). Utah State University has started up a somewhat similar enterprise to *Learning Design Solutions*. It began as an educational technology consulting firm out of the department of Instructional Technology & Learning Sciences under David Merrill's supervision. It is now a well-established venture in Logan, Utah, known as Letterpress Software, Inc. (http://www.lpsoftware.com).

Entrepreneurship in education, or *edupreneurism*, is a growing movement and is expected to expand along with Open Source and DIY activities in higher education. Because *Learning Design Solutions* is housed in the university's School of Education, which has not historically been involved in entrepreneurial activities, it also serves as an important vehicle for implementing the university's vision of entrepreneurship and engagement in campus-wide entrepreneurial initiatives. It also models entrepreneurship education and innovative thinking for other academic units. A detailed account on how to create and sustain an enterprise-based curriculum represented by *Learning Design Solutions* is offered in the next section.

7.3 The Entreprise-Based Curricular Model: The Case of *Learning Design Solutions*

This section explores the enterprise-based curricular model using *Learning Design Solutions* as an instance of curriculum implementation that aims at educating the twenty-one-century instructional designer. This alternative curricular model is examined in terms of learning theory and curricular elements such as targeting learners, teaching and learning philosophy, entrepreneurial approach, and roles of technology. The impact of this model on *Learning Design Solutions* members' learning and professional growth is also discussed.

The primary purpose of *Learning Design Solutions* is to create a context within which students can develop an entrepreneurial mindset and practice managing financial and business aspects of the enterprise. In addition, it hones their consulting skills and applies their instructional design expertise in ways that ultimately improve people's lives. The students take responsibility for all roles within the organization, including project management, customer relations, advertising, and dissemination. Every week, members and collaborators review and reflect on their processes and inquire how they can improve their services and make operations more effective. These learning experiences exceed any classroom learning experience and/or simulation exercise. They capitalize on students' practical strengths while testing the application of ideas, theories, and models learned in the classroom. These experiences happen in real time with real clients, and the decision-making involved carries real implications.

Learning Design Solutions grew out of an advanced instructional design course in which students conducted real-world work at no cost to different organizations. The focal learning activity in this course was to be part of a multi-team instructional consulting company designed to simulate a small firm that provided professional-level services free of charge. Students, in the capacity of technology consultants, worked with both university clients and organizations within regionally located small communities (e.g., government agencies, schools, and healthcare providers). The goals of this learning experience were to identify organizations' educational problems and to develop effective, valuable instructional interventions by addressing clients' instructional design problems and technology needs. In this course context, students developed key entrepreneurial abilities (e.g., identify opportunities, develop business concepts, assess and acquire required resources, and implement and manage a venture). While refining their consulting skills and instructional design expertise, they also practiced managing financial and other resources (each team of student consultants managed a small budget to support project development). This course engaged students in working *for* and *with* real clients in community-driven projects that had social significance and which required the completion of a product that met client specifications.

The community demand for instructional design work was greater than could be accommodated by this advanced instructional design course. Of the dozens of requests submitted, only two to three projects could be completed each spring. To address this issue, the course instructor and a group of graduate students envisioned starting up a center that could provide instructional design services all year round. This enterprise was created in the summer of 2008 with start-up funds from the Iowa State University John Pappajohn Entrepreneurial Center, followed by a significant grant from the College of Human Sciences Entrepreneurship Initiative. *Learning Design Solutions* is a unique enterprise within the university and one of few that are self-sustaining.

7.3.1 The Experiential Learning Influence on the Enterprise-Based Curricular Model

This enterprise-based curricular model is framed around the experiential learning theory and targets adult learners. Table 7.1 describes Kolb's (1984) characteristics of experiential learning and attempts to summarize the main principles of experiential learning that inspired *Learning Design Solutions*. The table also describes how these principles were instantiated in the work of the enterprise.

Table 7.1 Kolb's (1984) prepositions on experiential learning and instances of these characteristics in *Learning Design Solutions*' work

Kolb's (1984) prepositions on experiential learning	Instances of experiential learning characteristics in the work of *Learning Design Solutions*
1. *Learning is better conceived as a process than as outcomes*—learning is identified as a process that leads to a constant modification of ideas and adaptation of concepts to ever-present experiences	*Learning Design Solutions* is a nonhierarchical, collaborative organization founded on principles of equality, interdependence, learning, and service. Its members are instructional designers-in-training who strive for a deep understanding of the process of designing instruction. Constant experimentation and reflection about this process lead to high-quality educational products
2. *Learning is a continuous process grounded in experience*—this implies that "all learning is relearning," meaning that knowledge is created and tested out as people engage in different experiences that are relevant to their own learning	Members of *Learning Design Solutions* gain hands-on experience managing an educational technology consulting organization. They learn as they practice instructional design skills and test entrepreneurial practices in the daily operation of this organization. They choose to be part of the organization to improve their own learning and attain their career goals
3. *The process of learning requires the resolution of conflicts between dialectically opposed modes of adaptation to the world*—different knowledge results from the resolution of dialectic conflicts among modes of concrete experience, abstract conceptualization, active experimentation, and reflective observation. "… [L]earning is best facilitated in an environment where there is dialectic tension and conflict between immediate, concrete experience and analytic detachment" (p. 9)	*Learning Design Solutions*' membership represents different ways of perceiving the world. Conflict is a natural occurrence, but it is seen as beneficial. Through controversy, members help one other cope with biases of closed-mindedness, superficial evaluation of problems, and naive solutions. Another constant tension within the organization is its members' accountability for providing clients with high-quality solutions while simultaneously encouraging risk-taking and displays of initiative

(continued)

Table 7.1 (continued)

	Kolb's (1984) prepositions on experiential learning	Instances of experiential learning characteristics in the work of *Learning Design Solutions*
4.	*Learning is a holistic process of adaptation to the world*—"Learning is the major process of human adaptation" (p. 32). It takes place inside and outside school and throughout all life stages. It includes concepts such as creativity, problem solving, decision-making, and attitude change that focus heavily on basic aspects of adaptation	*Learning Design Solutions* members' reflective accounts often express views of learning as a process of growth and development, not just professionally, but as whole persons. During their interactions with other members and clients, they learn as much about themselves as they do about instructional design and entrepreneurism in education
5.	*Learning involves transactions between the person and the environment*—experience derives from exchanges between the learner and the environment	The structure of *Learning Design Solutions* is collaborative in nature, with each person playing a vital role. The positions in the organization are based on experience, ability, and commitment to the organization. Members are aware that their commitment to the projects, exchanges with clients, and the work environment are profound ways to increase the educational value of being part of the organization
6.	*Learning is the process of creating knowledge*—knowledge is gained through a bond between objective and subjective experiences in a process called learning	*Learning Design Solutions* creates a learning environment that deals with reality and embraces its messiness. It is not a simulated environment, but one that strives to promote learning as a process of development, adaption, growth, and meaning-making between the predictable and the unpredictable

7.3.2 Elements of an Enterprise-Based Curricular Model

Learning Design Solutions envisions a simultaneous improving of the community by developing high-quality educational technology projects and supporting of students at Iowa State University by providing them with real-world experiences so that they may develop professional and interpersonal skills as outstanding instructional designers and managers. This center is dedicated to accomplishing a three-part mission of product development, entrepreneurship, and adding educational value while enriching the lives of its members and the community it serves. It seeks to accomplish this three-part mission while utilizing collaborative and sustainable practices both within the organization and with entities and individuals outside of the organization. The following paragraphs introduce different elements of the enterprise-based curricular model instantiated in *Learning Design Solutions*.

Target learners. *Learning Design Solutions*' core community is comprised of a faculty member, a part-time staff member, and on average three to four students, mainly graduate students from the university's Curriculum and Instructional Technology program. However, other students, including undergraduates, from other areas (e.g., mathematics education, English, design, and computer science) are welcome and have made important contributions to the organization. Students' involvement in the organization takes place outside the requirements for their degree program. Everyone in the organization is perceived as an adult learner who aims at improving a range of different skills (e.g., management, business, consulting, design, and organizational skills) and increase knowledge in a multitude of areas (e.g., instructional analysis, evaluation, entrepreneurship, development and production of educational materials, and online education). In a broader sense, the members are individuals who, in addition to seeking income and experience, take on the responsibilities of maintaining *Learning Design Solutions*. These persons are committed to supporting the long-term success of the organization and cooperating with individuals both within and outside of the organization. Members sit on the *Learning Design Solutions*' Board and possess voting rights for items related to the organization. They have full access to all organizational documents. Members may also choose to become a project manager, and thus work independently with clients, manage teams of other members and collaborators, serve as the *Learning Design Solutions* liaison to clients, and report to the Board on the status of projects.

Student members of *Learning Design Solutions* gain the following benefits of membership:

1. Gain work experience through performing instructional design consulting for clients within Iowa State University and surrounding communities.
2. Gain hands-on experience managing a consulting organization as preparation for developing their own entrepreneurial practices.
3. Practice leadership skills while working in a group to guide the organization into the future.
4. Engage in mutual learning by utilizing a quasi-apprenticeship model for the dual purpose of training new members and developing interpersonal teaching skills.
5. Participate in on-going research and dissemination efforts.

At one point *Learning Design Solutions*' members represented seven different countries and identified with four different faiths, reflecting a breadth of diversity unparalleled in other entrepreneurial organizations on campus. From its inception, this organization has mirrored the characteristics of a global workplace. This is the precise environment in which students need to practice their skills not only in instructional design and entrepreneurism, but in participation in multidisciplinary and cross-cultural design teams. The members of *Learning Design Solutions* are a heterogeneous group of individuals committed to their education and keen on becoming highly competitive in the global job market.

Teaching and learning philosophy. Two core actions drive learning and teaching within this enterprise:

1. Working in real-world situations. People learn better when they are actively engaged in learning tasks that are directly related to their needs and interests.
2. Working in teams. Members learn concepts, tools, and techniques that help them become successful team players. Most of the projects require students to act as members of smaller teams (e.g., contributing to design teams) as well as of a larger professional community (e.g., presenting at professional meetings).

Members of *Learning Design Solutions* work in partnership with their clients. By constantly soliciting clients' input on project activities, members create solutions that truly meet clients' expectations. Organizational practice is continuously improved through reflection and careful analysis of evolving needs to address changes in the organization and advances in technology. Members are encouraged to constantly reflect in writing about their practices within the organization with the ever-present aim of learning, excellence, and professional growth. This is not a requirement for students' participation in the organization, but strongly encouraged among its members and collaborators as a strategy to grow as professionals.

Learning expectations and objectives are replaced by client project contracts with authentic expectations, deliverables, and due dates. The terms of these contracts are enforceable, meaning there are clear consequences for the organization if there is a breach of contract. Members are involved in every step of the contracting process, from recruiting clients and negotiating terms to closing contracts. Students' participation in *Learning Design Solutions* is not for credit or part of a course, therefore the students are not given a letter grade at the end of the projects. However, its members and collaborators' performance is evaluated in terms of client satisfaction and quality of products created. Members of the organization (including the faculty member) are involved in this evaluation process. For example, they engage in frequent design critiques at every stage of product design and development and at the end of each project a follow-up with the client is completed. The faculty member role is similar to a leader in a consulting firm (e.g., identify talent, support professional development, contracting with clients, managing project teams, and let students go if their performance is not acceptable and/or behavior is not professional).

To provide organizational continuity as students graduate and other students take over, *Learning Design Solutions* operates on a quasi-apprenticeship model in which more experienced members bring along less experienced new members and mentor them to ultimately take over. Not only do both current and new members benefit from the teaching and learning experience, but it also ensures an influx of new and fresh ideas, keeping the center current with the times. Along the way, time-honored traditions are renewed and others develop.

Entrepreneurial approach. In exchange for its services, this organization receives fees as a way to recover its costs. *Learning Design Solutions* operates on a break-even basis, meaning that clients are charged only to cover center expenses. The revenue generated goes toward paying students for their work on an hourly basis, as well as office supplies, marketing, equipment, and public relations materials. Revenues

Table 7.2 *Learning Design Solutions*' project examples

Client	Project
ISU campus online education unit	Conducted an instructional analysis as a basis for initial design. Created an outline (e.g., structure, organization, and content elements) of the online student orientation that serves as the basis for the development of ISU students' personalized learning networks
County-level emergency management agency	Developed a web-based tutorial to help the public learn how to stay safe during and after a tornado disaster. This web-based training includes interactive elements and self-assessments with feedback. It was aimed at university populations who may have limited familiarity with tornadoes

also contribute to the recruitment of high-quality graduate students by supporting competitive assistantships (the number of assistantships available depends upon sales volume). Currently, this enterprise is completely self-sustaining.

Learning Design Solutions prides itself on seeking projects with positive social impact. For example, its first client was its home county's coalition for disaster recovery (CDR). One of the organization members attended a sandbagging volunteer workshop and she realized CDR's training system could benefit from her colleagues' skills. The work team reorganized existing information, created illustrations, designed opportunities for practice in a simulated disaster situation, and produced instructional videos to help new volunteers learn the sandbagging process that is so critical to protecting communities from devastating flooding. This project was particularly important in establishing what *Learning Design Solutions* could offer to communities. Table 7.2 offers additional examples of the entrepreneurial consulting projects the organization has taken on.

Role of technology. The organization embraces Janusewski and Molenda's (2008) definition of technology, in which hard technology refers to tangible products such as computer hardware and software, video and audio recordings, and mobile devices and applications. Nevertheless, much of *Learning Design Solutions*' work deals with soft technology, including instructional analyses, evaluations, conceptualization and design of solutions, and process outlines.

Support technologies utilized at *Learning Design Solutions* include the following:

- Daily operations (focus on communications): Microsoft Office, Skype (extensive use), Email, Moodle (as intranet), Google Calendar, and Excel and Asana for project management
- Dissemination/visibility:
  - Web development: Adobe Dreamweaver, Photoshop, Illustrator, and InDesign
  - Social media tools: Twitter and Facebook (multiple pictures are taken and used for organizational memory)

- Client/project work: depends on the nature of the project; currently Adobe Creative Suite 3 (e.g., Photoshop, Acrobat, InDesign, PostScript, PDF, Flash), Illustrator, and Dropbox.com
- Research: Google Drive for housing research, project management, and research journals

7.3.3 Impact on Members' Learning

Since day one, being part of *Learning Design Solutions* has meant experiencing growth grounded in experience and reflection. Its members are encouraged to reflect deeply upon their practices and experiences as consultants and entrepreneurs in instructional design and most importantly on their own learning. Reflective practice serves "as a means by which practitioners can develop a greater level of self-awareness about the nature and impact of their performance, an awareness that creates opportunities for professional growth and development" (Osterman & Kottkamp, 1993, p. 2).

At any point during all projects, members are invited to share their thoughts and feelings about the nature of the project, issues, and challenges, as well as about the enterprise's daily operations. They are strongly encouraged to gather their reflections in a journal to be used as a tool for growth and development. For example, members may reflect on their insights about a project in which they are involved; how the project is (or is not) impacting their perceptions of their role and development as an instructional designer; or how their involvement in the project is (or is not) helping them broaden their understanding of the field and enhance their practice as educators. As a result, they are encouraged (and given financial support) to showcase their learning through papers and presentations at national and international professional meetings. Three short case studies about the impact of *Learning Design Solutions*' work on members' learning and growth as instructional designers and entrepreneurs are described below. Pseudonyms are used in this chapter to protect the members' identities.

Being able to interact with real clients was the most significant benefit that Flora, a female doctoral student in curriculum and instructional technology, reported from being part of *Learning Design Solutions*. She was a co-founder of the organization and one of its most enthusiastic members. Flora led the creation of *Learning Design Solutions*' business plan and the write-up of its first manual of operations. She explained that her motivation to be part of *Learning Design Solutions* resided in her determination to "create a workplace in which I would really enjoy my work. I could be challenged, I could do something meaningful, I could work with great people, and we could all learn together. Creating a community in which we can share our talents with each other, learn new ideas and skills, teach the next generation, and make a difference in the community is very important to me." She went on to describe that this experience "was important in as much as it helped me to see how great it is to have a group of people with whom you can discuss your project and be able to get productive feedback, yet still maintain creative control over [your] own project. It was one of the elements of a creative and entrepreneurial workplace… I really liked that!"

Flora's motivation to join *Learning Design Solutions* came from "the benefit of gaining related work experience and being able to interact with real clients. I started to realize that instructional design experiences are crucial for students. However, with the economic situation nowadays, it will be extremely difficult for graduate students to find a perfect internship or working opportunities while pursuing graduate degree."

As an international student from Malaysia, Flora was eager to bring this concept of graduate entrepreneurship to her *alma mater*. She was very much intrigued by this concept and used part of her experience in the organization to conceptualize her doctoral research study. In her own words, "LearnDS [Learning Design Solutions] has exposed me to the business side of Instructional Design. I've learned a lot about setting up a company, finding and negotiating with clients within the context of ID. What is more meaningful is that the purpose of LearnDS is much more community-oriented—that is to educate community—rather than purely business-oriented. This focus is very much related to my doctoral research."

Preparing for a complex working environment in academia was reported by Kaya as an important benefit of joining *Learning Design Solutions.* Like Flora, Kaya was a female doctoral student in curriculum and instructional technology and one of the organization's co-founders. She was particularly interested in a career as a university professor and recognized an opportunity in *Learning Design Solutions* to support her career aspirations in teacher education. She explained that being part of the organization offered her many opportunities to develop entrepreneurial skills "that would propel me into career paths in teacher education. I am having a chance to practice/perform all kinds of roles in this student-run organization: from managing and budgeting projects (including grant writing) to applying my consulting skills to learning problems within the community. As a future faculty, I believe my active involvement as a LearnDS member is better preparing me for a complex working environment in academia by giving me the opportunities to work with real life problems that I would never work otherwise in my graduate education."

Kaya had extensive experience as an instructional designer in her home country, Turkey, and was able to share these experiences with the other members of the organization. She was particularly skillful in recruiting clients and closing contracts. Her commitment to research put her in a privileged position to bridge theory and practice, as she explained: "By participating in real world projects, I am able to connect theory with practice and vice-versa and employ my communication and problem solving skills to propose creative solutions to a variety of educational problems. For instance, by participating in the design of a training workshop for a local community, I had a chance to participate in designing instructional solutions by considering many instructional aspects such as clients' and learners' needs and contextual factors."

Kaya always showed determination to have a career as a scholar in higher education. She took her work at *Learning Design Solutions* and turned it into a highly valuable learning experience. In her words, "[t]hrough my involvement in LearnDS as a graduate student, I am also more equipped to perform entrepreneurial activities, from writing business plans and budgeting projects to engaging in discussions on intellectual property and market research, that I will surely use in my future faculty profession. As an example, with my other graduate colleagues I participated in writing a grant to request 2 years of funding to support LearnDS. Finally, my experience as a graduate student entrepreneur in teacher education will help me to better adapt to new academic cultures that value intellectual and entrepreneurial initiative in new faculty members. As a future faculty entrepreneur, I will be able to take an active part in addressing several challenges in teacher education and provide my expertise to various educational contexts."

Access to new opportunities was described by Clara as the greatest advantage of joining *Learning Design Solutions*. Clara is currently a female doctoral student in curriculum and instructional technology and an instructional development specialist at the university's Center for Excellence in Learning and Teaching. She joined *Learning Design Solutions* in 2009 as a collaborator and moved up as a member in 2010. Clara was especially interested in faculty professional development and saw being part of the organization as a way to attain her career goal. This is how Clara explained it: "[j]oining LearnDS was important to my learning because it opens up new possibilities for me. First, I work closely with real-world clients in the community or university-wide to provide consultation and to design products to solve clients' instructional concerns. A lot of instructional designers may not have the chance to work directly with real-world clients. Therefore, they have to spend time to adjust or adapt when they accept their first job as instructional designer. Second, it is about the knowledge I can learn from LearnDS. I have the opportunity to be involved with all aspects of the project from contracting and negotiations through development and presentation of the final product. These experiences have trained my skills as a future instructional designer."

Clara was particularly proud of her project when collaborating for the first time with *Learning Design Solutions*. She worked on the re-design of a sandbagging training for a disaster recovery organization. The new workshop-style training included: (1) an interactive PowerPoint presentation with demonstrations, quizzes, and audience participation; and (2) an outdoor, hands-on competition in sandbag levee construction.

As a doctoral student, Clara was also interested in research and leadership opportunities. Reflecting back, she wrote: "…LearnDS has also provided me with research opportunities. I can work with peers and advising faculty to develop research agendas. This has helped me gain experiences in learning about how to write research papers and how to present the findings in professional meetings. In addition, I am also given a vast array of leadership opportunities. All the things I learned above will help me in my professional field. I am very grateful and thankful to be able to join Learning Design Solutions."

Two of these three individuals currently serve as members of the *Learning Design Solutions* Advisory Board, who are consulted on an as-needed basis for various issues, such as: establishing the vision and clarity of *Learning Design Solutions* as an organization; advice on current challenges that the organization is facing, including recruitment, membership, and client projects; and evaluative feedback of the organization.

7.4 Final Remarks

The rationale for creating an enterprise-based curriculum stemmed from the recognition of an opportunity to serve the many instructional needs of the surrounding community. The drive came from the chance to offer students different career venues in education and the invaluable opportunity to practice "live" what they were learning in their graduate and undergraduate programs, especially skills and knowledge related to the design of instruction. Additional motivation derived from creating a self-sustaining unit that could provide resources and funds to support students' professional development and research.

Learning Design Solutions' educational projects have created value on a number of levels. From the student perspective, they have provided fundamental skills in consulting and entrepreneurism, including innovation, problem solving, resource assessment, resource leveraging, and management and implementation of change. Student members also developed networks that led to professional opportunities, gained experience in opportunity identification and evaluation, and engaged in significant entrepreneurial career exploration in instructional design.

From an external perspective, clients gained access to professional expertise to address educational problems within their own organizations. Many of the organizations served by *Learning Design Solutions* could not have otherwise afforded this level of service. Clear value was created for these organizations through the innovative instructional technology solutions provided by the student consultants. The assistance provided to these firms could potentially contribute to their overall sustainability and allow them to gain efficiencies that would enhance their overall performance.

This unique instance of edupreneurism demonstrates a truly novel approach to teaching in the area of instructional design. It provides an exemplary entrepreneurship case and pedagogical approach in the field of education. This effort contributes to the expansion of a campus-wide entrepreneurship initiative with a focus on entrepreneurship in education. For the last few years *Learning Design Solutions* has forged partnerships with industry, community, and government organizations in need of instructional design assistance. To date, many client organizations have indicated that they were especially pleased with the opportunity to partner with a university to receive cutting-edge knowledge and solutions to issues in human resources, human performance improvement, personnel training, and community improvement. As Argyris and Schoon affirm, "learning from experience is essential for individual and organizational effectiveness and … this learning can occur only in situations where personal values and organizational norms support action based on valid information, free informed choice and internal commitment" (cited in Kolb, 1984, p. 11).

7.4.1 Challenges and Issues

Throughout this chapter, many of *Learning Design Solutions*' achievements and strengths were identified, but the enterprise also faces challenges. As Timmons (1989, p. 1) points out building "something from practically nothing" and "sensing an opportunity where others see chaos, contradiction and confusion" does not come without barriers and setbacks.

The experiential learning framework does come with flaws. This learning theory has been criticized for being overly complex and ambiguous, and for offering fragmented theoretical and philosophical foundations (Malinen, 2000). However, experiential learning provides a working framework and guidelines for action.

One of the major issues faced by *Learning Design Solutions* is ensuring continuity of membership. Since the organization is part of the university, members come from the many talented students who attend Iowa State University. High turnover is inherent, though, with most members staying with the organization for a maximum of 2 or 3 years. One way to overcome the challenge of turnover is to utilize a quasi-apprenticeship model whereby senior members continually recruit and train new members.

The continuous professional development of *Learning Design Solutions*' members puts extreme pressure on the organization. Even though members are talented and skilled in instructional design, programming, graphic design, and/or teaching and learning, many lack consulting and organizational skills. They then need to develop these skills as quickly as possible while working on multiple projects. Working in small teams and getting involved in activities within the organization, including project management, customer relations, advertising, and dissemination, helps alleviate this problem.

Finally, a major challenge to all *Learning Design Solutions* members is balancing one's own academic programs and career demands with the needs of a fast-paced environment where everything is real—authentic projects, actual clients, enforceable contracts. Emphasizing the organization's founding principles of equality, interdependence, learning, and service helps keep every member motivated and committed to the highest quality work.

7.4.2 Future Developments and Directions

The ultimate goal is to turn *Learning Design Solutions* into a leading research and development organization as well as a service center. In the future, more investigative activities will lead to discoveries of online learning environments that take into account experiential learning principles, to more robust methodologies for analysis and evaluation and, most importantly, to new knowledge about supporting novice instructional designers' development into "edupreneurs." The enterprise-based *Learning Design Solutions* offers its members opportunities to work with real clients while refining relevant skills that equip them to set up and manage their own enterprises after graduation.

Another important future direction is the continuous pursuit of organizational improvement through reflective practice and development of new products, services, and processes. Authentic reflection that aims honestly at analysing situations, issues, and challenges, testing existing views, perspectives, and beliefs, and promoting development and change is critical to the future direction of the organization.

Learning Design Solutions is currently conducting research that aims at: (1) understanding motivators, barriers, and critical success factors to becoming an entrepreneur in instructional design within real-world contexts; (2) examining the complexities of the decisions made, issues, processes, and best practices involved in transitioning from being a graduate student to actually starting up an enterprise; and (3) proposing strategies to integrate entrepreneurship into teacher education. This line of investigation follows Nabi, Holden, and Walmsley's (2006) recommendation of research "on the stories, circumstances, contexts and complexities of graduates on their journey from student to business start-up" (p. 373).

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8.1 Rethinking Traditional Lectures and Tutorials: A Rationale for Change

In recent times there has been a lot of discussion focused on the importance of student engagement as a predictor of academic success (e.g. Kuh, 2003; Kuh, Cruce, Shoup, Kinzie, & Gonyea, 2008) and the challenges of engaging students in their own learning (Mulryan-Kyne, 2010; Nelson, Quinn, Marrington, & Clarke, 2012; Rocca, 2010). A range of issues have been identified, including the need to facilitate independent and lifelong approaches to learning, graduate readiness and how best to assist students to apply their learning and see its relevance for their future careers, use of Web 2.0 learning technologies to engage students in "anytime, anywhere" learning, teaching large amounts of knowledge and skill efficiently, and teaching ever-increasing class sizes in inclusive ways (Biggs & Tang, 2007; Mandernach & Taylor, 2011; Mulryan-Kyne, 2010).

Many of these issues have been identified as relevant to psychology education in general (Cranney & Dunn, 2011) and more specifically by the teaching team in the psychology course that is the focus of this chapter. This second year undergraduate course in Developmental Psychology had historically been identified as a low-performing course according to formal student feedback. Compared to other courses in the programme, Developmental Psychology was seen by the students as heavily conceptual. Both formal and anecdotal evidence suggested that students perceived the course to cover too much theoretical content, to the extent that they felt overwhelmed by the workload and forced to engage in surface approaches to learning. Related to this conceptual focus, students found it difficult to see how theories and research presented could be applied to future work settings. Anecdotal evidence suggests that many of these issues are not peculiar to RMIT University. The common problem of teaching large amounts of conceptual and theoretical knowledge in undergraduate courses has been identified as particularly relevant to teaching lifespan development (Knight & Lee, 2009).

To address these issues, a number of strategies were trialled over several years, with the largest commitment of time and money allocated to the development of online learning resources using a web-based learning environment. A set of comprehensive online teaching modules were developed to supplement face-to-face interaction. These modules incorporated core readings and reflective tasks along with video footage illustrating key points of lifespan development. It was expected that these interactive resources would increase student engagement with the learning material and facilitate a deeper approach to learning. Although students responded positively to these online learning resources, feedback remained consistently lower than for other courses and students continued to struggle to apply the theory they were learning.

While researching alternative teaching approaches to address the ongoing problems with the course, the first author came across Boyce and Hineline's (2002) interteaching model. This teaching model was described in a text outlining practical approaches to teaching developmental psychology (Knight & Lee, 2009) and immediately appeared to be a good fit with the problems experienced by the teaching team.

8.2 A New Model to Enhance Student Engagement: Interteaching

Interteaching is based on behavioural principles and is designed to increase student engagement and academic outcomes by increasing student participation and active learning through immediate reinforcement of preparation and participation. It incorporates guided independent learning, reciprocal peer tutoring, instructor reinforcement, self-evaluation of learning, and brief lectures developed in response to student feedback. A distinctive feature of the model is that tutorials precede lectures as a way of distilling the learning topics upon which students most need direction (Boyce & Hineline, 2002). As such, interteaching inverts the traditional model for learning and teaching, putting centre stage the role of the student in preparing for class. While interteaching was developed prior to the proliferation of Web 2.0 learning technologies, the teaching model can easily be adapted using these technologies to enhance flexibility and access for students.

An important component of student engagement is *participation* (Rocca, 2010). Participation has been defined as an active engagement process comprising five components: preparation, discussion contribution, group skills, communication skills, and attendance (Dancer & Kamvounias, 2005). Participation leads to increased learning and increases in critical thinking and communication skills (see Rocca (2010) for a recent review). Engaging students via active participation has been identified in the literature as a particular challenge for tertiary educators, particularly in large classes (Rocca, 2010). Importantly, students themselves are aware of the benefits of participation for their own learning (Fassinger, 1995), and report a desire to participate more in class (Fritschner, 2000), suggesting that they would be satisfied with teaching models that include strategies to support greater participation.

One strong predictor of participation is class size, with increased class size associated with reduced student participation (Rocca, 2010). This finding has led to the development of alternative teaching models that emphasise active learning over didactic presentation of lecture content to a passive student audience. Often these models also incorporate specific strategies to increase participation during class time. A range of specific methods for increasing active participation have been identified. Guided class preparation, small-group discussion, instructor immediacy behaviours (i.e. eye contact, moving around the room), positive verbal and non-verbal feedback, reinforcement for participation, and assessment points for active participation have traditionally been used to increase student participation in class, and anecdotal and research studies support their use (Rocca, 2010).

Interteaching incorporates a range of these behavioural strategies to encourage active participation.

A central component of interteaching is *guided independent learning*. Before attending each tutorial or *interteach* class, a preparation guide is provided that outlines relevant prereading and a set of questions to answer based on the prereading. Students are expected to develop study notes based on this guide prior to attending the interteach session. They are informed that when they attend class, they will be expected to form dyads or small groups to discuss the topic material without reference to their study notes (Boyce & Hineline, 2002). Guided independent learning encourages students to take responsibility for their own learning and by doing so facilitates the development of skills required for lifelong learning. Use of *guided preparation* also assists students to manage their study more effectively, leading to perceptions of a more manageable study load.

This emphasis on students learning material before coming to class with the expectation that they will discuss their knowledge with their peers is based on cooperative and reciprocal peer tutoring learning models and predicts enhanced learning through peer reinforcement and tutoring others (Griffin & Griffin, 1998). Reciprocal peer tutoring is designed to motivate students to prepare to the level needed to explain their understanding to their peers, and self-evaluation is embedded into the model to encourage students to reflect on their preparation and performance and adapt their approach as necessary. It is based on the old adage that "we really don't know something until we have taught it to someone else" (Boyce & Hineline, 2002). It is also likely that as students learn the benefits of preparing for class, an independent, deep approach to learning is encouraged, which is more likely to foster a lifelong approach to learning, compared to a surface approach to learning "just to pass the exam". Further, the inclusion of reciprocal peer tutoring supports the development of team work and communication skills that are important learning experiences for students preparing for professional practice in psychology.

The central role of *reinforcement* in interteaching reflects the model's strong grounding in behavioural principles. Students receive credit towards assessment based on their participation in the interteach session (Boyce & Hineline, 2002), and instructor immediacy behaviours (i.e. eye contact, moving around the room), positive verbal and non-verbal feedback, and tangible reinforcement have also utilised to reinforce student preparation and participation (Saville, Zinn, Neef, Van Norman, & Ferreri, 2006). It is proposed that reinforcement for preparation motivates students to make steady progress with understanding learning objectives, resulting in a more positive learning experience throughout semester and a reduced need to "cram" just prior to exams. Instructor reinforcement and participation marks also provide strong motivation to participate during class time, leading to increased engagement with peers and teachers (Saville, 2011). Further, if students are expected to attend class with knowledge about conceptual and theoretical content, then class time can be used to assist students to apply what they have already learned through the use of case studies and other real-world problems. This is consistent with the goal of assisting students to see the relevance of theories and research findings to future work settings.

Following each discussion session (40–60 min), students complete an *interteaching record* to report on the most challenging and interesting aspects of the course content for that week. This feedback is used by the lecturer to develop content for the subsequent brief lecture (40–60 min) which occurs before the next tutorial class. This allows the lecturer to fill in gaps identified by students in their knowledge. Further, as Saville, Zinn, and Elliott (2005) have suggested, students may be more likely to engage with lecture material that is developed based on their feedback. The interteaching record has also been used as a self-evaluation tool, where students also rate the effectiveness of their peer-to-peer discussions (Saville et al., 2005, 2006).

As interteaching is a new teaching model, evaluation is in the early stages; however, the model is built on a strong theoretical and empirical base, and evaluation of interteaching to date has been promising. The model has been implemented within psychology programmes in a number of universities in the United States. Two studies employing experimental designs provide support for interteaching as an alternative model for teaching psychology. Students have reported a preference for the interteaching model over traditional lectures, and student performance on class tests was higher following interteaching compared to standard lectures (Saville et al., 2005, 2006). Similar findings have been reported in more recent studies with diverse student populations, including sociology students (Tsui, 2010), computer programming students (Emurian & Zheng, 2010), nutrition students (Goto & Schneider, 2009), and psychology students (Felderman, 2011). The model has also been implemented at Griffith University with Australian students completing mathematics and science courses. Preliminary evidence suggests that the model is viewed positively by students and is associated with improved learning outcomes compared to standard lectures (Gregory, Clarke, & Bridgestock, 2009).

8.3 Adopting Interteaching in Developmental Psychology

The teaching model implemented in Developmental Psychology at RMIT University in 2010 was based on the interteaching model reported by Boyce and Hineline (2002) and others (e.g. Saville et al., 2005, 2006); however, we have adapted it to meet our particular needs and continue to refine it using Web 2.0 learning technologies.

Developmental Psychology at RMIT University is taught across two campuses in the same semester. Prior to implementing interteaching, the two campus cohorts were coordinated separately, each taught with a traditional 2-h lecture followed by a 2-h tutorial each week. The two campus cohorts were comprised of approximately 60 and 110 students each. The course topics were delivered by two academics, each teaching in their relative areas of expertise, and topics were taught in the same order across campuses (according to the lifespan stages). This meant that lecturers travelled between campuses to deliver two identical lectures on one day. In addition to the inefficiency of teaching the same lecture twice, approximately 90 min per week was lost to travel time. A series of tutorial classes (comprising approximately 25 students each) were delivered each week by sessional teaching staff. Prior to interteaching, these were delivered after the lecture and focused on review and application of lecture material and guidance regarding assessment preparation. The existing teaching model therefore already had an emphasis on active small-group learning. While the central aim of the trial was to improve student engagement and academic outcomes, the model's de-emphasis on didactic teaching was viewed as an opportunity to also trial a flexible lecture delivery method that would reduce teaching and travel time and result in increased efficiency. Prior to the availability of Web 2.0 learning technologies, such flexible delivery approaches would not have been possible.

Prior to the implementation of interteaching, the course was delivered over 12 weeks. In week 1, students attended a 2-h lecture, and in weeks 2 through 12, students attended a 2-h lecture and a 2-h tutorial. Tutorials were delivered immediately after lectures on the same day and focused on content review and learning activities associated with the lecture material delivered earlier that day. To adapt the course schedule to suit the interteaching model, in 2010, students attended a 2-h lecture in week 1. In this lecture students were introduced to the topic of lifespan development and provided with a rationale and overview of the interteaching model. In weeks 2 through 11, students attended a 2-h tutorial that included an interteach session focused on that week's topic (approximately 1 h), in addition to work related to the major assessment. From weeks 3 through 12, students were provided with the opportunity to attend a lecture that was developed based on student feedback. Due to issues with room availability, this lecture was offered 1 week after the previous week's interteaching session and just prior to the interteach session on the following topic. In 2010, lectures were delivered weekly, but on alternate campuses during the teaching semester; students were provided with the option of attending the face-to-face lecture or accessing the lecture as a podcast. Students were familiar with accessing podcasts in this way in other courses in the programme, and the majority of students accessed podcasts rather than attending the face-to-face lecture at the alternate campus. As outlined above, this schedule was designed to provide flexibility for students and also to increase efficiency by reducing lecture delivery time and cross-campus travel.

As preparation for the first lecture, students are provided with an *Interteaching Guide for Students* that explains the teaching model and outlines the course structure and assessment process. The content of this guide is also covered in the first lecture to ensure that students are clear on the rationale for the model and the course structure and requirements.

Before attending each interteaching tutorial class, students are provided with an *Interteaching Topic Guide* which is delivered online using a web-based learning environment. This guide provides a very brief introduction to the topic, lists topic learning objectives, and outlines required reading from the textbook (and other sources where relevant). The guide details the preparation that students need to complete before their tutorial, including completing set reading and responding to a set of *Interteaching Discussion Questions*. These Interteaching Discussion

Questions focus on the learning objectives for each topic and include questions to test comprehension and ability to synthesise and apply the material. To encourage a deep approach to learning, students are advised to be prepared to discuss the answers to these questions in class without making reference to their study notes.

During tutorials, students are allocated to small discussion groups to participate in small-group peer-to-peer discussion focused on their understanding of the answers to the *Interteaching Discussion Questions*. They also participate in learning activities designed to demonstrate their understanding of the topic. In their discussion groups, students are also required to respond to *Interteaching Application Questions* that require them to apply their understanding to real-world issues (e.g. roles plays, debates). Tutors provide verbal and non-verbal reinforcement, tangible reinforcers (e.g. chocolate) for engaging in effective discussion, and grade students weekly based on evidence of (a) prior preparation, (b) active participation, and (c) effective communication skills. Grades allocated during the interteaching session account for 20 % of the total grade for the course. Tutors receive training in the interteaching model, and the grading process, and are provided with ongoing regular support throughout the semester.

Following each interteaching session, students complete an *interteaching record*. This form is used for self-assessment tool and as a source of information for developing subsequent lecture content. As a self-assessment tool, students rate their own and their group members' preparation and knowledge and the difficulty level of the material. As a source of information for lecture development, students report on the most challenging and interesting aspects of the course content and ask specific clarification questions. Using this same form, students are also able to provide more general feedback on the course and the interteaching model. Feedback provided on the interteaching record was used by the lecturer to develop content for the subsequent brief lecture (40–60 min) which was delivered before the next tutorial class.

8.4 Evaluating Interteaching: Outcomes for Students and Staff

8.4.1 Outcomes for Students

A single-group pre-post (non-experimental) design was used to evaluate the impact of the interteaching model in several areas, including exam grades, student perceptions of academic progress and learning, engagement with learning, and course satisfaction. The research evaluation was approved by the RMIT Science Engineering and Health (SEH) College Human Ethics Advisory Network (CHEAN). The methodology and results are summarised in this section.

A total of 142 of 169 students enrolled in the course volunteered to participate in the evaluation. Participating students were predominantly female (122 females, 20 males), ranging in age from 17 to 47 years ($M = 21.55$, $SD = 4.22$). Participants

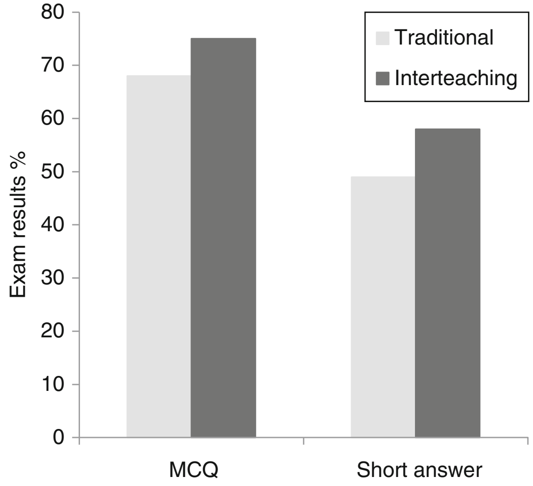

Fig. 8.1 Comparison of MCQ and short answer question exam results for traditional model and interteaching model

were predominantly Australian born (81.7 %) with English as the language spoken at home (69.9 %). The return rates for surveys at pre, post, and 6-month follow-up were 84 %, 72 %, and 27 %, respectively. Analyses were conducted on 100 matched sets of pre-post data and 33 matched sets of follow-up data.

Evaluation data indicated that interteaching was successful in improving student learning experiences and outcomes. Improvements were observed in academic achievement, student perceptions of their own learning, academic engagement, satisfaction with interteaching, and overall course satisfaction.

When compared to exam results in previous years, results indicated that depth of conceptual understanding was greater with interteaching compared to the standard teaching model. The mean total exam result with interteaching (71.2 %) was significantly higher than that recorded in the previous year using the traditional model (62.6 %). Figure 8.1 shows meaningful improvements in multiple choice question (MCQ) and short answer question exam results using interteaching.

Consistent with the improvements in exam results, the majority of students (62.3 %) reported that they believed they learned more with the interteaching model (see Fig. 8.2). While exam grades and student perceptions suggest that students learned more with interteaching, students did not perceive a change in their own academic progress. At all three data collection points, on average, students indicated that they believed they were progressing at “about the same” rate as they expected. Students’ perceptions that they were learning more, yet progressing at a similar rate, suggests that they were aware that the amount of learning required to do well with the interteaching method was greater than traditional models.

Interteaching had the expected positive impact on student engagement. A five-item survey was designed by the researchers to assess participants’ engagement in their own learning. These items ask participants to report how often they have engaged in a range of learning experiences including reading, assignment work, preparing for class, working with other students outside class time, and class discussion.

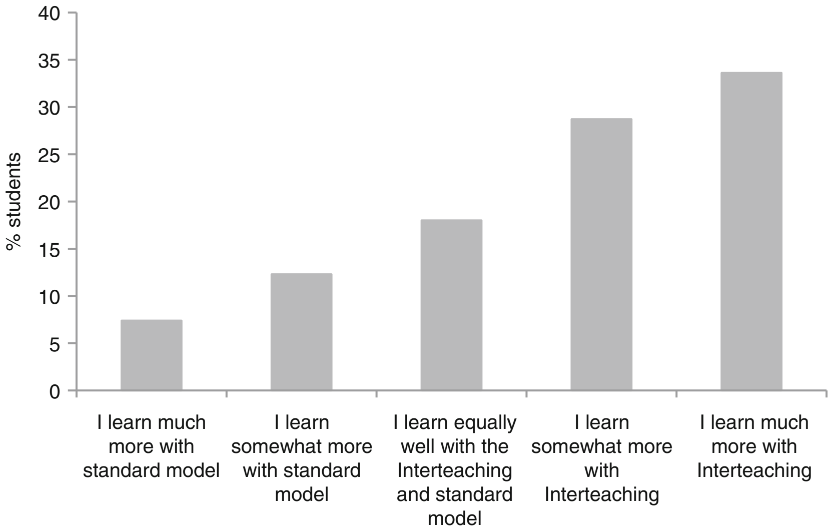

Fig. 8.2 Student responses on the post-survey item asking whether they believed they learned more with the interteaching model compared to the standard model

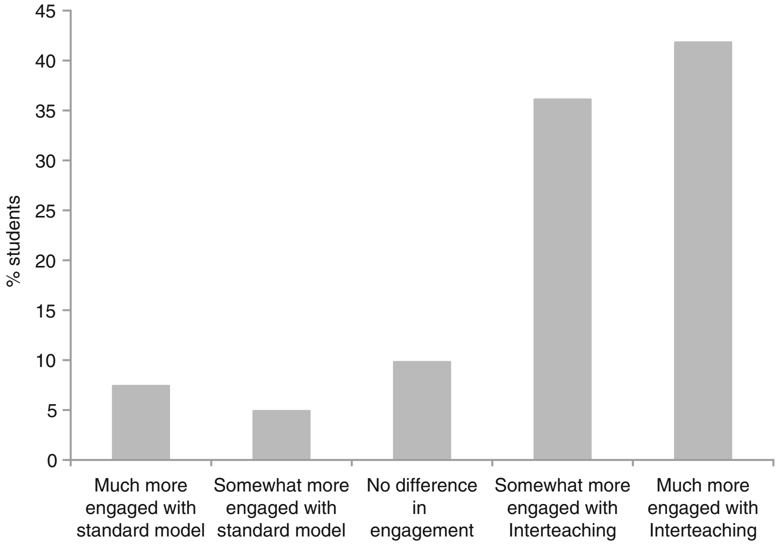

Fig. 8.3 Student responses on the post-survey item asking how engaged they were with the interteaching model compared to the standard model

A moderate-sized, statistically significant improvement in self-reported student engagement was observed by the end of semester. Consistent with this finding, the majority of students (77.9 %) reported being more engaged with the interteaching model compared to the traditional model of teaching (see Fig. 8.3).

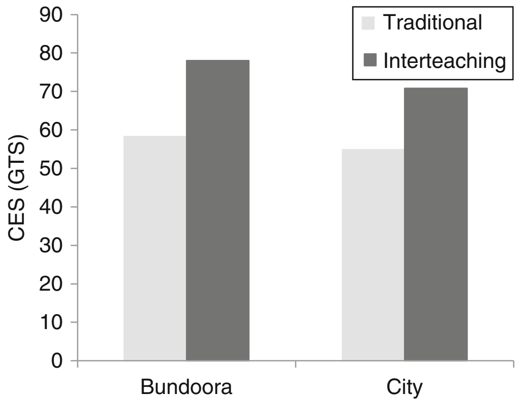

Fig. 8.4 Comparison of good teaching scores (GTS) for standard teaching model and interteaching presented separately for each campus

Student comments on the end-of-semester course experience survey (CES) suggest that students were aware of their increased engagement and the importance of continued commitment throughout semester for developing academic confidence and independent learning. Student-reported advantages of the interteaching model over the standard model included the following: "Engage more with tutors and other psychology students; builds up my confidence because of the engagement with others"; "Encouraged me to engage in my own learning"; "Influenced me to study topics more thoroughly throughout the semester, rather than just before exams".

To assess the impact of the interteaching model on student satisfaction, comparisons were made between 2009 (tradition model) and 2010 (interteaching) scores on the good teaching scale (GTS) of the RMIT University CES. Students complete the CES at the end of each course, and the GTS is considered a valid measure of student satisfaction with teaching quality. Averaging across campuses, there was an 18-point increase on the GTS. Figure 8.4 shows a comparison of CES good teaching scores for the traditional model and interteaching, presented separately for each campus.

While GTS scores are a general measure of satisfaction with teaching quality, GTS is influenced by a range of factors other than the teaching model (e.g. level of feedback provided on assignments, teacher ability to explain things). For this reason, students were asked directly about their preference for the interteaching model over the traditional model of teaching. The majority of students (63.9 %) reported a preference for the interteaching model (see Fig. 8.5), suggesting that increases in overall satisfaction can, at least in part, be explained by interteaching.

8.4.2 Outcomes for Staff

Implementation of the interteaching model has implications not only for students. The development of any innovation, particularly one that shifts the ownership of learning as radically as the interteaching model, is bound to impact on the staff who

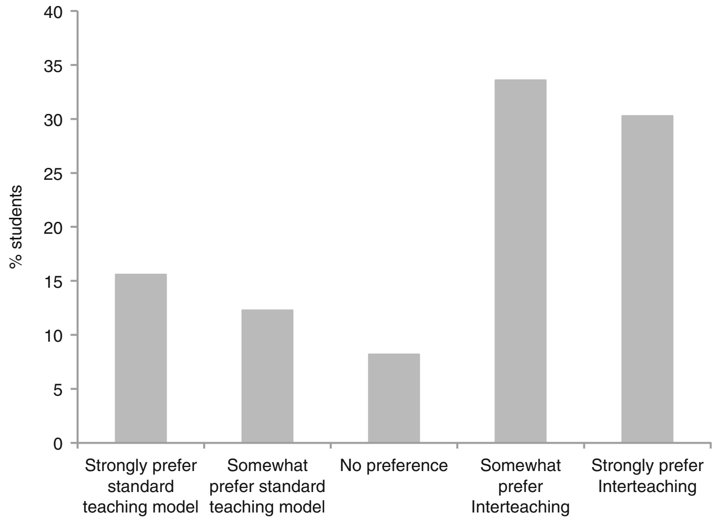

Fig. 8.5 Student preference for the interteaching model

teach it. Following the first year of implementation, we interviewed staff to examine their experiences of the model. Their responses are summarised in this section.

Of the eight staff in the teaching team, five participated in the interviews, including individual interviews with each of the lecturers and a 70-min focus group attended by three of the six sessional tutors. The lecturers were both experienced in the teaching of the course. The tutors working in the team were all psychology postgraduate students, with experience tutoring in psychology, but not necessarily in this course.

Beyond the work entailed in the implementation of a new teaching approach, results suggested that the interteaching model was associated with a shift in perceived roles and workload. Both the lecturers noted the time pressures of the model, with a tight turnaround between collation of the interteaching record information and preparation of the lecture material. However, this was seen as a trade-off for a more student-centred approach. Both lecturers expressed increased confidence that their teaching was aimed at the right level. The interteaching record made it "clearer what aspects I needed to flesh out or focus on in the lecture … I felt like I was pitching it at the right level for the students". This focusing of information on the needs of the students translated into perceptions of enhanced student engagement. "I had a sense", one lecturer commented, "that the changes were really positive for their learning of the material…. I did have a sense that they were really engaged".

The tutors also noted the interplay of both advantages and challenges in the model. Tutors noted that the increased responsibility of students for their own learning resulted in enhanced engagement. "It was a joy to see the students really engage; you really saw them connect with the material". Just as the student's role was perceived differently in the interteaching model, so too the tutors perceived a shift in their role compared to the traditional lecture/tutorial model. Because tutorials precede lectures in interteaching, tutors felt a pressure “to be much more on top [of the material] than with the regular teaching model”. This focus was not anticipated, given that the model emphasises both the preparation of students and the role of lectures in addressing questions. Nevertheless, tutors expressed complex and ambivalent attitudes towards the model, including their own expectation that they “teach content” and a resistance to doing this.

Tutors also commented on the effort required to grade students on participation each week. Tutors used the term “hypervigilant” to describe the approach they adopted in class. As one tutor explained,

> Because participation was such a huge part of their assessment it required that I knew every single individual; that I was monitoring how they were going as individuals and in groups it required a lot of concentration … it was really hard work.

The work required by the interteaching model was perceived to be greater than the traditional model. As one tutor concluded, “from a practical, selfish perspective it was so much work involved. It’s much easier to prepare and facilitate the standard tutorial model”. The benefit, however, of a diligent focus on student engagement was enhanced knowledge of one’s students and an increased ability to support students throughout the semester.

> You knew how every single student was going every week so you could really pick up if they were starting to fall behind or [if] they were struggling you pull them up instead of it getting to end of semester and they’re overwhelmed or they’re not engaging.

The perceptions that emerged from the interviews and focus group described both pleasure and frustration as the boundaries that had previously been clear around and between lecturer and tutor were muddied. Just as the role of the student is renegotiated in interteaching, so too are the roles of staff.

8.5 Issues and Implications: Ongoing Development of the Interteaching Model

Results from our evaluation of interteaching indicated that the model was successful in improving student learning experiences and outcomes. The majority of students reported a preference for interteaching and that they were more engaged and learnt more when using interteaching, and teacher perceptions and exam grades mirrored student perceptions. While the success of the model has led to its continued development in Developmental Psychology and recommendations for use in other courses, a number of areas were identified for improvement. These include the content of interteach sessions, tutor support, the assessment process, developing the communication skills of shy students, and the delivery of lecture content.

8.5.1 The Content of Interteach Sessions

When developing the tutorial programme, a standard structure for interteaching sessions was established. This structure began with students engaging in small-group discussion to discuss responses to interteaching discussion questions, followed by sharing of responses and clarification of misconceptions as a class. This was then followed by completion of interteaching application questions and activities in small groups. Student and tutor feedback indicated that following the same structure each week became repetitive as the semester progressed and that student and tutor interest could be increased by altering the structure and developing some alternate learning tasks. As a result, a set of enhanced tutorial activities have been developed in collaboration with the RMIT University Study and Learning Centre to increase student engagement with learning materials. More engaging ways of reviewing the interteaching discussion questions included taking on “thinking hat” roles in small-group discussion (de Bono, 2010) and inviting student groups to devise a simple learning activity or memory strategy to teach their classmates about a particular topic. Continual improvements have also been made to increase student engagement and responsibility for their own learning. These include the use of an understanding check quiz at the end of each interteaching session and a progress summary sheet to help students monitor their progress.

8.5.2 Tutor Support

While tutors understood the value of interteaching for student engagement and learning, and found teaching prepared students to be more rewarding, they reported workload pressure and concerns that they were required to step into the lecturer’s role. To address this issue in subsequent offerings of the course, the course coordinator provided tutors with regular meetings, a more comprehensive tutors’ guide that provided detailed answers to the interteaching discussion questions, and improved communication to students and tutors regarding lecturer and tutor roles. More recent feedback from tutors suggests that these improvements have resulted in reduced tutor stress and increased tutor satisfaction with interteaching.

8.5.3 Assessment

Tutors also commented on the effort required to grade students on preparation, participation, and communication skills each week. Tutors’ concerns were reflected in student feedback that they were not confident that tutors knew them well enough to grade them accurately. To address these concerns, a number of suggestions were offered by tutors, including the option of assessing each student on alternate weeks rather than every week. Assessing students in every other class without students knowing which week they will be assessed has also been suggested by others (Armstrong & Boud, 1983), and this seemed like the most acceptable solution. The assessment process was also improved by providing both tutors and students with a more detailed assessment rubric and allowing more tutorial time to explain the assessment requirements to students. We also placed a greater emphasis on the importance of tutors learning student names from the very first class and have trialled a range of strategies to assist tutors to do this (e.g. name tags). Feedback suggests that these changes to the assessment process have resulted in decreased tutor stress and increased student confidence in the assessment process.

8.5.4 Developing the Communication Skills of Shy Students

When planning the assessment for this interteaching course, a central aim was for all students to develop their confidence in communicating in small groups and to the whole class. We were mindful that the assessment process would be particularly challenging for shy students, and student and tutor concerns were monitored during the initial implementation. During the initial implementation, there were only a few cases where tutors raised concerns about quiet students, and tutors were advised to consult with students about the importance of developing communication skills and discussing ways for students to develop their confidence. As communication skills were explicitly stated on the assessment rubric, students also received feedback about their development in this area at mid-semester, allowing an opportunity to incorporate this feedback in the second half of the assessment period.

More recently, a number of methods to address this issue have been emphasised in tutor training and when explaining the assessment criteria to students. In tutor training, tutors are advised to monitor individual student participation from the beginning of semester and to consult with the coordinator about individual students who may need additional support. This advice is repeated throughout the semester and is also discussed with tutors when mid-semester feedback is reviewed. Tutors are supported to foster a supportive environment where shy students will feel confident to share their ideas, and this is assisted by the assessment requirements. The communication skills outlined in the assessment rubric include "encourages others to share responses and ideas using verbal and non-verbal prompts" and "challenges others' responses and ideas in an appropriate, assertive manner." Further, because interteaching focuses on student discussion in small groups, students could do reasonably well in this assessment without contributing to larger group discussion. Within this supportive learning environment, we hope that shy students will at least develop confidence and skills while communicating in small groups.

The student comment below reveals the concerns shy students have and alludes to the importance of focusing on assessment of communication skills:

> I just found that for someone like myself who does not feel very confident to answer questions in front of a class a little hard as I was prepared but sometimes felt I may come across as unprepared as I was nervous to speak aloud. Although I felt I definitely became more comfortable as the semester went on to offer my thoughts.

If discussion contribution had not been assessed, this student and others like her may not have “stepped out of their comfort zone” and developed the confidence to share her views. While we continue to monitor this issue and consider novel ways to address individual student needs, we see the development of communication skills as important, and this assessment as a means to do drive this development.

8.5.5 Enhanced Lecture Delivery Using Web 2.0 Technology

Student behaviour and feedback from the initial evaluation indicated that students may prefer flexible delivery of lecture content instead of weekly face-to-face lectures. Student attendance at face-to-face lectures in the interteaching model was low, and student feedback suggested that the reason for this was that students had already moved on to the next topic by the time the lectures were delivered. It seemed sensible for lecture content to be delivered prior to students beginning their preparation for the next topic; however, from a practical viewpoint, this was challenging. Given the constraints of timetabling and lecturer workloads, as well as considerations around flexibility of access for students, podcast delivery of lectures was considered. Research demonstrates that podcasts are perceived favourably by students (Chester, Buntine, Hammond, & Atkinson, 2011), particularly in regard to flexibility of access both in time and location (Jarvis & Dickie, 2010), learning satisfaction (Ip et al., 2008), and opportunities for revision (Shantikumar, 2009). More recently we developed and evaluated a series of brief audiovisual podcast learning modules (*podules*) to replace face-to-face lectures. These podules were developed based on student feedback provided on the interteaching record and were made available to students 2 days after the interteach tutorial. This allowed for students to review the lecture content before preparing for the next interteach topic. The incorporation of *podules* into the interteaching model marks a substantial adaption and highlights the role of learning technologies in shaping teaching practices.

These adaptations have been incorporated into the interteaching model, and the revised interteaching approach has been evaluated. A total of 99 students enrolled in the Developmental Psychology course volunteered to participate in an end-of-semester evaluation. Overall, results revealed that the gains in academic progress, student engagement, and student satisfaction observed during the initial implementation were maintained. These results suggest the adaptions have been successful, in particular, that the substitution of podules for face-to-face lectures in the course does not detract from the learning benefits of the interteaching model. The cost and time effectiveness of podules in comparison to traditional lectures further recommends the continued implementation of podules in the interteaching model.

8.6 Future Developments and Directions

Ongoing feedback continues to shape the implementation of interteaching in Developmental Psychology. Based on the success of the model in Developmental Psychology, interteaching is currently being implemented within a range of disciplines across our university. Based on research at other universities (Emurian & Zheng, 2010; Goto & Schneider, 2009; Tsui, 2010), it is expected that interteaching can be adapted successfully for use in other disciplines at RMIT. It is anticipated that this project will result in a sustainable training, evaluation, and dissemination model that can be implemented by other universities.

A number of important and interesting questions remain regarding the essential elements of interteaching and how interteaching works to increase student engagement and academic results.

While it is clear the interteaching model has been effective in a range of areas, further work is needed to determine the components of the model that are essential for increasing student engagement and academic performance. For example, are frequent quizzes necessary or are grades for participation enough to motivate students to do their best work? Boyce and Hineline (2002) discuss the importance of reinforcement and incorporate a range of different reinforcers, including quizzes that count towards student grades. Our adaption of the model includes non-assessed quizzes as student self-assessment to increase student engagement and responsibility for their own learning. While we have not assessed their effectiveness, they seem to act as a natural reinforcer. We also provide tangible reinforcers for participation which are not emphasised by Boyce and Hineline. It would be valuable to compare the effectiveness of different reinforcement methods in the future.

It is important to understand better how interteaching works to improve learning outcomes. Do increased expectations for student preparation and participation lead students to engage in a surface approach to learning—to learn "just enough" to perform well in class discussion? Or does the model increase engagement and interest so that students are motivated to engage in the deeper learning required for career success (e.g. analysis, synthesis, application)? Our exam results suggest that students are retaining more information compared to the standard approach; however, whether they are retaining this information beyond the exam is not known. Ideally, we would hope that interteaching leads to increased academic self-efficacy as students develop skills in a supportive learning environment, which facilitates increased engagement, a deeper approach to learning, and ultimately academic success. A more detailed analysis of the relationships between student engagement, student learning approach, academic self-efficacy, and academic performance with interteaching is needed before conclusions can be drawn. A better understanding of the relationship between these variables should guide future implementation of interteaching. For example, if we know that increases in academic self-efficacy are important for success with the interteaching model, greater emphasis could be placed on fostering student confidence.

Overall, most students are more engaged with interteaching and report a preference for interteaching over traditional teaching models. Our ultimate aim is to promote deeper learning and facilitate independent and lifelong approaches to learning. Preliminary results suggest that students are learning more with interteaching; however, it is unclear whether this learning is sustained over time or whether the skills acquired during interteaching are applied to learning in other courses. Our results suggest that investing in alternative teaching models can result in improved learning outcomes. There is also accumulating evidence that students are satisfied with podcasts, at least in the context of an enriched tutorial programme. However, more detailed evaluation of student use of podcasts is needed, as questions remain about whether all students have equal access to technology and whether students are using podcasts regularly and effectively. Future research that answers these questions will assist in providing a more engaging and effective learning experience for students. While interteaching is more engaging and rewarding for tutors and lecturers, there is the risk inherent in any innovation that interteaching, like similar alternative teaching models, leads to increased workloads for staff. This is particularly the case where teachers are required to develop new technological skills. For this reason, it is important that initiatives to adopt teaching innovations pay attention to resourcing and supporting staff.

This chapter began with the search for a better way to teach Developmental Psychology, one that would engage students and help them apply knowledge. We have found a new model focused on active engagement; a model that gives responsibility for learning to the student. Through the process of ongoing adaptation and evaluation described in this chapter, we have examined the effectiveness of this model and will continue to develop it both within Developmental Psychology and in other courses. The process of implementing and refining this new model has been a powerful one for the teaching team and our students, facilitating a renewed engagement with the course content and the process of teaching.

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Keywords Engaging science curriculum • Blended learning • Computer-aided instruction • Work-Integrated Learning • Digital wet laboratories

9.1 Introduction

Technological transformation is 'reshaping the fundamentals of how human beings from every corner of the globe communicate, interact, conduct their business, and simply live their lives from day to day' (Moe & Chubb, 2009, p. xi).

The world is changing at an unprecedented pace and so we must reimagine science education to suit today's world. This was one of the principal outcomes of the 2006 Australian Council for Education Research (ACER) conference called 'Boosting Science Learning' which was reviewed by Tytler (2007). The conference was organised in response to several government reports and papers (Logan & Skamp, 2008; Lyons, 2006; Tytler, 2007) that highlighted the mind-boggling problem of falling participation in science courses (particularly physical sciences) in the later years of secondary and also in tertiary education (Johnstone, 2012). In the forward to Tytler's report, Dr Jim Peacock (former Australian Chief Scientist) writes that he believes there are important considerations to be taken into account when reimagining science education:

- Science education should be discovery based in order to generate 'the spark of excitement'.
- Tasks should be relevant to the world around students.
- The teacher's confidence is as important as the materials used.
- Activities need to encourage collaboration just like real-world science.

Some even go as far as to say that the entire old model of higher education has reached a tipping point, is obsolete and facing a complete meltdown (Cuban, 2012) and needs to be disrupted to avoid total calcification. They call for transformation and a disruptive innovation model (Bower & Christensen, 1995; Bush & Hunt, 2011; Christensen & Eyring, 2011). These calls are often confirmed by alarming high university drop-out rates (Bowen, Chingos, & McPherson, 2009), soaring loan debt (Martin, 2012), return on investment of education data (Lavelle, 2012; Pew Research Centre, 2012) as well as higher than ever unemployment figures for university graduates (Yen, 2012), not mentioning the inevitable economic impact (Tan, 2012).

More recently, a number of press reports highlight the worrying fact that companies find it overall very difficult to hire *ready to work* skilled employees (Arum & Roksa, 2010) particularly in STEM (Science, Technology, Engineering, and Mathematics) disciplines (Koebler, 2012).

There has been an explosion of science knowledge with new advances in molecular biology and materials science. There has also been in the last decade a rapid development of innovative, collaborative and engaging online teaching technologies. Longitudinal studies of the effectiveness of these new delivery methods and platforms seem to show that (1) learning is taking place and (2) essentially the same results are produced as face-to-face instruction (Bowen, Chingos, Lack, & Nygren, 2012). A meta-analysis published by Shacher and Neumann (2010) reported that their results indicate students taking courses through distance education *outperform their counterparts in traditionally instructed courses*. We cannot continue to expect this generation of hyperconnected and hypermobile students to learn only in a didactic way, and the need to find alternatives to the exclusive face-to-face model is greater than ever. This was recently acknowledged by John Hennessy, President of Stanford University, in an article by Mossberg (2012). We need to provide choice, versatility and abundant hybrid learning scenarios: broadband Internet, smartphones/tablet computers, cloud-based applications, high-speed wireless technologies and interactive online learning platforms. Additionally the web can become a repository for resources and learning aids (Schell & Burns, 2002), for example, Merlot [http://www.merlot.org/merlot/index.htm], that can facilitate skill acquisition in experimental disciplines.

The fundamental question for this chapter is should academics rethink their role and start using new learning and teaching approaches that blend and utilise digital technologies in and out of the classroom? This chapter will discuss how innovative synchronous and asynchronous approaches have been successfully implemented in a biology programme at RMIT University (Australia) to engage students/staff and improve learning outcomes.

9.1.1 Rationale for the Adoption of Blended Learning and Work-Integrated Learning Approaches

Garrison and Kanuka (2004) define blended learning for the purposes of higher education as the blending of Internet technology with face-to-face learning. Garrison and Vaughan (2008) call it a 'thoughtful fusion of face-to-face and online learning experiences' (p. 5). As a test of how blended the learning is, there should be true integration and alignment between these two components (Ginns & Ellis, 2007; Olapiriyakul & Scher, 2006; Vaughan, 2010). When applied to practical laboratory sessions (digital wet laboratories), blended learning is not just an 'add-on' to a laboratory session, but an integral (and most certainly integrative) part of the functioning of, and activities within, the laboratory, much as one would find in industry. Like industry, computers are an integral part of acquiring, analysing, storing data and monitoring quality assurance, and laboratory practicals should, as much as possible, simulate real-world practice (Balamuralithara & Woods, 2009; Feisel & Rosa, 2005). Garrison and Kanuka also describe the 'proven potential to enhance both the effectiveness and efficiency of meaningful learning experiences' (p. 95) of blended learning, as illustrated by the large blended learning initiative launched at the University of Central Florida where '72 % (45,117) of students are enrolled in at least one fully online or blended course' and '87 % of the students are highly satisfied and 81–94 % of students succeed with an A, B, or C in the course' (Swenson & Bauer, 2012; para. 1). One of the strengths of a blended learning approach is 'to use technology to free yourself from the need to "cover" all the content in the classroom, and instead use class time to demonstrate the continued value of direct student to faculty interaction and discussion' (Bowen, 2006). This has been cleverly used in flipped classrooms (Bergmann & Sams, 2012; Houston & Lin, 2012) or in the UCLA's Gel Scramble tool for teaching molecular neurobiology (downloadable for free: https://mdcune.psych.ucla.edu/modules/gel).

The achievable efficiencies also means that the student workstations can be strategically positioned to display learning support materials in a timely manner and much of the assessment and feedback to students associated with the practical exercises can be performed 'just in time'. The original application of Just-in-Time Teaching (Novak, Gavrini, Christian, & Patterson, 1999) included pre-class activities designed to prepare students for instruction and to assess areas needing focused classroom activity. Used in the wet-practical laboratory, contextual resources created for pre-class activities can themselves be an in-class resource and blended into classroom learning and teaching activities (Grando, 2009; Marrs & Novak, 2004).

9.1.1.1 Closing the Gap Between Theoretical Knowledge and Applicability to the Workplace

Transformation of learning experiences when Information and Communication Technologies (ICT) are closely integrated with traditional teaching approaches is well established (Means, Toyama, Murphy, Bakia, & Jones, 2010). Learning spaces in many institutions have been redesigned in order to facilitate access to ICT, yet preserve and even enhance learning opportunities (MIT iCampus, 2007; Tregloan, 2007). ICT enhanced learning includes more challenge-/game-based (Freitas, 2006; Harris & Brophy, 2005; Prensky, 2001), simulation of the workplace environment and experiences (i.e. SciEthics Interactive go.nmc.org/khreb). In other words, learning by *actively* doing (virtually or hands-on, in-class or as an intern → Work-Integrated Learning) is paramount to effective preparation of science students for a natural transition into the workforce (Murday, 2010; National Academy of Engineering and National Research Council, 2012) and to develop students' ability to apply knowledge to real-world situations (Price, 2012). Integration of ICT into wet laboratories is not only timely but necessary given the already strong and growing technology focus of wet laboratories in the real world and in higher education institutions in general.

9.1.1.2 Is It Worth It?

The challenge with the rebuilding of wet laboratory learning spaces so as to take full advantage of the Web 2.0 technologies (in this case an online web-based learning system) is that it can be prohibitively costly, in an era when institutions are looking for ways to control costs and cut spending. However, smart integration of the technology into existing active learning spaces can have gains that mean that 'learning' can move out of the lecture hall and become real engagement (and achievement of intended learning outcomes) while performing realistic practical exercises, even with a large audience (Lloret, Garcia, Bri, & Coll, 2009; Yuretich, Khan, Leckie, & Clement, 2001). So is it really worth it? Absolutely according to a survey in 2012 by the EDUCAUSE Center for Applied Research, nearly 70 % of undergraduates said they learned most in blended learning environments while 54 % of students say they are more actively involved in courses that use technology (Dahlstrom, 2012).

9.1.2 Work-Integrated Learning

Farmer, Lindstaedt, Droschl and Luttenberger (2004) outline the workplace of a knowledge worker as comprising a 'workspace, a knowledge space and a learning space'. When applied to a laboratory simulating the workplace, workspace includes both the bench space and computer, learning space relates to the support for conscious learning, and 'knowledge space represents unconscious learning' (Farmer et al., 2004, p. 4). In our pilot projects for developing learning space components (learning objects), we have drawn carefully on the types of learning support that are created for professional development. The design of these learning objects includes defining the objectives of the learning experience and assessing learning outcomes *from* the experience (Conole, 2008; Conole & Fill, 2005). Along with learning objects relevant to workplace practice, we employ personnel from industry to give a workplace perspective and bring technical expertise. The closer to industry (so that we can simulate the laboratory space → reality-based learning), the greater the potential for unconscious learning (Gorman, Meier, Rawn, & Krummel, 2000; Van Wyk & de Villiers, 2009).

Arnstein, Sigdursson and Franza (2004) note that a physical divide persists between the physical and information spaces of biology wet labs. This issue has been addressed by installing a sophisticated laboratory-integrated computing system called Labscape at the University of Washington, Seattle. Labscape aims to invisibly integrate computing with laboratory equipment such that it can automatically sense the parameters of experiments. Arnstein et al. acknowledge that there may be positive and negative aspects to this level of sophistication. Although the digital wet laboratory at RMIT does not scale these heights of sophistication, we have drawn on the lessons learned with Labscape.

At RMIT University, digital wet laboratories have been adapted to serve the needs of service teaching as well as industry targeted training workshops/updates. Carl Wieman (2008), recipient of the Nobel Prize in physics in 2001 states 'The purpose of science education is no longer simply to train that tiny fraction of the population that will become the next generation of scientists…we need technically literate citizens with complex problem solving skills' (para. 1 & 2). A view shared by Irving Wladawsky-Berger (2012), former vice-president of technical strategy and innovation at IBM, 'STEM literacy is a particularly important subject for CIOs, given their role in leading this broad use of technology across the institution—and the challenge they face filling highly technical jobs at a time when STEM literacy is at a low level' (para. 2). MIT professor Richard Larson (n.d.) points out that 'a person has STEM literacy if she can understand the world around her in a logical way guided by the principals of scientific thought. A STEM-literate person can think for herself. She asks critical questions. She can form hypotheses and seek data to confirm or deny them' (para. 3). Face-to-face practical classes have still been found to be the best way to teach practical skills (Newton & Ellis, 2007), and indeed laboratory skills are a key competency for microbiology students (Merkel, 2012). In order for students to gain introductory skills, our first-year classes in cell, plant and animal biology as well as introductory microbiology include face-to-face practicals to tackle issues, demonstrate and practise techniques and discuss concepts.

9.2 Educational Environment: The Digital Wet Laboratory Project

In 1999, MIT through collaboration with Microsoft Research undertook a large-scale project to revolutionise teaching through the use of ICT (MIT iCampus, 2007). As part of that project, iCampus transformed 'the classroom experience by replacing traditional passive lectures with active learning experiences supported by information technology' (para. 4), reflected in the high quality of the annual innovative student projects (http://icampusprize.mit.edu/). Based on this, the transformation has also been applied to the learning activities in the digital wet laboratories of RMIT University (City Campus and Bundoora Campus) (Grando, 2009; Green et al., 2007; Vardaxis & Grando, 2007) firstly through continued development of electronic learning and teaching resources (such as digitised laboratory images, online microbial identification databases and real-time data acquisition display) and secondarily via deployment of an ICT management system. This ICT management system enabled files to be displayed/distributed and collected to/from student workstations (Fig. 9.1). It also controlled output to wall-mounted plasma screens.

Activities in the refurbished digital wet laboratories at RMIT University included (a) brief elements of lecture presentation, (b) electronic guides and resources, (c) self-directed digital learning, (d) hands-on experience in science, (e) group activities and (f) tutorial. The digital learning support materials such as electronic guides and resources have also been useful to prepare 'asynchronistic-comfortable' students and demonstrators before attending the wet practical classes (Jeschofnig & Jeschofnig, 2011). Use of these activities and electronic resources in concert transforms the wet laboratory into a transformative blended learning experience (Grando, 2009; Green et al., 2007). It has been reported that even when academics do not teach blended or online courses, 40.9 % of them regularly use simulations or videos in their courses (Allen, Seaman, Lederman, & Jaschik, 2012).

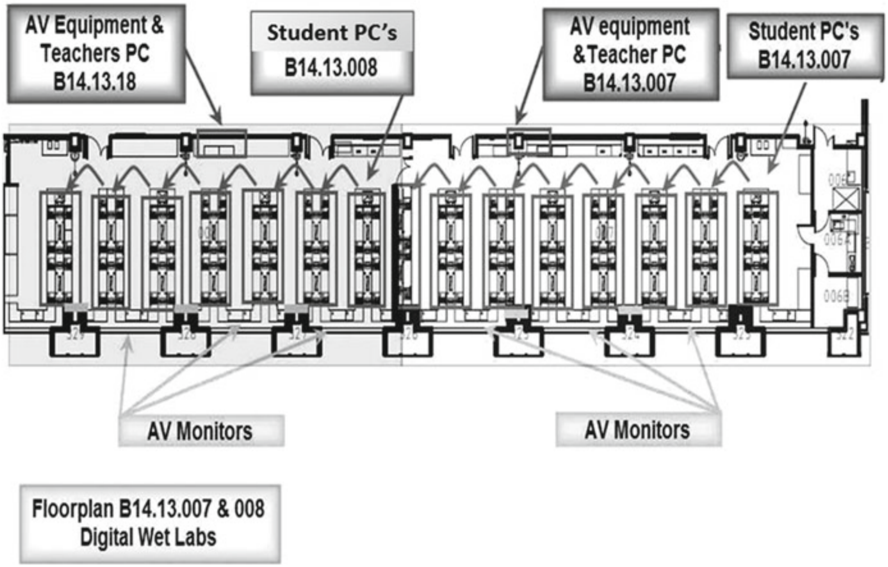

Fig. 9.1 Layout of RMIT city campus digital wet laboratory

MIT iCampus learning activities, as well as those of the tutorial lab at Melbourne University (Tregloan, 2007), are staged in specially designed classrooms designed to maximise student interaction, both with each other and with teaching staff. The building of these learning spaces required costly capital works that is not readily justified within the current competing budget climate facing Australian science schools. Noting that laboratory spaces, in research and industry, retain a linear bench geometry to allow easy access to chemicals and utilities, such a format was retained for the refurbishment of wet digital laboratories at RMIT University.

In order to get students to maximise the use of their time in class, it was decided to rethink the activities that students could participate in. It is known that pre-class preparation promotes participation in the classroom (Santandreu Calonge, Chiu, Thadani, Mark, & Pun, 2011). In the Introduction to Microbiology class, we also wanted students to feel that their classroom exercises mattered so we situated the exercises within relevant case studies. The National Center for Case Study Teaching in Science (NCCSTS) realises the importance of using case studies and has developed a website to showcase science examples (http://libweb1.lib.buffalo.edu/cs/). Since the programme leader had many years working in industry, it was decided to source these case studies from real-world examples. Although the digital wet laboratories project spanned the disciplines of cell, plant and animal biology and microbiology, the amount of blending varied with discipline. We will focus on the discipline of microbiology for this report as this represented the most extensive of the transformations in the curriculum.

9.3 Content

Introductory microbiology at RMIT University is taught in the first year of the Biomedical and Applied Science degrees. In total there are around 500 students spread over 2 campuses. These students have chosen to study towards degrees such as Biomedical Science, Laboratory Medicine, Biology and Biotechnology and Food Science. For some degrees such as Pharmacy and Pharmaceutical Science, it is the only exposure the students will have to practical techniques in microbiology. Previous to the changes made to the course (as shown in Fig. 9.2), the students had 18 h of lectures and 12 h of practical exercises. There was no assessment of skill acquisition other than written exams. For the blended learning approach, the lecture content was reduced by one third by removing topics that could be explored in an alternative way through online learning modules. Lectures were recorded using a personal digital recorder so that students could access the audio recording of each lecture online in the course Blackboard site. The course curriculum changed to include (1) pre-practical preparation, (2) practical exercises rewritten as case studies, (3) mini-introductory talks in the digital wet laboratories and access to student support materials in the digital labs and (4) formative in-practical class assessment of skill acquisition through examining student practical techniques (Froyd, 2008; Garcia, Gasiewski, & Hurtado, 2011; Merkel, 2012; Nielsen, 2011; Smith et al., 2005; Sokoloff, Laws, & Thornton, 2007).

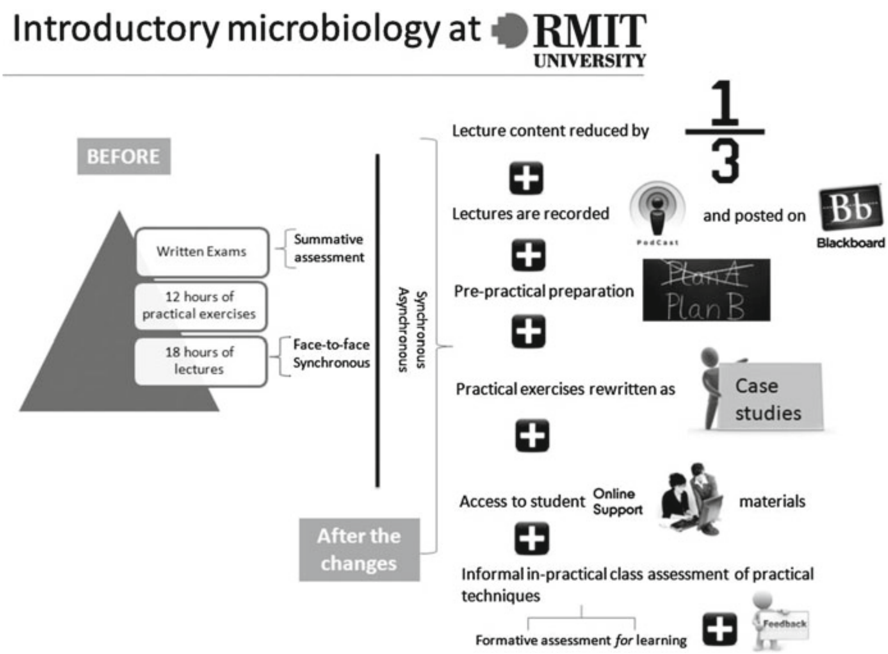

Fig. 9.2 Curriculum before and after the project changes

9.3.1 Pre-practical Preparation

Students were set weekly diagnostic online activities (Riffell & Sibley, 2005), to be performed before each of the first three practical classes (three modules). These modules were worth 10 % of their course mark, and completion of the module was measured through the performance of online tests. Each test consisted of 20 multiple-choice questions and students had to achieve a minimum of 80 % correct on each test to receive the full 10 % of marks. Students could perform these tests unlimited times; however, if they missed a test, they only received two out of a possible ten for each test completed.

The first of the weekly activities consisted of the viewing of three in-house videos produced on safety in the microbiology laboratory. These videos had been produced as part of learning and teaching grant to explore the educational use of video. During semester break, two students who had recently completed the course and had experience with producing 'YouTube' video were paid for 2 weeks to firstly workshop the contents and then act out humorous scenes to illustrate laboratory safety. These videos were then edited and annotated by our staff to produce the safety videos that have been viewed by each cohort of students in the class since 2008. The feedback on these videos from staff and students has been very positive.

The next two weekly activities took the format of what we have called learning PowerPoints (Amare, 2006; Berk, 2011). Each learning PowerPoint would cover either content briefly (already covered in lectures, thus allowing for quick revision) or introduce new content. Students were able to self-check their understanding through questions built into the learning PowerPoints that linked to explanations of the answers (Fig. 9.3). At the completion of each of these learning PowerPoints, the students completed the 20 multiple-choice question on line test.

A student commented on the usefulness of the pre-prac learning PowerPoints:

> I found them really helpful. There were some aspects of the prac that I wouldn't have understood if it wasn't for the pre-prac PowerPoint presentations

and

> You know you can find what you're looking for, especially if you have the idea wrong. You thought you have it right, and then you see it in the actual PP, then you go, hey now, I get it, and doing it again reinforces it

Students were also able to review their lecture material on demand by listening to pre-recorded audio, carefully designed with the online listener in mind. This included frequent references to slide numbers and pauses for questions to test the students understanding of the material. A student commented:

> The availability to listen to the audio while working through the notes has made learning this subject far far easier. In fact I have become extremely enthusiastic about the subject and look forward to my study time for the unit each week. Your effort in the unit set-up is appreciated.

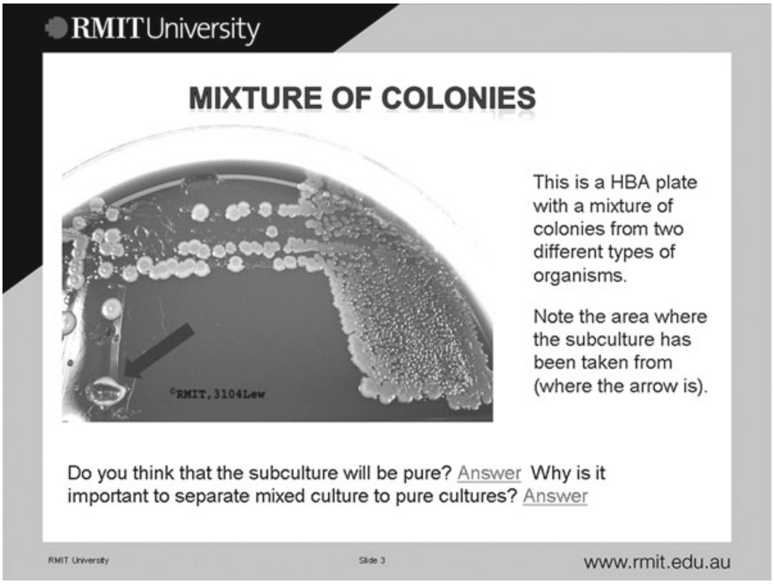

Fig. 9.3 Example slide from a learning PowerPoint exercise

9.3.2 Exercises Converted into Case Studies

As mentioned in the Introduction, it is important to engage students in (1) problem solving and (2) discovery. Making challenging tasks relevant to the world around them is therefore of paramount importance (Kuh, Kinzie, Schuh, & Whitt, 2005). Previously, students were only provided with instructions and recipes in order to practise technique, and assessment tasks focused on this narrow outcome. In the new version of the practical manual, each exercise was prefaced with a description of a case study (inquiry-guided/problem-based learning) to situate the students' learning in a real issue (Lee, 2012; Prince & Felder, 2006). An example of such a case study in shown in the box below:

Case Study to Situate Learning

Analysis No 4: A food manufacturer is concerned that they have had two reports of projectile vomiting in infants following the consumption of infant food cereal. They have sent samples to ACME science for investigation.

Case studies were inspired by real-world examples common to the experience of the teaching staff in order for the instructors to feel confident in helping students understand the importance of performing analyses as accurately as possible. Also, exercises were designed so that the work involved in some analyses is divided amongst a team of two (think-pair-share) and sometimes four students to encourage brainstorming, collaboration and teamwork (Oakley, Felder, Brent, & Elhajj, 2004; Springer, Stanne, & Donovan, 1999).

9.3.3 The Practical Session

As each of the six practical sessions was scheduled for 2 h, it was important that the class was well organised and structured. This was enabled by the format of the digital wet laboratory. To create a digital wet laboratory, an existing practical laboratory was fitted with a student computer at each student workstation (Fig. 9.1). A central teacher station had software installed that (1) enabled content to be streamed or sent to each student computer and (2) have content streamed to a number of plasma screens on the walls around the practical laboratory. Each class began with between 5 and 10 min of material that would have previously been in the lecture, but had now been moved to the relevant practical. This mini-lecture was streamed either to plasma screens or student computers.

Students then had sent to each of their screens an electronic resource pack. This contained resources such as *how to* videos and recipes for techniques that would be used in that class. Each resource pack was tailored for a particular class so that students received a new one for each class. Students would then have a mini demonstration of techniques by their class instructors (one class instructor/12 students).

The remainder of the laboratory time was for students to investigate and report their case findings into laboratory books. As new skills were learned in each class, students were assessed on their skill acquisition. For instance, the first week they learned to use a microscope to investigate a variety of microorganisms. They were taught trouble-shooting techniques in this class. In their second class, students again used a microscope to investigate a new case; however, they were required to show the instructor that they were able to set up the microscope for viewing as the instructor had previously 'meddled' with the microscope set-up! If students did not manage to use the microscope professionally, they received instant feedback and were given an additional opportunity the following week (reflective process) to master the practice (Dunne, 2011; McDonnell, O'Conner, & Seery, 2007). With coaching, each student passed each technique hurdle in the 6 weeks (three assessed technique hurdles). The two remaining assessment tasks were performed during the final sessions, and these were for how students recorded their experimental findings and a 'happy mark'. The happy mark was based on how eagerly they engaged in the collaborative activities (teamwork) and whether they attempted to ask relevant questions. We stressed with students that a positive attitude and good communication skills are vital in the sciences!

In order to keep the sessions running on schedule, a lesson plan was displayed on each of the screens (Fig. 9.4). The electronic resources pack on each student's

Lesson Plan Session 1

- Introduction by Danilla — 10 min
- How to use the microscope video — 10 min
- Instructor demonstration — 20 min
  - Safety
  - Using the microscope
  - How to perform hand hygiene prints
- Ex. 1a S1 – practice setting up mic with prepared smear
  S2 – complete the "What organism am I?" quiz — 20 min
- Then swap roles S1 and S2 — 20 min
- Ex. 1b Plate culture with mystery organism — 10 min
- Complete Hand Hygiene Study Part 1a — 10 min
- Discussion of your results and answers with demonstrator — 15 min

Fig. 9.4 Example of lesson plan to keep students on time

computer means that they could access help when their instructor might be busy helping or assessing a student. A visitor to the digital wet laboratory noted how focused and engaged the students were in their activities compared to other practical classes (reproduced with permission):

> I was impressed with how focused the students were in this class I observed in the digital wet lab (quite different to what I see in my lab classes, though I note it is a different student cohort, so that might make the difference!). I want one! I can't wait until we get a similar lab in my area!

Initially instructors in this class expressed concerns that they would be made redundant through the provision of so much pre-preparation and online resources during the sessions (Redmond & Lock, 2011; Vaughan, 2004). Instead these instructors have commented on how well prepared the students were for class and that the students assimilated the theoretical knowledge well over the short series of sessions.

The students themselves have expressed amazement at their knowledge and skill acquisition over such a short period of time. Students have commented:

> In this particular class the digital learning has been exceptional. Instructions clear, information easy to find and follow and assistance given quickly when assistance required.
>
> I have only experienced advantages in comparison to former lectures conducted at uni. I have accelerated learning, better explanation and tools to complete assessment.
>
> Just a quick email to express mine and my classmates enthusiasm and appreciation of both the GERMM and pre-practical slideshows as used in Microbiology 1 (BIOL2158.) Both of these resources have been invaluable through our studies and practical classes, and no doubt will be for future classes and years.

Importantly more students are expressing an excitement to continue a career in science after their interest has been ignited by the material.

Table 9.1 Learner satisfaction survey (5-point Likert scale; $n=32$)

Aspect	Response
The role of the digital learning support of my practical classes has been clearly communicated to me	4
I have been provided with constructive feedback in my digital learning support of practical classes	3.9
Digital learning made my practicals more interesting	4
Digital learning helped me with my understanding of my practical classes	4
Digital learning enabled me to prepare for the practical class	4
I have sufficient support to enable me to use the digital learning materials	4
Digital learning helped me identify areas in my learning that required further attention	4
Digital learning demonstrated that I was making progress in my understanding of the practicals	4
Digital learning demonstrated that I was making progress in my understanding of the overall course	4.2
Working with digital learning support enhanced my IT skills	3.5
Digital learning combines well with the learning in the practical laboratory	4.2
The whole digital learning experience was positive	4.5

9.3.4 Digital Wet Laboratory Evaluation

To determine the effectiveness of the blended learning approach to digital wet laboratory learning (DWL), students attending one offering of a DWL practical class in 2008 were surveyed using an online *Learning Experience Questionnaire* designed during the 2007 phase of the project. They were invited to provide responses using a 5-point Likert response scale with point 1 marked 'strongly disagree' and point 5 marked 'strongly agree' (the three in between points were not marked). At the end of the scale, a point was provided marked 'don't know' and if marked did not form part of the score. Questions about their satisfaction with the technology and learning gains on specific outcomes were also included to help instructors gauge the success of the first offering of this course. Students were invited to stay at the end of class to complete the survey, and the survey was handed out and collected by someone not associated with the teaching of the unit.

9.3.4.1 Findings

Thirty-three students were invited to complete the survey, and 32 completed surveys were returned. Students were not given any incentive to encourage them to participate. The average rating (on 5-point Likert scale; $n=32$) obtained for each statement is presented in Table 9.1.

Students' ratings suggest that (1) they felt the digital learning approach was particularly engaging and useful, (2) it helped them improve their skills, (3) boosted their motivation and confidence levels as well as (4) self-efficacy. The structured blended approach as well as the alignment with the learning and teaching activities in the practical laboratory was well received, and the way the instructors supported them was useful and strongly appreciated.

Staff were also strongly supportive of the changes (the following comment is from an academic invited to participate in the project):

> Thank you for the opportunity to contribute to this project, and I wish you all the best with your endeavours to get more digital materials up and running. It was a huge success.

Another academic noted that the digital wet laboratory enabled a more integrated approach to discussing experimental data generated by students:

> The groups' results are then entered into the main lab computer to be shared with the rest of the class. The results from the whole class are displayed resulting in a discussion of the variety of data collected. The overall results are then sent to all students for their reports

It was interesting to note that students are still attempting to print out all the resources. For instance, students commented that there was 'too much to print out'. Over time we have seen less students coming to class with printouts due to the ready access to online access to the material. A teacher commented:

> Most students access their prac lab notes via the lab computers rather than printing them out

In one laboratory where computers were retrofitted, bench space was reduced due to keyboards. A student commented:

> Not enough bench space to keep things aside. Digital is really great, however bench space could be maximised

It is hoped with the introduction of touch screen technology will reduce the problem of situating keyboards amongst experimental material.

9.4 Discussion

9.4.1 Digital Wet Laboratory Challenges and the Way Forward

Combining digital with experimentation is not new to the workplace, increasingly science professions rely on real-time computer-based acquisition and analysis of experimental data (Fig. 9.5). This presents many challenges for tertiary institutions as the laboratory environment in science may use hazardous chemicals and Bunsen burners. In industry, laboratories overcome this by using electronic versions of burners and fume hoods for working with chemicals.

An additional challenge was justifying the cost of fitting out existing laboratories with computers. In 2007 a project grant was received to transform the existing city campus laboratory into a digital wet laboratory. By comparing the results of quality assurance questionnaires (Table 9. 2) distributed to students that give a good teaching

Fig. 9.5 Student and teacher discussing experimental results with the aid of computer resources in a digital wet laboratory

Table 9.2 Good teaching scores (GTS) comparing those in the digital lab (city) to the Bundoora cohorts

	GTS 2007 (%) predigital lab	GTS 2008 (%)	GTS 2009 (%)
BIOL 2256 (city cohort, digital lab 2008)	53	75 post-digital lab	70[a]
BIOL 2257 (Bundoora cohort, no digital lab until 2009)	57	53	60 post-digital lab

The GTS is calculated by adding the number of students in a course that ‘agree’ or ‘strongly agree’ with good teaching items on a questionnaire as a percentage of all student responses, so the GTS ranges from a low of 0 to 100 %

[a]Students commented on slow and unresponsive computers. Requests were made to the Information Technologies Department to address this issue

score (GTS) for each course, we were able to argue that students at the Bundoora campus (Melbourne, Australia) were disadvantaged by not having access to computer resources during their practical classes. We also have students who travel from remote parts of Australia to undertake laboratory classes, and these students may not be able to afford or have access to computers. This argument was successful and a practical laboratory at Bundoora was also transformed into digital wet laboratory for 2009.

It is interesting to note that in 2009, when the Bundoora cohort first performed their practical classes in DWL, the GTS result did not rise as markedly as the City cohort had in 2008. The Bundoora students may have been influenced by the fact that the School of Medical Sciences had implemented DWL in other laboratory medicine classes in 2006. There may have been a lack of ‘wow’ factor in this group of students who had already experienced DWL in other classes. It is interesting that one Bundoora student commented:

> Why haven’t we had this a long time ago, I mean we have computers for everything else, why can’t we have them in the labs?

A limitation of the evaluation performed on this project could raise the question ‘Are the students’ learning less now?’ Students are required to demonstrate technical capability development through assessment of their performance of techniques. In fact the ready access to resources helps them practise in class before assessment. The curriculum is also reviewed by a programme team, and no adverse findings have been reported by those who teach at second-year level. In fact there is anecdotal evidence that students who enter into our university from elsewhere have knowledge ‘gaps’ and lack of technical expertise. To help these students, the digital materials developed for first-year classes have been embedded into the second year as bridging materials, and we have received messages of thanks from those students.

9.4.2 The Paperless Laboratory

During the introduction of digital wet laboratories at RMIT University, other discipline groups such as biology (cell, animal and plant) have been supported with project funds to develop learning resources to be used both in and out of laboratory sessions. The aim of this work was to enable students to progress more efficiently through the practical sessions so that they have more constructive time in class to digitally analyse their findings and compare their results with those of other students and those of previous experiments. Too often students take home the results of practical classes only to flounder in the interpretation of these findings while trying to write up results out of class. On the conversion of practical manuals to digital manuals, a tutor in cell biology commented:

> The digital answer sheets made submission of student work run the smoothest ever. The students really liked them and found them very easy to use. The answer sheets eliminated all need to reiterate over and over what was required for submission.

and

> The updated pracs – with errors removed – also made the ‘pracs’ run much more smoothly and the students were much more positive about their experience than they have been in the past.

and

> Digital access to the lab manuals also allowed us to update anything on the spot rather than thinking of it and then forgetting to do anything about it…. All up it was a great success.

9.4.3 Electronic Marking of Reports

We are currently piloting the use of electronic devices to mark student scientific reports (Berque, Bonebright, & Whitesell, 2004; Derting & Cox, 2008). As many science classes involve the drawing of observations, moves to electronic reporting have been slow. The availability of pen devices can change this, and so in our physics laboratory, electronic tablets and pens have been provided for students to draw their findings. These electronic files can be easily accessed by instructors who also mark up these reports with comments and then send the files back to students. In this pilot trial, the turnaround time for feedback to students was reduced significantly compared to the traditional submission of paper reports. This has also been observed by Santandreu Calonge et al. (2011). A demonstrator noted:

> …because they have to have it done by the end of their session and it has to be marked by the end of their session, so it's really good because I don't leave the class with any homework for me. I don't have to worry about marking them in my own time. It's just done during the session and that's it. So that's really easy.

Tracking of reports was simplified as students could see the status of their reports from anywhere and at any time.

9.4.4 Online Tutorials

In an alternative offering of introductory microbiology for allied health students where it has been requested that separate tutorials be included in the offering, the large numbers of students have led us to trial online tutorials.

Each week 20 questions were placed online in a discussion forum and these explore concepts introduced in lectures. Students were advised that participation in these tutorials is not compulsory; however, participation in these online tutorials will allow a 2 % upgrade if this will result in a higher grade designation such as distinction upgraded to high distinction and fail upgraded to pass. In order to qualify for an upgrade, students must participate twice in any online forum, and they must participate in two of the six online tutorials. Their participation may take the form of addressing the tutorial question in discussion format that helps a reader better understand the concept at the centre of the question or, in reply to an existing discussion, provide new information and alternative explanations that help explore the concept and lead to better understanding.

The tutor participated after the closing time of the tutorial by addressing any discussions that miss the point of the question or to further discuss problems with any discussion threads posted (Flynn, 2012). In our evaluation of participation in these online tutorials, we have found around an 80 % participation rate. The main incentive for participation is that the questions on the summative exam are taken from this pool of online discussion questions!

9.4.5 Electronic Glossaries

Students who progress from this introductory microbiology to the intermediate and advanced level microbiology will be performing a number of advanced tests that require interpretation of results. The recipes for performing these tests and guide to interpretation have always been provided as a separate text that students purchase. Unfortunately many of the tests that the students perform result in the interpretation of colour changes, and the text was produced in black and white to reduce the cost to students.

In 2008 we received project funds to produce a glossary of electronic resources in microbiological methods (GERMM). This project catalogued all tests performed in intermediate and advanced microbiological techniques. Each test description is accompanied by colour photographs of test reactions. Where the name of tests or microorganisms may be difficult for students to pronounce, these words are hyper-linked to an audio file of the pronunciation (Parsons, Reddy, Wood, & Senior, 2009). The tests were arranged alphabetically and are accessed through Blackboard which was accessible during the practical classes or outside of class for student preparation. Students found this resource invaluable as it is easy to navigate and use and has improved their understanding of the tests and terms used in our discipline. Students commented:

> I have only experienced advantages in comparison to former lectures conducted at uni. I have accelerated learning, better explanation, tools to complete assessment

and

> Without the digital learning I probably would have failed!

We are currently exploring how an augmented reality-based learning system could be introduced to help students understand difficult concepts (Maier, Klinker, & Tonnis, 2009) and how learning analytics could help use what is learned to revise curricula, teaching and assessment in real time.

9.4.6 Off-Campus Science Labs

There is abundant evidence that it is possible to teach introductory science labs online to large audiences (Gilman, 2006; Jeschofnig & Jeschofnig, 2011; Smith et al., 2005; Stowe & Lin, 2012; Udovic, Morris, Dickman, Postlethwait, & Wetherwax, 2002). The excellent guide to resources for best practices in teaching lab science courses online by Jeschofnig and Jeschofnig (2011) includes an appendix describing how to place an introductory microbiology class completely online. Northwestern University, with support from the Hewlett-Packard Catalyst Initiative and the National Science Foundation, is also offering a collection of remotely accessible labs with its iLabs network (http://ilabcentral.org/about.php). This addresses one important aspect of such an introductory class in that it can be difficult to staff such large classes with instructors. In the first-year offering of introductory microbiology, there were around 500 students, and with a ratio of one instructor to 12 students, it was challenging to find that number of experienced instructors. This was somewhat alleviated by offering classes at a variety of times; however, instructors are usually not able to take more than three classes.

We would be reluctant to move down the path of simply dispatching instructions for students to perform the exercises at home. A key component of our classes was that the in-class electronic resources have freed time for instructors to watch student technique and give them instantaneous critical and constructive feedback. Also as mentioned at the start of this chapter, it is important that students be exposed to confident experienced instructors and that they have ample opportunities to perform collaborative activities.

9.5 Conclusion

The majority of students today 'think and communicate in fundamentally different ways than any previous generation' (Jukes, McCain, & Crockett, 2011, p. iii) and it is incumbent on academics to engage these digital natives.

The intensive use of digital wet laboratories has enabled teaching staff to reconceptualise their teaching strategies and curriculum such that a constructively aligned blended hybrid lecture/tutorial-laboratory session could be conducted. Theory was supported with online exercises which were immediately followed by the supporting blended practical activities to directly reinforce understanding and promote feedforward (Brinthaupt, Fisher, Gardner, Raffo, & Woodard, 2011). In this format, some lecture material was able to be moved out of the lecture theatre and be delivered in shortened duration or blended with or integrated into laboratory exercises with greater opportunity for students to engage in active learning in the appropriate laboratory context.

We found that (1) academic staff expressed increased levels of motivation and found that they were able to more productively reprioritise their time as deeper learning was obtained during laboratory practical sessions. (2) Students' expressed high level of engagement and enthusiasm during the course as interactions (face-to-face and online) increased exponentially. Learning and teaching approaches in higher education institutions across the globe are indeed changing inexorably and ineluctably: while academics should not really worry about their very adaptive digital resident students (White & Le Cornu, 2011), they should actively brainstorm innovative ways to fully engage them inside and outside the classroom. The launch of MOOCS (massive open online courses) worldwide has in recent years challenged the education sector, and despite resistance and reluctance, new modes of delivery had to be adopted to cater to industry and students' needs. Change is scary but required, and university departments were often dragging their feet (and still are!) before implementing necessary measures to improve learning and teaching practices in their institutions, where the quintessential lecture format is still the norm.

Colleges of sciences in Australia do not always come to mind first as being at the forefront of the educational e-revolution. But it is changing rapidly with, for instance, fully online open courses in microbiology using reality-based learning and online teamwork (Santandreu Calonge & Grando, 2012) to engage nonscience majors.

The preliminary evidence of successful achievement of learning outcomes in the digital wet labs is extremely encouraging and promising, but (1) there are quite a few limitations ('organic growth', limited budget, staff training and turnover, not enough yet statistically relevant student engagement data), and (2) we are still in a trial and error [iterative developmental stage]. We are constantly fine tuning activities and gradually increasing the amount of content and collaborative activities delivered/done online, based on feedback from an expanding base of students and our discussions with colleagues worldwide in our field and others.

Will the course content continue to evolve? Most likely as we will have to adapt to an ever more 'part-time', mobile and computer-savvy audience and thus develop more digital tools to meet the learning needs of our students. Are we thinking of going back to the traditional practice in teaching our microbiology programme? Not a chance.

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10.1 Introduction

Chiropractic teachers in a university in Melbourne changed the curriculum for their second-year undergraduate chiropractic students by integrating case-based learning in a multimedia format. The decision to integrate video-cases with a new educational technology called *MAT* (media annotation tool) followed a series of prior and progressive steps to promote clinical thinking centred on case-based learning. Case scenarios based on authentic clinical chiropractic practice were developed to help students to vicariously link theory to practice—something the students typically don't start to achieve substantively until they are placed in a clinical learning environment in year 4. (The full 5-year programme is a '3 + 2' model; three undergraduate years, then two postgraduate.) The teachers initially introduced cases in print mode, then in video, which were ultimately rendered as interactive video by integrating *MAT* software.

The video-cases were produced in-house and based on real-life clinical scenarios. Consultation with industry professionals and academic colleagues and cross-referencing to case reports in the literature were integral parts of this process. The videos were professionally produced and filmed using an actor-patient and a practicing chiropractor in the key roles and demonstrate a complete clinical 'workup' (consultation) of a patient presenting with a headache. Each video was divided into two separate clips for student consumption: the patient history (the first part of the consultation) and the clinical examination.

The innovative integration of *MAT* positioned the video-cases into an active environment enabling small group collaborative activities that scaffolded through progressive activities to decision-making. These activities centred on students developing and applying clinical thinking to the case under focus. The lectures became supportive resources to this work required in *MAT*—indeed lectures became responsive to student efforts in *MAT*. Case-based activity in *MAT* and in lectures required students to draw on knowledge and skills concurrently built in corequisite courses (subjects). By using the scaffolding provided by the learning design, the students could ultimately reach their own working diagnosis on the patient in the video-case before knowing the expert diagnosis.

As part of a larger multiple-case study, second-year chiropractic students and their teachers formed one case for examining curriculum integrations of *MAT*. Data collection was triangulated via mixed methods of pre- and postsurveys, observation and interview sessions (students and teachers), and post-subject learning artefact analysis.

The data provided rich fodder to establish models of *MAT* use, of which the chiropractic model is offered in this chapter, as well as evaluation of this model. The chapter also provides issues and implications useful to share with others who may be considering curriculum change involving interactive case-based learning and finishes on further developments and directions for the chiropractic curriculum model. But first, the chapter commences with the rationale for changing the chiropractic curriculum including theoretical perspectives that underpin the changes that were made.

10.2 Rationale for Curriculum Change

Rationale for change in the chiropractic curriculum primarily rested on the teacher-identified need to stimulate clinical thinking in students earlier in the 5-year chiropractic programme. Secondly, there was teacher awareness to keep abreast of contemporary higher education teaching theories, including evolving teaching practices and integration of suitable educational technology for the twenty-first-century learner. Thirdly (and somewhat serendipitously) the availability of the university developed *MAT*, plus project funding to support *MAT* integrations, provided a potential match to the identified needs for the chiropractic students. These three factors helped steer curriculum change and are further detailed below.

10.2.1 Clinical Thinking

Many universities recognise the need to develop generic skills in their graduates, to enable them to be professionally capable employees and to continue to be life-long learners. They generally emphasise skills related to 'communication, problem-solving, critical thinking, information literacy and teamwork (ACNielson, 2000; McColl, 2003)' (de la Harpe & Radloff, 2006, p.21). de la Harpe and Radloff (2006) recommend that 'the development of "generic" skills is accepted as a legitimate part of the curriculum, [and] must be acknowledged and respected' (p.31).

'Clinical thinking' is a generic skill required for practicing health professionals, such as chiropractors. By way of definition, clinical thinking may be considered to be the application of knowledge, judgement, and experience in conduct of diagnostic tasks and management. A method of stimulating clinical thinking is 'case-based' teaching. This offers information to students in an integrated manner and encourages students to process information in an active way through context-specific clinical scenarios. Case-based teaching methods espouse theory to practice whereby there is a transfer of skills to vicarious operational settings and participants develop skills in identifying, analysing, and solving problems (Stolovitch & Keeps, 1991). Case-based learners continue into their professional careers as self-directed learners and have the ability and desire to learn autonomously throughout their careers (Sutyak, Lebeau, & O'Donnell, 1998). This method of teaching can enhance integration of the basic and clinical sciences, when basic science information is actively applied to the clinical conditions studied (Hansen & Krackov, 1994).

In recent years, web-based interactive case-based training systems have been used and appreciated in teaching students: medicine (Simonsohn & Fischer, 2004; Shokar, Bulik, & Baldwin, 2005; Reimer et al., 2006), nursing (Yoo, Park, & Lee, 2010), midwifery (Gray & Aspland, 2011), physical therapy (Loghmani, Bayliss, Strunk, & Altenburger, 2011), and paramedics (Williams, 2006, 2009). Additionally, Talmage (2001) integrated case-based teaching into chiropractic lectures and the students reported that they preferred this to traditional lectures in addition to performing better on integration of material. Literature around the use of case-based teaching in a multimedia format in chiropractic curricula is still emerging.

In the research case under focus, the chiropractic teachers recognised the need for earlier promotion of clinical thinking, to strengthen the students' clinical and diagnostic skills of students in final years, and chose to integrate case-based learning in a multimedia format. The importance of these clinical skills for chiropractors has been recognised by other chiropractic educators (Sandefur, Febbo, & Rupert, 2005; Wyatt, Perle, Murphy, & Hyde, 2005). An underdevelopment of clinical thinking may be due to insufficiencies in both integration of theory into practice and in clinical training opportunities. A number of studies have suggested that patients attending chiropractic teaching clinics may not truly represent the broader case mix seen in general practice (Niyendo & Haldeman, 1986; Niyendo et al., 1989; Niyendo, 1990; Holt & Beck, 2005; Kimpton, Polus, & Walsh, 2011), for example, by attracting a large student population. Hence, student's experiences may not be sufficient to manage patient presentations seen in general chiropractic practice upon graduation. The new curriculum model was designed as a means of potentially bridging this gap.

10.2.2 Evolving Teaching Practice for Contemporary Students

Engagement with content by 'problem solving, critical thinking, or whatever else the learning skill might be' does not automatically mean that students will learn the skills or equip them to describe the processes, and electronic environments are not for transfer of content, but for access, organisation, and evaluation (Weimer, 2002, p.50). The function of content in a learner-centred model can, under a constructivist lens, evolve to 'invention and self-organization … [allowing] learners to raise their own questions, generate their own hypothesis and models as possibilities and test them for validity (Fosnot, 1996, p.29,' in Weimer, 2002, p.13).

Despite significant shifts to integrate various interactive media forms in contemporary student-centred learning practices, the lecture-centred model has not been entirely supplanted. Recent uses of lectures as resources for students, rather than the main source of learning, are evident in inverted or 'flipped' classroom curriculum models. Institutes such as Penn State University, for example, (see The Pennsylvania State University, 2012) enable students to access their lectures online at a time and place that suits them. Scheduled lectures/tutorials become the forum for students to discuss the content, raise questions, explore examples and applications, etc. Innovative ways of using lectures to increase understanding, rather than transmit knowledge, have potential for extending a learning-centred approach (e.g. Black, 1993).

The chiropractic teachers in the study had evolved their teaching practice, aiming to meet the learning/eventual professional needs of their student cohorts. This included awareness for the twenty-first-century learner to be actively engaged, facilitated by integration of suitable educational technology. The teachers sought interactive, student challenging activities with authentic rational underpinning them, where students put in the effort to get the learning rewards. They saw the potential of video as choice media for providing student access to realistic and authentic clinical case examples and aimed to render the video scenarios interactive rather than passive learning.

10.2.3 *Availability of* MAT

The educational technology used in the chiropractic model is a relatively new *MAT*, which is currently enabled to annotate video. 'Video annotation tools are online or offline programs that allow a user to mark portions of video and reflect on it by adding written, spoken or visual comments to that section of video' (Rich & Trip, 2011, p.16). Some of these tools include guiding frameworks compared to others with open architecture, and some have collaboration enabled (Rich & Trip, 2011). The guidance framework and collaboration options in *MAT* are enabled according to the learning objective:

> *MAT* allows video-based artefacts to be uploaded and annotated online, and… enables learner selection and categorisation of areas of video, with each selected area marked with a coloured 'Marker' along the video timeline. Each Marker links its video segment to its own annotation area, which comprises text-entry/dialogue panels structured to build into a cycle of learning. The various panels are titled: 'Notes', 'Comments', 'Conclusion', 'Teacher Feedback', and 'Final Reflections', and can be progressively opened and closed depending on the learning activity. (Colasante, 2011, p.66)

A preceding pilot study examined *MAT* integration into third-year undergraduate physical education (PE) curriculum and found that the intervention of *MAT* was largely effective in the PE study: 'The tool provided a structured learning cycle… [and] promoted active learning with meaningful materials to construct meaning from them' (Colasante, 2011, p.85). Challenges in using *MAT* for this educational purpose included the technological framework of *MAT*, which 'curtailed some flexibility by the learners under observation, e.g. inability to add a new Marker' after settings changed to streamline activities across the class (Colasante, 2010, p.218). Additionally, some students noted vulnerability on seeing/sharing own performance in video, and others valued or criticised peer feedback depending on the level of quality (Colasante, 2011). The latter lead to a finding that '[t]he need for personal versus shared annotations in *MAT* should be determined per learning activity, by considering benefits for others to read and collaborate, compared to inhibitors' (Colasante, 2011, p.84)

MAT and project supports became available at a time when the chiropractic teachers were ready. They had well-developed student-tested video-case studies and were seeking ways to enable students to interact with them meaningfully. Activities would require collaborative student effort to stimulate clinical thinking towards the scenario and to later apply and practice this clinical thinking. The teachers were able to take advantage of an internally funded project which supported a number of integrations of *MAT*, supporting teacher and student training in *MAT* use, set-up and design, plus research and data collection.

10.3 Methodology

The methodological approach involved a multiple-case study where the chiropractic case was one of several. The research sought to examine the effectiveness of *MAT* as integrated in a variety of new curriculum models. Therefore, while the chiropractic study was not a classic single case, it was analysed in isolation to present as the case study in this chapter.

Data collection methods employed in the study were observation and interview in the form of 'interactive process interviews' (IPIs), pre- and postsurveys, and artefact analysis. The mixed methods yielded both qualitative and quantitative data. The research framework and instruments were developed and trialled in a preceding pilot study (Colasante, 2011), and therefore, the study benefited from pretested research instruments with minor design adaptation, plus additional data from learning artefact analysis.

An emphasis was placed on capturing the chiropractic case as accurately as possible by harnessing the opinions of student and teacher experiences. However, the research deliberately avoided relying solely on perceptions by including observation/demonstration and artefact analysis. While some research may choose an approach solely reliant on user perception, for example, e-portfolio application in Carroll, Markauskaite, and Calvo (2007), and potentially reign in useful detail, this is countered by others who indicate scepticism for educational technology research that does not follow some empirical principles. Muller, Eklund, and Sharma (2006), for example, caution against purely qualitative approaches that harness only user attitudes. By triangulation of data or 'the act of bringing more than one source of data to bear on a single point' (Marshall & Rossman, 2006, p.202), the value of the research is potentially increased—albeit triangulation is not necessarily 'about getting "truth" but rather about finding the multiple perspectives for knowing' (Marshall & Rossman, 2006, p.204).

10.3.1 Chiropractic Study Participants

The chiropractic cohort was purposively selected as one case in a 2011 multiple-case study, where teaching cohorts who identified as integrating *MAT* into their curriculum were invited to participate.

Seventy-eight students were enrolled in the class, with 75 active during the semester of the study. The number of survey participants approximated 50 % (see Table 10.1). Eight students participated in the IPIs (observation/demonstration followed by interviews; further explained below), as did both teachers. Twenty-nine students consented to access to their learning artefacts of *MAT*-related activities. Survey and IPI student participant numbers represent those who both consented and then presented for participation.

Class demographics were harnessed from the presurvey, representing 50 % of the class. This sampling shows an age range predictable for second-year undergraduate students with most in the 18–25 age bracket (86 %); the remainder in either the

Table 10.1 Chiropractic cohort research participation levels

No. of students in course (subject)	Presurvey participants	Postsurvey participants	IPI participants	Access to learning artefacts
78 (75 active)	39 (50 %)	37 (47 %)	8 students (10 %) 2 teachers (100 %)	29 (37 %)

31–40 age bracket (8 %) or 41–50 (6 %). The gender breakdown was almost even (51.5 % male). English was the first language for most (just over 90 %), and all reported daily access to computers and the Internet. Over three-quarters of the students reported medium to moderately high Information and Communication Technology (ICT) skill levels (78 %), while minorities at either extreme reported high ICT skills (17 %) and moderately low or low skill level (6 %).

Overall, this sample illustrated a relatively positive attitude to online learning in their course. Three-quarters nominated liking online learning and few reported they do not (3 %), the remainder liking online learning some of the time (22 %). These numbers were similar when asked more specifically if they 'would like to use an online tool to help me understand the presentation and assessment of headache conditions' (79 % agreed, 18 % neutral, and 3 % disagreed).

The university ethics committee gave permission for the research to be conducted. Pseudonyms are used in this chapter to help support the narrative; to reference quotes from interviews and employ a consistent format, where '[S1, Lani]' refers to 'student one' and pseudonym, the 'T' in '[T1, Isabella]' refers to teacher, and numbers are randomly assigned across the eight student participants and two teachers.

10.3.2 Data Collection Methods

The data collection methods involved:

- Pre- and postsurvey
- Interactive process interviews
- Artefact analysis

The survey was administered to the students in two parts. The presurvey at semester starts harnessed-base demographics plus student attitudes to online learning. It sought primarily quantitative responses, with additional space to write comments. The postsurvey was administered towards the end of semester, when their work in *MAT* was substantially completed, harnessing student opinions of their experiences of learning in the new model. Comprising mainly Likert-styled questions, it additionally sought qualitative responses to several open-ended questions.

The chiropractic students and their teachers were invited to participate in 'IPIs'. These involved half-hour observation (and/or demonstration) and interview sessions, involving 10–15 min of direct/participant observation while using *MAT* and thinking aloud, followed immediately by 10–15 min discussing their learning experiences in the course. Where students or teachers had completed their active work in

MAT, they were asked to demonstrate and verbalise their activities during the first part. Eight students participated in individual IPIs, although the final two essentially proved that data saturation was reached. However, all student interviews added to the rich voice of the project and further IPI volunteers would have been welcome. Both teachers participated in individual IPIs, which provided depth on issues of activities undertaken and the user experience.

Student participants were also invited to allow their *MAT*-related learning artefacts to be used for purposes of the study, as were the teacher participants who provided feedback in *MAT*. Evidence of student online interactions related to *MAT* activities was analysed only after the completion of the semester and all results were submitted.

Substantial data were collected and the data mined for this chapter were illustrative and evaluative of the curriculum model employed.

10.4 The New Curriculum Model Developed

The chiropractic curriculum model was drawn from the data, in particular the teacher 'IPIs', cross-validated with data from student IPIs and artefact analysis to ensure accuracy. This model is presented in both 'macro' and 'micro' levels, that of curriculum design (overall for course/subject) and the learning design (structure of the learning and teaching activities within the curriculum) (Dalziel, 2012).

Overall, the chiropractic model had a base of two discrete but interlaced and dependant cycles of learning across the semester, both comprising micro activities, and each leading to specific learning goals. This fitted into a larger picture, the whole second semester, as it took advantage of and fed into concurrent learning in other subject areas. The course (subject) was redesigned to allow the students a consistent flow of study for their professional clinical thinking skill development as they moved through various activities of orientation tutorials, lectures, and online learning in *MAT*. For a sense of this approach, including prepreparedness and how they linked to other subject areas, see a teacher's view in Vignette 1.

Vignette 1: Pre-commencement: Teacher View

this is Natalie's subject area, she's presenting the theoretical material about headaches, so we're actually getting the students to think about that, think about the history-taking skills, thinking about the examination skills that they're learning elsewhere [in concurrent subjects], and analyse and develop their clinical thinking… we were able to get them to do that in *MAT*… we made sure it was all delivered at the same time, we got it all prior to *MAT* coming on and then obviously the process to get the students to be able to use *MAT*. [T1, Isabella]

The chiropractic teachers uploaded two videos to *MAT*, one related to each learning cycle, which were essentially a single video of a clinical scenario divided into two parts:

- 'Consultation' (Part I): the first part of the consultation to establish the patient history
- 'Examination' (Part II): the physical examination of the patient

Following learning design preparations and training on how to use the new technology, the two chiropractic teachers created small group access in *MAT* by dividing the class of 78 (75 active) into 13 groups of five to six students, uploaded the first video, and entered analysis categories, ready for the students to begin. See Fig. 10.1a, b for an overview of the model, with more later on each of the embedded learning cycles.

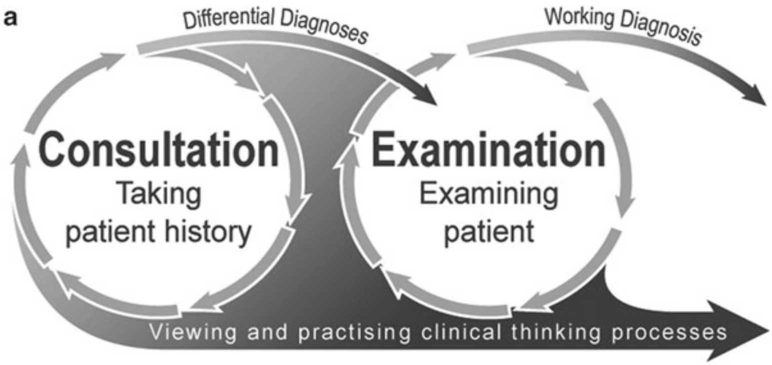
10.4.1 Learning Cycle 1

The first learning cycle, 'Consultation', was activity intensive and occurred over the first-half of semester. The students were required to analyse the consultation video, that of the patient presenting with a headache and an experienced chiropractor taking her medical history. Initially individual work, the settings were then adjusted in *MAT* to allow peers to view each other's analyses within their small groups, to compare and contrast and commence discussion. They had collective group goals of (1) arguing for and choosing one member's analysis to represent their group for teacher feedback (mid-cycle) and (2) providing a short list of possible diagnoses (end cycle).

Course resources included the concurrent on-campus lecture series on headache presentations, expert chiropractic modelling in the video, peer collaboration, and teacher feedback within *MAT*. Additionally, scaffolding and guidance were provided by teacher-prepared instructions, and the guidance of the analysis categories created in *MAT* to help the novice structure their thinking using a chiropractic professional framework. General resources (textbooks) were also utilised. Figure 10.2a illustrates the range of activities that the students engaged with during the first learning cycle, supported by the descriptors provided in the 'key' (Fig. 10.2b).

10.4.2 A Closer Look at the Analysis Categories and Activities for 'Learning Cycle 1'

The marker types established by the teachers in *MAT* for the first learning cycle set the categories of analysis and effectively guided the learning. Fourteen categories were created to frame the student analysis of the headache presentation and to



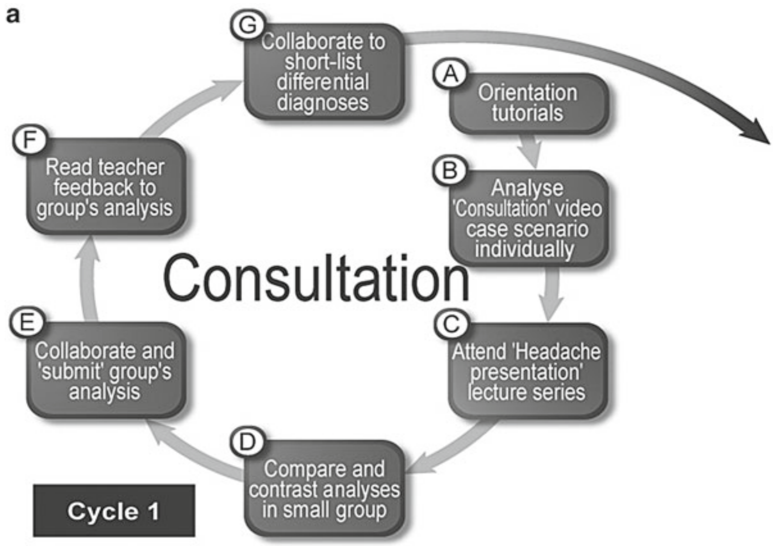
b

Descriptive key - curriculum model	
Consultation	Learning cycle 1 based on the 'Consultation' video
Examination	Learning cycle 2 based on the 'Examination' video
Arrows extending from and beyond each cycle	The first arrow indicates work from the first cycle required to advance into the second, and the second arrow represents post cycle activities, including application of new skills and knowledge into future learning and professional practice.The gradual darkening represents consolidation in learning processes.
Arrow underpinning model	Represents the overall focus of the model, that of viewing and analysing the video (in two parts) across the semester and viewing and practising clinical thinking processes. The gradual darkening represents consolidation in learning processes.

Fig. 10.1 (**a**) Representation of the chiropractic curriculum model (macro or course/subject-wide view). (**b**) Descriptive key to curriculum model

engage the clinical thinking process. They included 'Location', 'Onset', 'Trauma/Injury', 'Duration', 'Frequency', 'Character of pain', 'Intensity of pain', 'Course since onset', 'Pattern over a day', 'Relieving factors', 'Aggravating factors', 'Associated symptoms', 'Previous history', and 'Previous treatment'. These categories were to guide the students' thinking while they do not yet have chiropractic expertise and were correlated to categories being introduced in other subject areas. Further thinking on this is offered by the two chiropractic teachers, Vignette 2.

When students chose an area of video to analyse, they marked it, selected one of the categories, and entered notes. Each created marker stayed anchored to its segment of video. The notes entered were, in effect, clinical summaries in the form of



b

Cycle 1 - Descriptive key	
A	Attend one of the orientation tutorials for *MAT* training in the context of commencing the first learning activities
B	Independently analyse the 'Consultation' video-case scenario, explicitly selecting and aligning segments of the case to expert categories, supporting with notes
C	Attend the series of theory lectures on headache presentations throughout the semester
D	Compare and contrast own case analysis, categorisations and notes to peers in small group
E	Collaborate in small group (via flexible modes in or outside *MAT*) towards defined goal to select a peer's case analysis to represent the group
F	Read teacher's feedback to group via (1) formal responses to group representative's analysis, (2) ad hoc responses to online group discussions
G	Collaborate (via mode of group's choice) to arrive at a short list of differential diagnoses for the patient presentation

Fig. 10.2 (**a**) 'Learning Cycle 1' of the chiropractic curriculum model—'Consultation'. (**b**) Descriptive key to learning Cycle 1

'clinical notes'. This was done individually to enable sufficient reflection time, then opened to allow students to view the analyses across their small group and comment or collaborate on various points of analysis. The value of doing this activity was particularly related to professional record-taking practice, as noted by one of the teachers in Vignette 3.

Vignette 2: Marker Types: Teacher View

So our markers to the right there, Location, Onset, etc., were defined by us and the students had to mark the video according to where they thought those points occurred, where the practitioner was discussing information under those categories… At the same time, in another course, they were being taught how to take a patient history, a clinical patient history. So that was concurrent. So whilst the definitions [of the categories] weren't completely transferrable [between subjects], they were reasonably compatible. [T1, Isabella]

Each of those markers are very important aspects… for when you're taking a history for a headache sufferer. Because the classic type of history is referred to as an eight-point history. Now that encompasses some of that but you need to take a little bit more than that when you're actually taking a headache history… it's more than [eight] required; the extra information you need to assist you in formulating a… differential diagnosis for headache. [T2, Natalie]

Vignette 3: Professional Record Taking: Teacher View

in many respects what they were actually doing was writing clinical notes, so it was their first experience, they didn't realise it but they were actually going through a process which they'll do once they get into clinic of writing the findings based on the history they'll be taking… and as practitioners taking a history especially for headache is one of the most important steps in a case history to assist you in the diagnosis… case notes are also very important and they're often a thing that once you're out in practice people actually become quite poor at keeping. So it is sort of a way of introducing them to record keeping as well as learning to take clinical notes. [T2, Natalie]

To actively encourage the process of comparing and contrasting their analyses, the students were asked to nominate one person to represent the group with their findings. They collaboratively determined one representative for their group—engaging with each other's annotations and differentiating between levels of accuracy—using various forms of communication such as the blog tool or email linked from *MAT*. One single entry in a 'Conclusion' annotation panel in *MAT* formalised the group response and conveyed it to the educator. This is further explained in Vignette 4 by one of the students.

After reviewing feedback from their teacher in *MAT*, via the 'Teacher Feedback' annotation panel, each group then collaborated to arrive at a short list of possible

Vignette 4: First Group Goal: Student View

the conclusion part was pretty simple actually, only one of us had to do it, like everybody would read through everybody else's stuff and then decide who had put the markers in the best places, who put enough information, the best sort of information, [and] it was easiest to come up with a working diagnosis. In my group I was the nominated person so we just had to go to one point and say I am the nominated person. Our teachers would then go through and… they'd use what I've done as a way of marking everybody's… [The team collaborated] via the blog in the main home page… and say 'okay, I think this person did this well, this person did that well. We all agree this person's the best, we'll get them to do it'… After that, the teacher would obviously go through and she'd read through what I'd written, where I'd put the markers, what was happening in the video at the point of that marker. And she'd say I'd agree, I wouldn't agree, perhaps you need to put a little bit more information here. This might not have been quite the right marker [category], you know that sort of thing. [S5, Chelsea]

differential diagnoses, listed in order of most to least likely. They then submitted their short lists to the teachers, using the 'Final Reflections' annotation panel. Importantly, this student-generated list became the marker types (categories of analysis) for the next video, 'Examination'. Essentially, the work that the student groups did in the first cycle of activities was critical for their continued clinical analysis of the second video.

10.4.3 Learning Cycle 2

The second learning cycle was less activity intensive and occurred over the second-half of semester when the students experienced competing assessment due dates. The students analysed the 'Examination' video, as the next phase in the clinical workup, where the practitioner conducts a physical examination on the same patient presenting with headache. The findings from the examination and patient history are then considered together to determine the 'working' diagnosis. The analysis of the video in this cycle was intended to be an individual task; here students could only see their own annotations in *MAT*. However, several of the small groups chose to continue collaborating using means such as the blog tool linked from *MAT* or other online or face-to-face means.

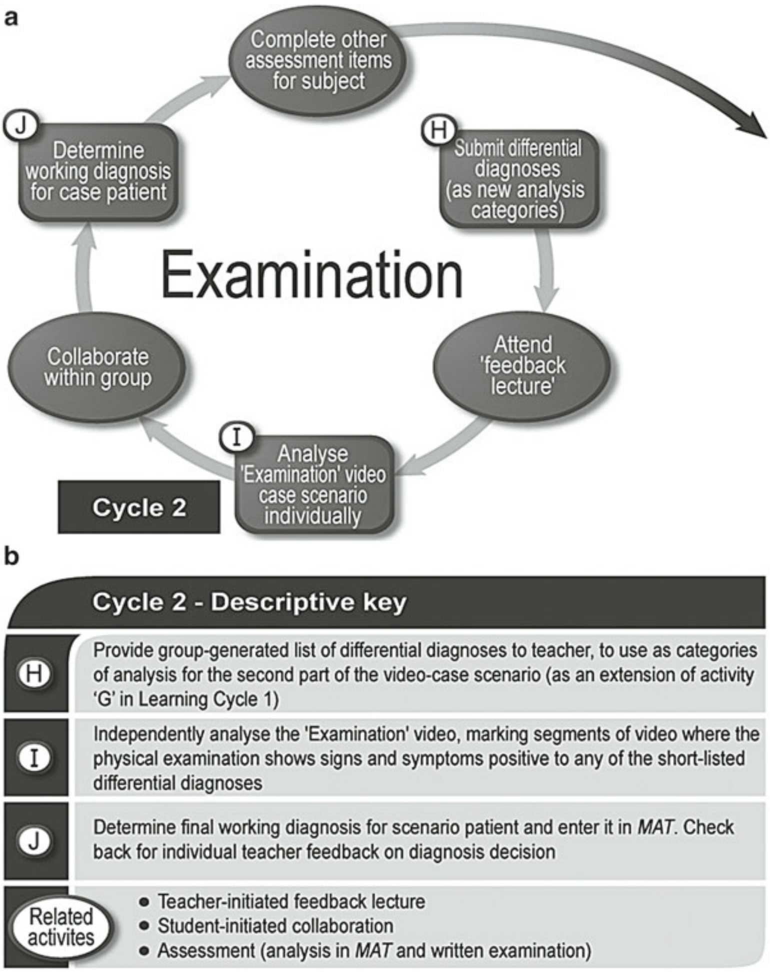


Fig. 10.3 (**a**) Learning Cycle 2 of the chiropractic curriculum model—'Examination'. (**b**) Descriptive key to learning Cycle 2

The students used their differential diagnoses as their analysis categories for the 'Examination' video. Teacher feedback and assessment for this cycle were on individual efforts, however, an additional and optional 'feedback lecture' was provided for the whole class.

Figure 10.3a provides a representation of 'Learning Cycle 2'. The shapes in the figure differentiate *MAT*-required activities (rectangle) interspersed with optional and/or related activities (oval). Figure 10.3b adds a descriptor key.

Vignette 5: Student Activities in Cycle 2: Student View

we went through to an 'Examination' video… basic physical examin[ation], which we had to watch and then… once we'd made our diagnoses of what we thought it was, we had to go through and mark each time something in the video correlated with what our diagnosis was… there's certain signs and symptoms… that go along with each of our diagnoses, and so anytime one of those came up we just marked it and the one [diagnosis] with the most markers won really… it all fitted together really well. [S4, Tori]

prior to going into the assessment you already worked out a few… differential diagnoses, before you decided on the working diagnosis anyway, so it was already down to two or three. Some people put in some erroneous differentials but I didn't think they stood up… the clinical sense came through ruling out other differentials which is the purpose of it anyway, you don't really want to have a self-fulfilling prophecy of, through your assessment, but you work out the test for all things, all the differentials and then it leads you towards the conclusion which may be different from what you'd thought could be the primary one. But in this case it was, I think it was straightforward. [S6, Luke]

10.4.4 A Closer Look at the Analysis Categories and Activities for 'Learning Cycle 2'

At the end of the first learning cycle, the students generated analysis categories for the 'Examination' video in the form of three to five possible/differential diagnoses, which the teachers added in *MAT* as specific group marker types. They varied a little across the 13 groups, 'cervicogenic headache', 'myofascial pain syndrome', 'migraine', 'tension-type headache', and 'TMJ joint dysfunction', compared to 'cervicogenic headache', 'myofascial pain syndrome headache', 'TMJ headache', and 'space-occupying lesion', for example.

The predominantly individual analysis of this cycle saw finalisation of the clinical thinking episode. The students watched the examination of the patient for evidence that confirmed any of the differential diagnoses they had short listed. See Vignette 5 for examples of student explanations.

The students arrived at a working diagnosis by evaluating which of their possible clinical options (differentials) had the most evidential support, and once they determined if their diagnosis was clinically valid, they then created a final marker on the video with a note stating what their working diagnosis was for the patient. A 'feedback lecture' was, however, provided early in this cycle, because as indicated by a student (Luke, S6, Vignette 4), some students 'put in some erroneous differentials' and the teachers wanted to ensure that the clinical thinking process was engaged as much as possible.

The ‘feedback lecture’ was designed in response to the short lists of differential diagnoses submitted by all 13 student groups. The collective list—once compiled for teacher analysis—showed a few surprising inclusions. This initiated an optional-to-attend lecture scheduled outside routine class time, which most students attended. The teacher discussed with the students the various differential diagnoses in a way that further modelled the clinical thinking process. It was intended to stimulate further thinking as the students finalised their working diagnosis. For teacher thinking on this lecture, see Vignette 6.

Vignette 6: Feedback Lecture: Teacher View

we actually gave them a feedback lecture… [I] had introduced them to headaches because these are second year students and they’re not used to clinical, anything clinical; they’ve been learning anatomy, pathology, physiology, the basic sciences. And my course is one of the first that introduces them to clinical thinking or clinical conditions… [I] was introducing them to headache while… they were using *MAT* too. But what happened after we finished… the first video, and I’ve thought it was really helpful, we had a great turn up of students, they really appreciated it. We actually… gave them feedback in a lecture rather than on the *MAT* but based on the findings we got from *MAT*, from what they had written, we were able to give them feedback… and we went through each of the marker types and said right, well what does this indicate, it indicates this, this and this… we were just trying to ensure that they were thinking along the right track before leading into this new ‘Examination’ [video] and I think because there were many steps involved it was pretty important that the students were kept engaged with it and had plenty of feedback… this was also after we had got their list of differentials from them so they still went through the process of working out their own differentials but we gave this… to assist them in their clinical thinking before they started to move into examination. [T2, Natalie]

10.5 Evaluation of the Chiropractic Curriculum Model

The evaluation of the chiropractic curriculum model sought to determine whether the main learning objective had been achieved in professional preparation for the students, particularly to engage clinical thinking in year 2 of the undergraduate programme. The analysis has been drawn from data mined in student IPIs (interviews) and postsurveys and cross-validated by teacher IPIs and artefact analysis. It begins with an overview harnessed from the postsurvey of effectiveness in work preparation plus what students nominated as key barriers and enablers to their learning. It then unpacks three subareas (primarily from IPIs) of role modelling and challenge, reflecting on and understanding key learning and eventual professional practice readiness.

*10.5.1 Learning Effectiveness of the Model/*MAT

Collated postsurvey questions summarise student opinions of learning effectiveness of the chiropractic model in preparing students for the workplace. Figure 10.4 illustrates largely positive responses across questions on learning towards professional preparation, with higher level of agreeance to questions as they become more specific to the students' chosen profession. The graph shows accelerating positive responses from role modelling and interesting learning challenges (between 60 and 70 %) through to learning about health presentations and other activities relevant to their eventual clinical practice (between 70 and 90 %). A minority disagreed in these issues (3–17 %).

Two open questions in the postsurvey offered student views on both 'barriers to learning' and 'things about *MAT* least helpful to learning'. These have been themed, with examples of student responses quoted in Table 10.2. Out of 37 postsurvey respondents, 14 chose to respond to the former question and 13 to the

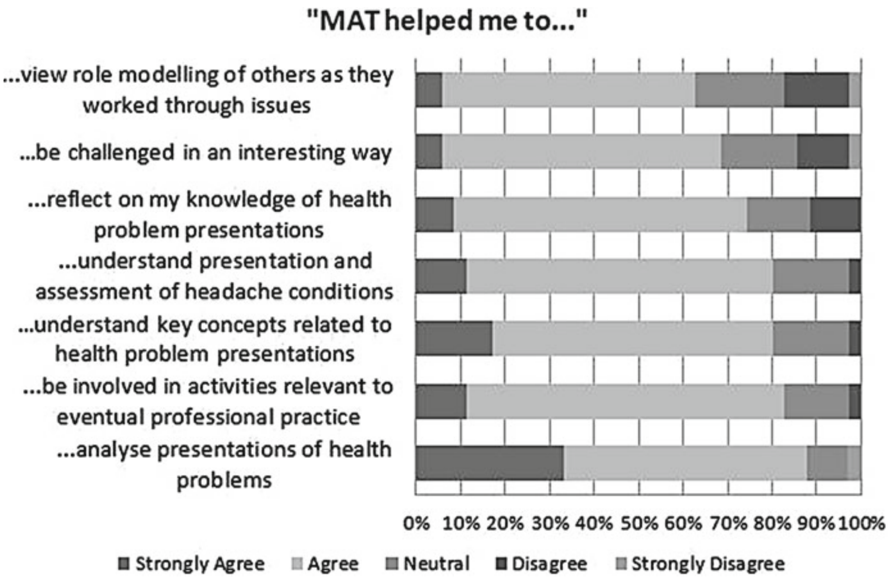


Fig. 10.4 Responses to postsurvey questions on *MAT*'s effectiveness in model

Table 10.2 Negative factors raised by students in a postsurvey open question

Dissatisfaction for	Example student quotes to represent range (some almost identical responses not repeated)
Technical issues	The site was occasionally very difficult to use
	Not the smoothest website, but once you knew how everything worked, it was alright, however slow
	Need an input time function
	Not knowing when other students had answered
	The amount of time the software took to use
	The technology was slower for me than it could have been
Teamwork	Working in a group of people I don't really know; would prefer to pick own group
	Not being able to choose our own group members
	Not all group members participated which made it hard to come up with decisions as a group
	Leaving 1 person to be 'chosen one'
Repetition or usefulness of tasks	Repetitive nature of tasks
	Video annotation was complex and not particularly useful
	It was fairly mundane; I'm not a big fan of computer work
Confusion	Instructions were not very good to follow
	Some of the instructions about the completion of tasks was sometimes confusing
	Differences between *MAT* and other courses was confusing
Only one video-case to analyse	Only one case

latter; some entered multiple issues. No single theme tended to overwhelm; however, the most prominent issues beyond technical were related to teamwork, repetition of tasks, confusion with instructions (or more generally), and having access to only one video-case to analyse. Several explicitly stated they had no issues.

Eighteen students responded to the question on 'what about *MAT* was most helpful to learning', and again, some gave multiple factors. Overall, three response themes emerged: appreciation of real-life examples, being able to anchor descriptions and discussions to segments of the video-case, and being able to link theory to practice. These themes with student quotes are provided in Table 10.3. Two outlier quotes included 'The entire program' and 'I had to'; the latter perhaps referring to extrinsic motivation of assessment requirements.

Table 10.3 Positive learning factors raised by students in a postsurvey open question

Appreciation for	Student quotes
Real-life examples	Watching a real chiropractor
	Real situation
	Viewing another chiro in practice
	Seeing how an actual chiropractor dealt with a patient
Anchoring notes/discussions to segments of video-case	The markers enabled me to actually locate findings and use them to create a diagnosis
	Watch and re watch it, feedback, student interaction
	The fact *MAT* I would place markers where there were clinical findings and review and edit those markers with comments as well. How others would comment on it also
	[Noted appreciation for a subset of the annotation activity:]
	Online collaboration
	Individual work
	Other students comments
	Review and editing
Linking theory to practice	Application of knowledge acquired in lectures
	Having to go over what we had learned and use it in a 'real world' situation
	Linked to theory
	Seeing a role play of clinical situation and how what we are learning is applied
	Viewing what we've learnt in clinical practice

10.5.2 Role Modelling and Challenge

The chiropractic model centred on the learning challenge of engagement with expert modelling represented in video. Majority student agreement and minority disagreement to being challenged in an interesting way (Fig. 10.4) were elucidated by interviewees noting the activities were straightforward, with some saying too easy, and acknowledgement that this was due (at least in part) to the just-in-time style of applying what they were concurrently learning to the analysis of the patient scenario in *MAT*. There was some recognition that while activities seemed easy, they did help link theory to practice. One student with an established health professional background who found it tedious rather than challenging also saw several benefits of using *MAT* compared to traditional learning and assessment methods. For further illustration read student views in Vignette 7.

Vignette 7: Ease of Activities/Tedious: Student View

it can be tedious at times, especially when you've got 'okay do this in this 2 days, do that in that 2 days'… it definitely helped with the learning of the headache types because you did have to know them while you were looking at them, because you couldn't just watch a movie, 'oh that was interesting, what did I just learn?' you had to know what you were doing, because you had to write down markers… if we had of been given it and said 'okay you don't know anything about it but you've got to kind of make it up yourself', that would have been more of a challenge. Because then we would have to go out and find all the information first off because we were, at the same time we were doing MAT, we were still learning about the headache types so we were having a lecture, we'd been given a task in that so everything's sort of fresh in the mind and not set in yet. So it was kind of moulded as we went along. [S5, Chelsea]

I found some of it a little bit tedious… seemed a little bit slow in some ways, but then you need it to go slow because you need to go through it and do all the marking and everything… I think you learn more from this, I already know more from this, just looking at differential stuff, than you do from doing an assignment I think… I mean I was looking up stuff as well, and looking at differential diagnoses… and looking those up and then cross-referencing those kind[s] of things at the same time. But because it gives you a different format to learn in and it gives you a visual format, and audible format, and you interact with it and you can compare with your peers in the same thing as well, it's much easier, much better assignment because you can talk about stuff… it has benefits, on multiple, multiple points compared to assignments. [S6, Luke]

The teachers interviewed were satisfied with student engagement levels, noting that *MAT* rendered the video-case interactive in a way that the students had to work with 'the clinical thinking in as the industry modelling… to pull it apart, mark it, think about it' ([T1, Isabella]). However, one teacher noted a reduced level of engagement towards the end of the semester, predicting its cause as competing study commitments in a heavy end-of-second-year study load. This was confirmed by the artefact analysis, which showed a small minority were not active in *MAT* in the second cycle of learning towards the end of the year, that is, 70 students were active compared to 75 in the first cycle.

Having an expert chiropractor presenting industry modelling in the video was appreciated by the students, with few qualifications, of which might explain the minority disagreement to the role-modelling postsurvey question (Fig. 10.4). Excerpts of student interviews included positive phrases such as:

- 'He's [chiropractor in video] really good… He's not just messing around and saying lines off a piece of paper, he knows what's going on and it makes it more real'. [S7, Shohini]
- 'You got into the practice atmosphere, so you could actually see the way it works, the way you should word your questions… He did a few physical examinations on her and… you see which order they come in and you find the red flags, so you know exactly what to be looking for'. [S8, Hasibe]
- 'His line of questioning for elimination of more serious risk factors and those kind of things helps, and doing it in a calm and relaxed way without alerting the person to that he was… inquiring as to more sensitive possibilities was quite good'. [S6, Luke]
- Also see student postsurvey comments under 'Real-life examples' in Table 10.3.

Qualifications to appreciation for modelling included not quite the equivalence of being in a clinic, and half (four out of eight students interviewed) stated they would like more video-cases for comparison and/or extension of their learning. Reasoning for more cases included exposure to more patients and sets of symptoms, comparisons of how different chiropractors approach tasks and how to approach different situations, or even the very practical suggestion of learning the process with one scenario, then applying it to further scenarios to better prepare for fourth year practical work. Of those who noted that a video-case was not the same as being in an actual clinic (three out of eight), all conceded it was the next best thing, especially wherever it was difficult to get timely access to a clinic.

One of the teachers noted a limit to role modelling by video-cases in that the direction of the clinical process is set, and there is limited room for the students to go off on a differing direction with their analysis—although there were variants in the potential diagnoses short listed by the students.

10.5.3 Reflecting on and Understanding Key Learning

There were indicators from the interviews that the video-case analysis approach to learning helped the students to reflect on and gain key concepts and understanding, as related to presentation and assessment of headache conditions. For example, they liked being able to see the overlapping of marker types on the video to confirm complexities, yet filter through these various categorisations to help make conclusions. This aligns with the mostly positive postsurvey data on reflection/understanding questions (Fig. 10.4) and the learning enabler theme of anchoring discussions to segments of video-case (Table 10.3). Albeit, this is potentially a factor better realised at a later date, such as fourth year when they are more clinically active.

Some students offered caution on the method of reflection and analysis. They suggested keeping an open mind and think about the process even if it seems relatively easy, allowing flexibility in *MAT* use to cater for busy students' preferred style and pace of study and taking care that the students understand the reason why the analysis categories are chosen and why they might vary between headache and

Vignette 8: Cognition: Teacher and Student View

[the model] actually challenges their knowledge base and integrates a number of their learning areas and then puts it into the clinical thinking machine, so that they get to use that… So they're like the brains behind the operation. They have to be the person analysing what's going on and thinking about each part. [T1, Isabella]

MAT's actually quite interactive… by having these marker types, it actually forces them to sit there and watch and listen to the video. And to think about 'well what's happening in this?' rather than just sitting there passively watching the video, they're actually working with it… actually thinking about what they've seen and what does it mean. So that to me is essential for what I'm doing in the class so that they understand that it's what they're learning and what does it mean for them. So it's an opportunity to actually go through that process with them and also it's sort of a way of enforcing how they should be learning their material too. [T2, Natalie]

I understand what they're [teachers] trying to do… rather than going listing down 'cervicogenic headaches, these are the signs and list the symptoms for it'. So actually going 'Alright, this patient's saying this' and trying to link that with your lists, rather than just… rote learning everything. [S2, Alistair]

other patient scenarios. The teachers saw benefits of building their students' knowledge base in the model. For excerpts of the teachers' views on student cognition, plus a student view on how he saw the teachers' approach, see Vignette 8.

10.5.4 Eventual Professional Practice Readiness

Postsurvey questions with nearest relevance to application in eventual professional practice received strong support from the students (Fig. 10.4). Additionally, students nominated the theme of linking theory to practice as a learning enabler (Table 10.3). From the interviews, prominent themes emerging related to clinical thinking application in authentic learning situations and relevant to eventual chiropractic practice were:

- Professional clinical note taking derived from applying a clinical thinking process (particularly first learning cycle)
- Arriving at appropriate diagnosis (particularly second learning cycle)

The interviewed students discussed the various requirements to annotate the video-case, often in ways that included terminology of the thinking practitioner plus referring to applying theory to practice. Some examples of this from the first learning cycle are offered (Vignette 9; previous Vignette 4).

Vignette 9: Clinical Note Taking: Student View

She [nominated peer representing group] had the most description I think, and the most succinct answers… you see here it's quite dot pointed, which is how you would do it in practice. You wouldn't be writing full sentences out and everything. It was just quite professional… [For example,] under 'trauma', this student has written, 'Had a car accident 2 years ago. Quite close to the time of onset. Was hit from the right-hand side and caused a whiplash injury to the neck from right to left. Had moderate to severe neck pain for about a week after the accident. Did not hit head. The headaches didn't start until about 2 months after the accident'… I think it's a really important tool in terms of patient—not interaction because you can't really—but clinical note-taking and things like that, and associating a real patient with a condition. Rather than just learning about a condition you can actually, say, draw from that and then add that into a patient file and differentiate what they could possibly have… Rather than just jumping in with a patient straight from the go. I think it's important to learn how to do this and then get feedback on whether we're doing it correctly. [S1, Lani]

Vignette 10: Clinical Thinking Process: Student View

we kept referring back to the lecture notes. I found that not just what was clinically wrong with her but as a patient, not just as a person, this particular patient, because of her age and her sex and all the symptoms that we've got … there was a stronger case for a cervicogenic rather than myofascial pain syndrome. [S7, Shohini]

The students tended to appreciate how the process applied in the model ultimately made clinical sense on arriving at their final or working diagnosis. Being able to look at the coloured categories across the timeline of the video-case to literally see their 'thinking' against their short-listed differential diagnoses evidenced the process. Even some who guessed the diagnosis earlier appreciated the quality of the process. See Vignette 10 for a student's view.

The teachers confirmed the clinical note-taking process as an iterative product of the students' clinical thinking. One teacher demonstrated in *MAT* a student annotation to a segment of the video-case and confirmed that the 'summary of the main clinical findings at that point' would appropriately represent clinical notes that a practitioner would either write or enter into a computer.

Vignette 11: Clinical Thinking Process: Teacher View

[This model] engaged the clinical thinking process in a way that it isn't normally done in pre-clinical years. So whether they were aware of that or not, I don't know but I guess, I imagine that some of them got that. They … [implemented] a process of theoretical information, think about the tests that they were doing in other areas and then go through that clinical process and arrive at a conclusion. So that's clinical thinking, so this will stay with them I hope, I think. So they've had a simulated experience and interacted with it years pre-clinically. So normally what happens is that those students go to the teaching clinic and then they get to apply this mass of information, you know in about Year Four of the program. This is Year Two. [T1, Isabella]

The teachers, as practitioners and academics, noted that the decision-making in *MAT* made clinical sense, while acknowledging that the students were not yet ready for thinking at expert levels. This model had laid the groundwork, engaging the clinical thinking processes up to 2 years earlier than had previously been the situation. This was recognised as an important step in student learning towards professional practice readiness. See Vignette 11 for a teacher's view on the clinical thinking process.

10.6 Issues and Implications Arising

A two-cycle curriculum model was designed based around real-world clinical video-cases that students interacted with in the new multimedia format of *MAT*. The rich data set of the study illustrated the model and provided evaluative findings.

An earlier work-in-progress report on *MAT* integrations across four higher education curricula, including this chiropractic cohort, showed that 'Higher satisfaction responses by students were presented in *MAT* cases that had some or all of: (1) teacher presentation and upload of videos in *MAT* (compared to student… upload…); (2) teacher feedback; (3) learner-learner interaction to achieve meaningful goals; (4) formal assessment requirement' (Colasante & Lang, 2012, p.462). The chiropractic model showed indications of comparably stronger student satisfaction likely because it encompassed all four of these factors, each of which emerged in the data of this chapter.

The first factor, whether teachers or students created and/or uploaded the videos, was due partly to technical angst experienced by other cohorts during video upload. The chiropractic students appreciated the professionally produced videos, particularly due to the expert chiropractic modelling of clinical thinking, and how it was the next best option to actual clinical experience. The second factor, teacher feedback, was embedded in the chiropractic model at progressive steps to scaffold learning, in deliberate manageable workloads for the moderate to large class (75 active students). Additionally, a previously unplanned 'feedback lecture' was provided to further scaffold and model clinical thinking processes.

The third factor, peer collaboration, was required to achieve two progressive goals in the first learning cycle (nominating peer analysis for group representation and short-listing differential diagnoses) and was engaged by students during the second cycle, even though collaboration was not required to achieve the final goal (to determine working diagnosis). The activities in *MAT* interrelated to study throughout the course (subject) and contributed to assessment—the fourth factor—via group work in the first learning cycle of the model and individual conclusions at the end of the second cycle. This work also aided preparation for the final written examination, which together comprised the course assessment requirements.

The chiropractic model presented aligns to several e-learning curricula design recommendations from a JISC e-learning programme report (McGill, 2011) that include (summarised) the following:

- Allocate development and preparation time for curriculum change.
- Change curriculum design to integrate technology (don't just 'add' technology).
- Integrate active approaches to learning using technology that supports real-world experiences and collaboration.
- Include developmental feedback and peer dialogue.

The report also notes that good projects have 'clear and well articulated reasons for trying out… different technological approaches' (p.25). The rationale for chiropractic curriculum change involved a genuine learning need to promote clinical thinking earlier in the programme, intrinsic teacher interest in meeting the theoretical and technological learning needs of a modern student cohort, and the availability of technology to assist, in the form of *MAT*. However, while rationale was clear in design, the findings of the study suggest clearer articulation to the student cohort was required. For example, additional steps for headache analyses are compared to other (eight point) clinical presentations, realism of selecting own team members in authentic scenarios, and methodical steps required in the clinical workplace. Taking this last point further to acknowledge the simulated technological interface, the view of activities as tedious—even though students understood underpinning value—could be tackled by explicating the need for a balance between what happens in the real world and what is achievable towards this by using *MAT*, for example, to keep pace as a class as setting changes in *MAT* affected whole class (e.g. opening from individual to group analysis). Foregrounding of the end goals may assist, although the students' perceptions around the stepwise progression instructions may align to theory that '[t]hinking doesn't happen in a lockstep, sequential manner, systematically progressing them from one level to the next' and should be more complex and messy (Ritchhart, Church, & Morrison, 2011, p.8); formative chiropractic clinical thinking is underpinned by a methodical approach. The video-case provided the complex content to interact dynamically with, and the systematic approach formed the basis of how a chiropractic expert may logically handle the case, albeit a little altered by the technological interface of *MAT*. If later controls in *MAT* become more granular, then guidance could mature to a more holistic approach and allow groups to set their own pace. Such *MAT* improvements are not impossible, as already the student-initiated idea of 'need an input time function' (Table 10.2) has been addressed; video segments can now be selected by entering time range (or by original 'stretching' of marker wings by mouse).

Findings potentially relevant to other collaborative artefact-centred/case-based models include:

- Using a two-cycle integrative model
- Offering multiple scenarios/cases
- Incorporating a responsive feedback mechanism

10.6.1 Two-Cycle Integrative Model

The chiropractic curriculum model was structured over two distinct but interconnected learning cycles. To promote learning from multimedia, Mayer and Chandler (2001) found that 'part-then-whole' or 'part-then-part' learning architectures were favourable over 'whole-then-whole' and that interactivity only improved learning if it was consistent with how students learn, for example, 'in a way that minimised cognitive load and allowed for the two-staged construction of a mental model' (Mayer & Chandler, 2001, p.396).

Additionally, Mayer and Chandler (2001) acknowledge the role of pretraining to help students understand behaviour in each stage of the multimedia. The chiropractic model offered tutorial sessions to orient students and commence the first activities with both pedagogical and technical support on hand, then a concurrent lecture series on headaches to use as resources for the work in *MAT*.

10.6.2 Multiple Scenarios/Cases

The chiropractic students valued the modelling of the expert practitioner in the video-case; however, half of the students interviewed recommended more than one scenario to encounter a variety of experiences. Reimer et al. (2006) found positive correlation between the number of cases and student achievements.

Muller, Sharma, and Reimann (2008) offer that others' schema presented in social interactions—arguably the chiropractor with the patient in the video—can help the novice form a mental template that models the expert example. They also note the role of individual engagement with a case followed by collaborative work, when they argue that 'observing should precede engaging in dialogue to set groundwork for ideas to come and limit faulty effort (Bandura, 1986; Vygotsky, 1978)' (Muller et al., 2008, p.294).

Additional cases could also provide ‘alternative conceptions’ where students experience deeper learning when discussing and challenging misconceptions presented in video (Muller et al., 2008). In the chiropractic model, alternate conceptions were limited to where short-listed differential diagnoses were incorrect. However, misconceptions could be incorporated into video-cases later in the chiropractic programme, such as common errors that occur in clinical history taking, permitting the students to fine-tune their clinical thinking skills.

10.6.3 Responsive Feedback Mechanism

The ‘feedback lecture’ was initially unplanned and therefore did not feature explicitly in the research evaluation instruments. However, it was important in the overall teacher feedback mechanisms of the model which helped scaffold the students’ clinical thinking processes. To scaffold learning in computer-supported collaborative environments, teacher steps of ‘diagnosis’ (or identification), ‘intervention’, and ‘evaluation’ might be useful (van de Pol et al., 2010, in van Leeuwen, Janssen, Erkens, & Brekelmans, 2012). The chiropractic teachers identified students’ midpoint short-listed differential diagnoses as showing a minority of improbable options. Teacher identification was indeed aided by the nature of explicit online communications compared to group/class discussions (van Leeuwen et al., 2012).

Potential misdiagnosis by the students was always possible as they were novices in clinical thinking. The teacher-chosen ‘intervention’ was to hold an additional, voluntary lecture to provide targeted feedback. However, this was not surface feedback, or one of only ‘feedback, explanations, instruction, modelling, hints, and[/or] questions’ (van der Pol et al., 2010, in van Leeuwen et al., 2012, p.306), but rather a combination that aimed to tease out clinical thinking in the students by facilitating them through the process using the student-determined range of differential diagnoses. The timing of this intervention occurred as students commenced their engagement with the second learning cycle of the model; therefore, the teachers could monitor their progression to determine effectiveness of the intervention.

Evaluation of the feedback lecture’s role towards effectiveness of the model could be designed into future research.

10.7 Future Developments and Directions

Since this study, the model has been used in a subsequent second-year chiropractic undergraduate class as well as an adaptation for postgraduate chiropractic students. Evaluation of these further integrations is underway. Additionally, more patient scenario video-cases have been produced, expanding to a suite of videos, or ‘headache series’.

The widening of video-case-based learning across the chiropractic programme is aligned with the findings of a recent study. Loghmani et al. (2011) reported that the most common recommendation by students for future use of a case-based learning model was more consistent implementation across the curriculum.

Future directions include implementation of the curriculum model, and adaptations of, into other health-care study programmes. In particular, models for integrating interactive media-based clinical interactions may well provide an increasingly relevant and sustainable vehicle for students to gain elements of their clinical experience. This could have great value in a climate where it is increasingly difficult, logistically and economically, to secure medical and allied health education clinical placements. In addition, there is considerable potential scope for adaptation as tools of continual professional development for qualified health practitioners. There are also options to develop further video-cases which are not exemplars of clinical practice but variants of practice. These directions would provide an opportunity to further stimulate and facilitate problem-solving, critical thinking, and clinical decision-making skills, which are positive attributes of case-based learning often cited by students (Loghmani et al., 2011) and form skill sets useful for health practitioners of the future.

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practice-based education. We conclude by noting unresolved technological, pedagogical and ethical issues associated with the use of these technologies and suggest areas requiring further investigation and research.

Keywords Practice-based education • Rich media technologies • Videoconferencing

11.1 Introduction

Universities offer a range of *practice-based courses*—for example, law, medicine, education, nursing and engineering—that produce graduates who are accredited for professional practice. However, students often enter practice-based courses with a limited understanding of the nature and characteristics of the practical work of the field, and moreover, there is often a disconnection between the theory of the discipline area—learnt at university—and any teaching and learning that takes place at sites of professional practice. This problem is acerbated by the fact that professional and clinical placement opportunities have become increasingly scarce in many fields (Andre & Barnes, 2010; Le Cornu & Ewing, 2008). In this chapter we argue that this disconnection between learning at universities and learning at sites of professional practice creates three fundamental difficulties. First, students often have an incomplete knowledge of the practice context, particularly early in their course when covering material at university, which makes developing an integrated conceptual and practical understanding difficult. Second, in their university-based learning, students are asked to apply the theoretical ideas they have been studying to contrived or inauthentic problems; and third, when students do engage in learning at sites of professional practice as part of their course, the messages provided by their supervisors in professional practice may be different from the ones they receive from their university lecturers.

In this chapter we critically review how educational researchers and curriculum developers have traditionally addressed the problem of helping students make connections between their university learning and their more practically oriented learning (e.g. Bates, 2008; De Jong & van Joolingen, 1998). In this review we highlight three common ways in which this issue has been approached through curriculum design: work-integrated learning programmes, inquiry-based learning designs and simulation. We identify particular issues with each approach and show how each addresses only part of the problem and has the potential to create new difficulties. We then consider how rich media technologies such as videoconferencing, web conferencing and mobile video can be used to connect university classrooms to sites of professional practice and in doing so help to address the identified issues with traditional approaches to practice-based education. The chapter concludes by noting unresolved technological, pedagogical and ethical issues associated with the use of these technologies and suggests areas requiring further investigation and research.

11.2 The Problem: Disconnect Between the University and Sites of Practice

11.2.1 Theory and Practice

Researchers across a variety of professional disciplines have highlighted differences in the bodies of knowledge and theories studied at university and those used either explicitly or implicitly by practitioners, for example, nursing (Spouse, 2001), teacher education (Cope & Stephen, 2001) and social work (Johansen & Ouellette, 2008). The complex relationship between theory and practice has been a key focus for a number of theorists. Schön (1983), for example, drew the distinction between 'espoused theories', that is, the theories that one articulates when asked to describe what informs one's practice, and 'theories in use', which are the theories which implicitly underlie one's practice but which are often not articulated by the practitioner. Schön argued that decisions made during practice are often informed by a patchwork of experiences which are collectively drawn upon in making a decision to act in a particular way, as distinct from a cohesive body of theory.

Schön (1987) argued that much of the learning at universities centres on the delivery of explicit theory supported by research from what he described as a 'technical rationalist' perspective. However, Schön (1987) recognised that this approach does not adequately prepare students for work in the field as there is an artistry in the everyday work of practitioners that involves difficult to articulate, implicit knowledge. He argued that excellent practice occurs when the implicit knowledge that the practitioner holds is utilised within the work context. This occurs through the rapid interaction of theory and practice and is embodied in the concept of 'reflection-in-action', where a practitioner adapts and changes their work, based around the unique circumstances of their practice. In Schön's view, theory and practice become intertwined. The formal theory taught at universities, along with practice experience, informs the theory in practice that the practitioner draws upon and continually evolves.

Schön's view of the relationship between theory and practice is reflected by Benner (1984) in her distinction between 'knowing that' and 'knowing how'. She argued that 'knowing that' refers to an understanding of formal theory, while 'knowing how' includes the ability to put theory into practice. Benner suggested that ideally professional practice should draw on both types of knowledge but that in some cases practitioners appear to know how to undertake certain practices (e.g. learnt through personal experience and reflection) without necessarily being able to articulate the explicit theoretical knowledge associated with that practice. In a sense these practitioners are exhibiting tacit knowledge, which Eraut (2000) describes as knowledge which can't be articulated or is articulated in ways that don't fully match the practice. This illustrates Polanyi's (1966) argument that 'we can know more than we can tell' (p. 4). For Benner, the challenge for practitioners is to expand and develop their personally held theories that inform their practice into something which can be articulated. As with Schön, Benner sees formal theory as adding to personal theory which is drawn upon in practice.

A logical consequence of Schön's ideas is that learning about practice cannot occur effectively in isolation from actual practice experiences but needs to include opportunities to practice and to reflect on practice experiences. Consistent with this, researchers such as Billett (1996) have been critical of the assumption that conceptual knowledge can be learnt in the classroom and automatically transferred to the practice context. According to Billett (1996), learning is closely linked to the circumstances of its acquisition and transfer beyond these circumstances cannot be assumed. Lave and Wenger (1991) also argued for learning about practice while situated in the site of practice rather than in the isolation of an educational institution. They used the term 'legitimate peripheral participation' to describe the way in which a new practitioner is gradually enculturated into a 'community of practice'. An important aspect of their ideas is the problem for new practitioners of understanding the language spoken within the community of practice and appreciating the subtle meanings conveyed. Barab and Duffy (1998) highlighted the challenges involved in providing students with authentic practice experiences and differentiated between the 'practice fields' students usually encounter in their studies and actual communities of practice.

In the following sections we outline three common difficulties associated with linking theory and practice in higher education settings. The first is that students, especially early in their studies, typically have incomplete conceptions about the context and nature of practice, the second that the opportunities for students to apply theory to authentic problems in authentic settings are precious but often limited and, the third, that there is a dissonance between theory taught at university and the practice experienced in practice setting.

11.2.2 Students' Incomplete Knowledge of the Practice Context

An important problem in professional courses that is particularly pertinent early in the students' study, especially before they have undertaken professional experience placements, is that many students have quite unrealistic and incomplete understandings and conceptualisations of the professional context (Grainger & Bolan, 2006). This is problematic because lecturers may regularly refer to the professional context in which the ideas will be applied, but the lack of a shared conception of the practice context can mean that the message received by the student can be very different to the message the lecturer is attempting to convey. For example, in teacher education, students may be studying a theory-laden subject such as the sociology of education, and their incomplete knowledge or misconceptions about the diversity of the school student population and the challenges in establishing relationships with the parent community can impede their ability to fully understand and appreciate the importance of the course content. In nursing, students may be studying theoretical concepts related to pharmacology without fully appreciating the way this knowledge will be applied in managing the administration of drugs to patients.

Even more significantly, clinical care students are unlikely to appreciate the importance of the more subtle aspects of their work such as issues of power in health relationships and clinician self-efficacy until they have experienced the dynamic of the clinical setting. Part of the problem here can be an inability to accurately visualise the practice context due to knowledge acquired from personal experiences of the context a long time in the past or from popular portrayals in the media. For example, education students learning to teach practical subjects such as art or industrial technology may have out-of-date notions of the teaching spaces used in these disciplines and may not appreciate the significant changes in the characteristics of these specialist teaching spaces that have occurred in recent years.

Even once students have undertaken professional placements, their experience is typically limited to a very small range of placement contexts. Not every student has the opportunity to undertake a placement in every type of classroom or clinical area. In nursing, students may never have the opportunity to consider areas such as community nursing, sexual health or occupational health nursing, while in teacher education the students may not encounter specialist classrooms or schools in multicultural communities in their placements. It is practically impossible to offer every student the possibility of experiencing a placement in some of the smaller, more specialised or more remote professional contexts. Additionally the fact that when students do undertake more specialised placements they are likely to have unique experiences that are not shared with the lecturer limits their usefulness as hooks for the lecturer to use in discussing theoretical ideas.

11.2.3 The Need to Apply Theory to Authentic Problems

As discussed above, for students undertaking professional courses, an understanding of theory alone is insufficient; there is an expectation that students are able to apply their theoretical knowledge in practical situations. Many researchers have problematised the notion that theoretical knowledge can readily be transferred to other contexts. For example, Billett (1996) argues that 'learning is now seen as being more closely linked to the circumstances of its acquisition than previously acknowledged' (p. 263) and that as a consequence 'learnt knowledge may not readily transfer to circumstances that are different or remote from those which were its source' (p. 263). Consequently, it is generally accepted that course designs are needed that specifically address the additional learning required in order for transfer to occur. One element of such designs might be explicit instruction focusing on the cognitive and meta-cognitive skills needed to be able to identify the knowledge required and successfully apply the identified knowledge in new situations (Pea, 1987). The most important element of such designs, however, is the provision of learning tasks in which students are required to use their theoretical knowledge to help solve authentic problems.

Such problems may be authentic in the sense that they resemble the ill-structured nature of the problems the students will encounter as professionals (Herrington, Reeves, Oliver, & Woo, 2004) or may be authentic in terms of the context in which they are undertaken. Traditionally the problems students undertake at university tend to be ‘closed’, with a single clear solution and with only relevant information provided. The provision of ill-structured or ‘open-ended’ problems within a university context can be challenging because they require quite different approaches to assessment and because students can be initially resistant due to the additional complexity. Gulikers, Bastiaens and Kirschner (2004) highlight the inclusion of physical or social aspects of the target professional context as an important element of authentic learning, consistent with Brown, Collins and Duguid’s (1989) notion of situated cognition. Applying their theoretical knowledge in the context of truly authentic problem solving is expected to both help cement students’ understanding of the theory and also increase the likelihood that they will be able to transfer their learning to problems they encounter in sites of professional practice as graduates. However, the provision of truly authentic problems within a university context is challenging and consequently is rare in most courses (Stein, Issacs, & Andrews, 2004), while some commentators (e.g. Petraglia, 1998) argue that true authenticity is not possible unless the learning is actually situated in the professional or everyday context.

11.2.4 Competing Messages: Differing Lenses, Languages and Knowledge Priorities

Another problem in professional education is that students receive different messages from their university lecturers than from their supervisors on professional placement. In some cases this can occur because lecturers tend to favour research-informed theoretical ideas and practitioners tend to take a more pragmatic approach. In other cases the problem can be more complex with practitioners drawing on different bodies of theory than lecturers or with practitioners acting in ways consistent with the university-described bodies of theory but describing their practice or their rationale for practice decisions in different ways.

In teacher education, for example, these different messages can occur in many areas of student learning such as classroom management, pedagogy and lesson planning. Typically lecturers tend to emphasise a more theoretically informed approach, whereas practitioners tend to be more pragmatic and practically focused. For example, particular teaching strategies may be advocated within schools which are not collectively supported by the academic community. At times the prevailing theories or implicit theories in schools have been criticised within academia but the new theories replacing them have not yet been taken up.

Sometimes, it is not so much that the messages are in conflict, but rather a case of different ways of looking at the situation, different languages for describing practices or different implicit or explicit theories underpinning the same practices. In nursing, for example, clinicians frequently describe their roles in terms of the clinical activities that they undertake. This reinforces student perceptions that the primary focus of nursing is to undertake medically related practical tasks rather than allowing them to recognise the thinking and decision-making that the autonomous practitioner is actually engaged in (Buresh & Gordon, 2000). For example, community nurses are more likely to describe their work as consisting of visible tasks such as wound management, medication management and palliative care rather than more abstract activities such as developing self-efficacy, reducing health risks, coordinating care across multiple professions or negotiating acceptable treatments within a complex and changing environment. In some cases the clinical practitioner may exhibit practices which are consistent with fundamental principles like empowerment while at the same time telling students that such ideas are esoteric and that the student should focus instead on the practical skills involved in the practice. It may have been that ideas like this are so embedded in the way that practitioners go about their work that it is difficult for them to identify and describe them.

One way that students tend to negotiate their way through these competing messages is to learn how to articulate a perspective based on the theories acceptable to their lecturers within their university assignments while developing approaches within their practice that are more underpinned by the bodies of theory either explicitly or implicitly accepted by practitioners in the site of their professional placement. In some ways this accords with Argyris and Schön's (1974) distinction between 'espoused theories' and 'theories in use', but in other ways the students' situation is more complex because as well as having distinct espoused and enacted theories, they may in some cases have two sets of espoused theories, those they produce when required for their lecturers and those they produce in the practice setting (see, for example, Reupert & Dalgarno, 2011).

11.3 Approaches to Reconciling Theory and Practice in Practice-Based Education

The need to find ways to help students make connections between their university learning and their more practically oriented learning has been the subject of both curriculum development approaches and educational research for many years. In this section, three approaches, work-integrated learning, inquiry-based learning and simulation, are each discussed in turn.

The approach that has become most prominent in the 25 years or so since Schön first began to articulate the issues involved in practice-based education is the inclusion of work-integrated learning initiatives within professional courses. These initiatives—where typically a student spends a portion of their university programme on a placement in a professional setting—have become popular in response to what Bates (2008) suggests are the 'increasing demands for workplace-based experiences to be built into undergraduate degrees' (p. 305). There are many examples of how these placements can be designed and implemented (Budgen & Gamroth, 2008, for example, for a review of placement design within nursing curricula), but most approaches adopt some form of an apprenticeship model of learning or draw more broadly on the notion of communities of practice (Lave & Wenger, 1991). Fundamental to these approaches is that there is a shared responsibility between teaching staff from the university and professionals at the site of practice, coordinated through clear curriculum and assessment, that provides a link between what is learnt in theory and what is applied in professional practice.

A second way in which curriculum design has been used to bridge theory and practice is through inquiry-based models of teaching and learning. Associated most commonly with Jerome Bruner's notions of 'Discovery Learning', inquiry-based learning can be regarded as an umbrella term that covers a range of similar but different curriculum and instructional approaches: problem-based learning, case-based learning, discovery-based learning and project-based learning (Bruner, 1962). While there are important differences between these approaches, what they share in common is the objective of situating the development of a student's knowledge and understanding in the context of 'real-world' activities, problems or scenarios. So, for example, a popular model of problem-based learning in health science education provides students with a clinical problem scenario that is used as a vehicle for students to both uncover and understand fundamental biomedical and clinical science principles (Barrows & Tamblyn, 1980). Similarly, project-based learning may give teams of students a real-world project that needs to be planned, investigated, managed and completed over time (Helle, Tynjälä, & Olkinuora, 2006). Civil engineering students might be asked to consult various stakeholders in an effort to determine how and where a state government should build a new dam; business students might be asked to manage (mock) investors' stock portfolios over a period of time within real fluctuations and constraints and with a goal of achieving ascribed performance targets. Typically, these problem-based or project-based activities are undertaken within the university setting; however a variation that is common in clinical education is for students to explore clinical case studies in a classroom environment in the clinical placement setting with the support of a clinical practitioner or clinical educator.

A third way in which learners have been provided with curriculum that attempts to integrate theory and practice is through the use of simulation. A range of simulation methods have been used in education and training. De Jong and van Joolingen (1998) make a useful distinction between conceptual simulations—simulations whose main purpose is to assist learners understand relationships between facts, concepts and principles—and operational simulations where the focus is on procedural tasks and the knowledge and skills required to perform them. Both have been used widely in education and training with the former most often associated with the development of theoretical knowledge (e.g. with the learner exploring a computer-based simulation) and the latter associated with the development of practical knowledge and skills. Operational simulations can be more obviously used to bridge theory and practice.

Operational simulations can be constructed using a variety of methods, tools and technologies. In the context of medical education, Maran and Glavin (2003) identify a range of simulations types, which can be distinguished by their fidelity, whether they involve real people, mannequins and/or computer-based environments, and

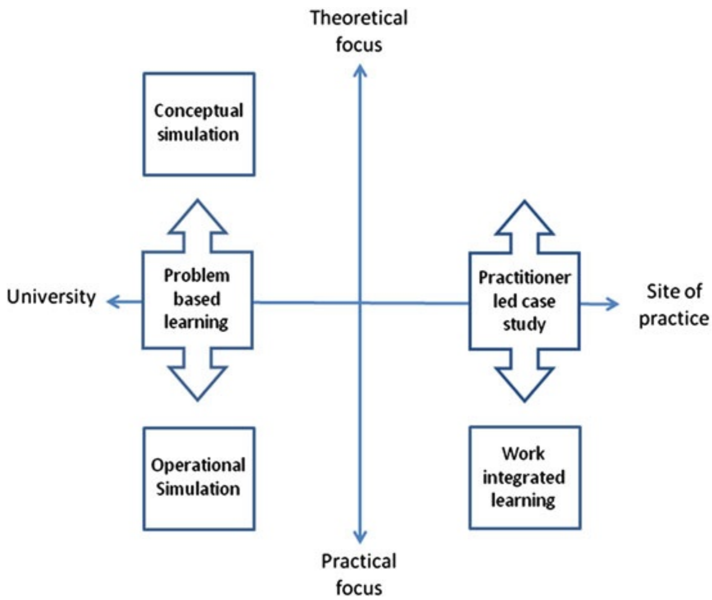

Fig. 11.1 Practice-based education approaches, situated at university or in the site of practice and degree to which each focuses on theory or practice

their cost. For example, ‘real-world’ simulations can involve face-to-face role-plays among students where participants take on the character of different players in a professional scenario or can involve an actor playing the part of a patient who presents to students with a clinical complaint. Mannequins or other ‘part-task trainers’ are often used by health professional students to practice clinical skills such as resuscitation or cannulation. Virtual and computer-based environments have also been used extensively for operational simulations. Again, in the health sciences, clinical cases can be presented to students as ‘virtual’ patients. Students take virtual histories, order virtual tests and arrive at virtual diagnoses with these educational tools (e.g. DxR Development Group, 2011). Simulation-based role-plays can also take place online with participants working through scenarios using text, audio or videoconferencing (e.g. using Adobe Connect, Elluminate or Skype). Emerging technologies such as 3D immersive virtual environments (e.g. Second Life) have provided additional platforms for operational simulation in education and training. For example, Gregory et al. (2011) described a virtual classroom environment in which teacher education students role-play school students and teachers, and in a similar way such environments have been used in medical education to allow trainee surgeons to practice complex surgical procedures and routines (O’Leary et al., 2008; Seymour et al., 2002).

Bringing together these various approaches to practice-based education, Fig. 11.1 identifies those which tend to be situated at university and those which tend to be situated in the site of practice and the degree to which each focuses on theoretical or practical knowledge. In the diagram, the group of university-based strategies within the inquiry-based learning category have been grouped together under the heading of problem based learning, which is the most commonly used of these approaches, while the inquiry-based learning approach normally situated in the site of practice, which we have termed practitioner-led case study has been shown separately. Similarly, simulations have been separated into operational simulations (including e.g. role-plays and practical simulations using mannequins) and conceptual simulations. The arrows on either side of problem-based learning and practitioner-led case study indicate that these approaches can focus either on theory, practice or a combination.

While each of these curriculum approaches accommodates some of the concerns educators have about linking theoretical knowledge development at university with practical knowledge development on placement, each also has difficulties. Work-integrated learning programmes, while helping to address students' lack of knowledge of the practice context, can be subject to the key problem outlined earlier in this paper, of students being provided with competing messages across the university and practice contexts. That is, because of the professional context of learning, the knowledge that is developed by students is often practically focused and perceived as separate from theoretical knowledge developed on campus. This issue of the separation between the university-based and practice-based components of students' learning has been acknowledged by many professional educators, and the key approach that has been used in attempts to address it has been the provision of assessment tasks to be undertaken while on professional placement which require explicit linkage between the two contexts (see Allen, 2011 for a discussion). However, work-integrated learning opportunities have been recognised as being expensive and in short supply (see, for example, Hall, 2006), and consequently attempts by university educators to prescribe tasks for students to undertake while on placement which integrate their theoretical learning and their practical learning can at times result in a tension due to the students and/or placement supervisors' prioritisation of practical knowledge development during the limited time available (see, for example, Reupert & Dalgarno, 2011).

Inquiry-based and simulation-based learning designs have a different set of difficulties. A primary concern with these approaches when it comes to the integration of university and practice situated learning is that the problems, scenarios and simulated environments often lack fidelity compared to the real-world context. Students are presented with scenarios or simulations that often require them to 'suspend disbelief' and pretend they are interacting in a real-world context. While many of the learning activities and tasks students are required to complete are worthwhile simulations of the real world, ultimately they are just that, simulations. While simulations are valuable and allow students to focus on particular elements of practice, there is benefit in students eventually experiencing the full, sometimes messy, real world of practice. The argument is that students cannot really develop a deep appreciation of the practice context until they experience the real world, in real time, for themselves. This is not to say that students need to directly experience every practice context or every possible practice scenario during their training—rather it is to say that although simulated experiences can, in an efficient way, provide students with a wide range of (simulated) scenarios and contexts, they need to be complemented by actual real-world experiences.

An additional issue associated with both simulation- and inquiry-based learning programmes designed within the university context is that they may have elements which do not in fact match the real world at all but are designed instead to exemplify the theoretical understandings prioritised within the university. Consequently in a subtle way, they may also extenuate the problem of competing messages across the two sites.

11.4 The Alternative: Rich Media

As discussed above, there are three specific aspects to the problem of disconnections between universities and sites of professional practice in professional education courses: incomplete knowledge of the practice context, the need to apply theoretical ideas to authentic problems and competing messages across the two sites of learning. Of the three approaches or classes of approach commonly used to address this disconnect—work-integrated learning, inquiry-based learning and simulations—all address only part of the problem and all have the potential to exacerbate part of the problem. The question posed in this paper, then, is to what degree can the use of rich media to connect university classrooms to sites of professional practice address the shortcomings of these conventional approaches. In order to explore this, it would be valuable to first describe how rich media, and specifically the three key technologies of videoconferencing, web conferencing and mobile video can be applied within teaching and learning contexts. It is then argued that such applications of rich media have the potential to address each of the problems outlined above.

Videoconferencing refers to the use of audiovisual systems that enable synchronous communication between remote participants. Popular room-based videoconferencing systems used in education include the Polycom and Tandberg systems, while Skype is currently the most commonly used desktop videoconferencing application. Early videoconference systems were often large and cumbersome and significant effort was required prior to use to outfit a dedicated videoconferencing space or room. More recently, these systems have become more flexible and mobile, and the widespread availability of desktop systems has created new opportunities in contexts where their use would previously have not been feasible. Much of what has been written about videoconferencing in an educational context has been concerned with the application of different types of videoconferencing technology, describing the range of videoconferencing platforms that exist and discussing their relative strengths and weaknesses (see, for example, McBride, Fuller, & Gillan, 2001). Other researchers have developed guidelines for educators on the use of videoconferencing (see, for example, Arnold, Cayley, & Griffith, 2002).

The most common applications of videoconferencing in higher education to date have been designed to bring together learners who are dispersed across various locations (see Anastasiades et al., 2010; Hinger, 2007). This may involve the use of videoconferencing to effectively transmit a lecture which is given from a central site to other locations in real time. Alternatively, videoconferencing can be used to engage numbers of students in small group discussions from two or three sites. Other researchers such as Dymond, Renzaglia, Halle, Chadsey and Bentz (2008) and Dyke, Harding and Liddon (2008) have considered the value of videoconferencing for assessment of remote students' performance.

A body of studies has more explicitly considered how videoconferencing can be used to link university teaching with sites of professional practice. For example, Ayre, Hanlon and Armstrong (2007) describe a trial in which teacher education students and their lecturer observed via videoconference a teacher in a remote classroom demonstrating approaches to differentiated reading instruction and then subsequently discussed the strategies used with the teacher after the conclusion of the school lesson. A key educational feature of this kind of implementation is the reflective conversation with the remote practitioner after observing the practice. A number of others have also reported on studies where preservice teachers have observed remote classrooms via videoconferencing technology (e.g. Kelland & Gibson, 2008; Knight, Pedersen, & Peters, 2004; Lehman & Phillion, 2004), and similar studies have been undertaken in other professional disciplines, such as nurse education (see, for example, Rush, Walsh, Guy, & Wharrad, 2011). With videoconferencing systems it is not only possible to have a live video stream of professional practice into a university classroom, it is also possible to record sessions so that they can be used to create a bank of scenarios for subsequent stimulus and reflection.

An alternative to videoconferencing that shares some of the functionality, particularly of desktop videoconferencing, is web conferencing. Like desktop videoconferencing, web conferencing does not require the specialised hardware needed for room-based videoconferencing, but simply requires appropriate software to be loaded onto participants' Internet-connected personal computers. Popular web-conferencing systems include Adobe Connect, Wimba Classroom and Elluminate (now Blackboard Collaborate). These tools, as well as including videoconferencing capabilities, also allow groups of individuals to enter online 'virtual classrooms' in which they can work collaboratively via video, audio and text. Participants in a web-conference can share documents, form breakout groups and vote on issues under consideration. One possible advantage of using web conferencing rather than videoconferencing to stream vision of the practice context to students is that with web conferencing students can view the video on their own computers and consequently do not need to be present in the lecture theatre. Moreover, the additional communication features of the web-conferencing system may be used by the lecturer to provide commentary or to highlight aspects of the practice for the students to focus on, for example, using the text chat tools within the system. Although there are published studies exploring the use of desktop videoconferencing to link university-based teaching and learning that takes place in practice settings (see, for example, Pemberton, Cereijo, Tyler-Wood, & Rademacher, 2004), there are few examples in the literature that describe how web conferencing has been used for this purpose, perhaps because web-conferencing platforms have only recently matured as an educational technology.

A final rich media technology that could help to bridge sites of university and practice-based learning contexts is mobile video. The rise in popularity of powerful personal mobile computing devices including smart phones and tablets has been accompanied by an emerging interest among educational technology researchers in how the video recording capabilities of these devices can be used in education. In addition to smart phones, flip cams—small, cheap, high-definition video cameras—have also attracted attention as devices that could be used to record activities for teaching, learning and assessment in higher education. There has been a long tradition of using professionally created video of real or simulated professional practice as a prompt for learning in both university and professional practices settings (see, for example, Admiraal, Janssen, & Gielis, 2008; Barnett, 2006; Hung & Tan, 2004; Liaw, Kennedy, Keppell, Marty, & McNair, 2000; Santagata, Zannoni, & Stigler, 2007). Typically creating these 'video vignettes' has required significant planning and production before they are packaged for students to interact with. High-resolution mobile video devices, to a large extent, allow this process of planning and production to be circumvented; the individual can record parts of their own or others practice for later analysis, discussion, reflection, evaluation and assessment. The use of video captured by mobile devices also has a relatively short history in higher education contexts. One recent example comes from a project at the University of Queensland in which health science students used flip cams to assist with learning and assessment of physical examination skills (Haakan, Fox-Young, Long, & Bogossian, 2013).

11.5 How Rich Media Can Address the Identified Problems

As discussed above the students' limited knowledge of the practice context or the absence of a shared knowledge of the elements of the practice context can impinge on the students' ability to effectively contextualise foundational concepts during their university learning. The shared viewing by students and lecturers of a practice episode through rich media can allow lecturers to use the episode as a hook for discussing a range of general concepts that come up within the subject or course. This could be done through the use of video (e.g. captured using mobile video devices), but it is likely that a live videoconference link to a site of practice followed by a live debrief with the practitioner afterwards will make the experience particularly engaging. There is no need to suspend disbelief as what is occurring on the screen is really happening at the time that the student is watching it. Students would have the opportunity to, firstly, see examples of authentic, professional work in a wide range of contexts and, secondly, have opportunities to engage in 'legitimate peripheral participation' (Lave & Wenger, 1991) with the work through observing and interacting with the practitioner. The value to the student of hearing the practitioner's reflections on the practice is not to be underestimated. Mattingly (1998), for example, suggests that the informal conversations and stories that practitioners develop and share are rich with content that is particularly helpful, for example, in developing clinical reasoning skills in a health practice context.

A further benefit of using rich media to bring sites of practice into the university classroom is to provide students with knowledge of professional practice contexts in an area that may otherwise be inaccessible for them or in a wider range of areas than could be expected to be experienced through their professional or clinical placements. For example, in teacher education, there is a need for students to be prepared to teach in a diverse range of schools with children from a wide range of cultures and socioeconomic backgrounds, but they may not have the opportunity to undertake sufficient placements during their training to provide the breadth of experience that they need. Using rich media to observe lessons in real time at a diverse range of schools, in the context of university classes focusing on educational sociology or multicultural competence, will help to make the learning in these courses more authentic. Clearly the range of practice contexts that students can experience will still be constrained by the class time available and by the availability of practitioners who are prepared to make their practice accessible in this way; however, it is argued that the use of these strategies, alongside traditional professional placements, has the potential to substantially increase the range of experiences students have to draw upon.

The second aspect of the problem faced by practice-based educators identified above is that of providing learning experiences for students where they have the opportunity to apply their theoretical learning within the context of authentic practical problems. Ultimately students need to, as part of their professional or clinical placements, actually undertake fully authentic problem solving within the site of practice. However, within the context of their university learning, the use of rich media to connect to sites of practice can provide an authentic 'hook' to the problems they undertake at university. For example, episodes of practice viewed through rich media at university can be used as case material for authentic problems.

Finally, a key potential benefit of the use of rich media tools to bring university classrooms and sites of professional practice together is that by doing so, the differing messages the students receive from these two important sites of their professional education will be reconciled. That is, it may address some of the difficulties with linking theory and practice by ensuring that both have prominence at the same time. One might expect that while students sit in university classrooms, they are attuned to thinking in theoretical terms while they may on the other hand be accustomed to thinking and talking in more practical ways while visiting sites of practice. For example, the viewing together of videos of practice episodes, or alternatively being physically present at university while, as a class, viewing and interacting with a site of practice via videoconference or web-conference, may challenge these distinct ways of thinking and force students to reconcile any differences between the two. In addition the opportunity to reflect and review what is occurring as it happens and immediately afterwards can show both how theory is informed by practice and how practice draws upon theory. Where there are conflicts between theory espoused in the university learning environment and what the students see, there are opportunities to look at why this occurs and explore the complexity of the context of the episode.

The use of rich media to connect university classrooms to sites of professional practice may also have the potential to give prominence to different ways of knowing or different ways of thinking about practice. Students will have the opportunity to contrast the different ways in which the practitioner rationalises their practice decisions and the ways in which the lecturer or academic facilitator conceptualises the practice. The complexity of the practice context can help to highlight for the student any oversimplifications in the way that they have theorised practice and help to highlight the ways in which alternative sources of information or ways of thinking beyond the theory can inform the practitioner's decisions. Students may observe the application of tacit knowledge in action (Eraut, 2000; Polanyi, 1967) or see evidence of the 'artistry of practice' (Schön, 1983). For example, in clinical education, videoconferencing an authentic patient interaction would allow clinicians opportunities to talk about the implicit knowledge that has informed their thinking and actions thereby illustrating for students examples of practice that draw not only on the practical, visible clinical tasks but also on the less apparent aspects and the thought and theory that underlies them. In some cases students may be able to recognise these more subtle aspects of practice themselves, but more commonly one might expect that reflective comments from the practitioner and questioning by the academic facilitator might scaffold the students to see beyond the obvious and develop new insights into practice.

In this section, it has been argued that using rich media to connect university classrooms to sites of professional practice can help to address the key problems faced in practice-based education identified earlier in the paper, that is, incomplete knowledge of the practice setting, the need for theoretical knowledge to be applied to authentic problems and the competing messages across the two sites of learning. Table 11.1 summarises the arguments above by describing the conventional approaches to addressing the three identified problems along with the ways in which rich media tools can help, as well as summarising the key limitations of these approaches.

Having summarised in Table 11.1 the ways in which the use of rich media can address problems that remain unaddressed by traditional practice-based education approaches, Fig. 11.2 illustrates the positioning of the rich media-facilitated approaches within the theory/practice and university/site of practice framework shown earlier. The diagram illustrates how using rich media in the ways argued in this chapter can bring together the university and the site of professional practice to bridge the gap between theory and practice in a new way.

11.6 Discussion and Conclusion

It has been argued in this chapter that the use of rich media tools to bring the practice context into the university classroom can potentially address a number of key practice-based education problems in a new way. However, there are a number of technological, ethical and pedagogical questions that need to be addressed and issues that need to be resolved before the use of these tools for this purpose can be expected to become commonplace.

Table 11.1 Summary of the benefits and limitations of traditional approaches to addressing the problems faced by practice-based education along with those of the proposed rich media-facilitated approaches

	Key problems faced by practice-based educators		
	Incomplete knowledge of the practice context	Need to apply theory to authentic problems	Competing messages across the two sites of learning
Work-integrated learning	✓ Provides rich experiential knowledge of the practice context	✓✗ Although the work context is by definition authentic, the limited connection with the university may limit the application of theory studied at university	✗ Messages on professional placement often conflict with messages from university
Inquiry-based learning	✗ Typically shows a somewhat simplified perspective on the site of practice	✓✗ Provides opportunities to apply theory in the solving of authentic problems; however, the university setting limits the contextual authenticity	✗ Typically shows a simplified university perspective on the site of practice
Simulation	✗ Typically show a somewhat simplified representation of the site of practice	✓✗ Provides opportunities to apply theory in the context of problem solving; however the fidelity of a simulation will always be less than the equivalent authentic context	✗ Simulations may be developed from a university or practice perspective but they won't help reconcile the two
Rich media	✓ Provides a valuable view of the practice context scaffolded by the lecturer	✓✗ Limited opportunity to undertake problem solving while observing but opportunities to use the observed practice as a rich case on which to base authentic problems	✓ Allows two sites of learning to come together simultaneously

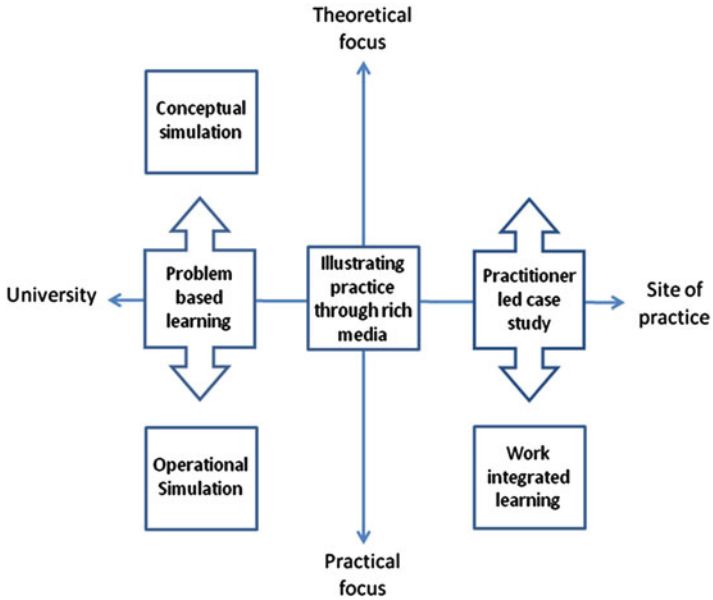

Fig. 11.2 The position of learning designs involving the use of rich media to connect university classes to sites of professional practice within the theory/practice continuum

A key technological question that we feel could be the focus of future research is the degree to which high visual and audio fidelity is important in capturing or transmitting video footage of sites of professional practice. For example, the minimum video resolution and frame rate and the maximum latency for particular types of practice episodes to ensure that the students' experience is sufficiently realistic and communication between the students and lecturer and the practitioner is smooth needs to be explored (see, for example, Winer & Cooperstock, 2002). Aside from the hardware required for high-fidelity media capture and transmission, there is also the issue of bandwidth and the implications for mobility (i.e. due to the fact that wireless broadband bandwidths are currently insufficient for high-quality video transmission). Other technical issues that need to be addressed relate to the quality and positioning of cameras, microphones and video screens in the site of practice and the university classroom, the feasibility of the use of mobile cameras to allow convenient capture of practice episodes in a variety of contexts, and the potential use of specialised devices such as head-mounted cameras and motion trackers.

There are a number of important ethical issues to consider in setting up rich media connections to sites of professional practice, particularly those revolving around the privacy and anonymity of the participants in the practice context (e.g. patients, students, customers). Some of the issues are specific to particular practice contexts (e.g. health, education), while some are common to all. There are also different issues to be considered depending on whether the rich media is viewed live, in real time or recorded for later viewing in or out of class. While some authors believe that the privacy and confidentiality risks are similar to those which occur in a face-to-face context and that they can be managed using the same legislative and policy frameworks (Hebda, Czar, & Mascara, 2005), a counterargument is that having a larger number or potentially unseen viewers of the context adds additional issues beyond those occurring when students visit sites while on placement. In situations where the video footage is captured for later viewing, there are additional issues related to security of access which institutions need to address (see, for example, Shaw, Keh, Huang, & Huang, 2011).

Finally, it is important for educators to realise that as with the introduction of any new technology into the learning process, there are likely to be learning design issues which emerge during the first implementation. For example, the use of rich media in the ways indicated in this paper has some complexities from a pedagogical perspective because the lecturer's facilitation role moves beyond the activities occurring within the traditional teaching and learning structures of the higher education institution. The development of guidelines including example learning designs will be helpful to lecturers and also to practitioners as these new approaches are adopted (Hathaway & Norton, 2012). A particular aspect of the learning design which is unique to these new learning scenarios is the process of scaffolding the students' experience of the practice episode to ensure that learners come away with a rich, shared understanding of the practice observed (Mitchell, Marsh, Hobson, & Sorensen, 2010).

In this chapter we have called for the use of rich media tools to connect university learning environments to sites of professional practice. We have argued that this will help make explicit the relationship between students' university learning and their learning on professional placement and will help students tackle the challenges of reconciling the different messages received within these different contexts. Additionally we have developed a conceptual framework to help contrast the use of rich media tools in this way with traditional practice-based education approaches. The proposed framework highlights the way in which each approach addresses the need for theoretical knowledge or practical knowledge and the degree to which each can be situated either in the university or the site of professional practice. Finally, we have highlighted some of the technological, ethical and pedagogical issues that could be the focus of research into the use of rich media in these ways. Despite the fact that there are a number of unresolved questions about how best to use rich media tools for this purpose, we believe that many universities and many professional and clinical contexts are already well set up to commence using rich media in these ways. Consequently, we encourage professional educators to look for opportunities to implement these approaches, ideally in partnership with researchers undertaking systematic qualitative and quantitative studies of their efficacy, in order to provide the Higher Education and practice communities with an expanded knowledge base to draw upon in addressing the pedagogical problems described in this chapter.

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12.1 Introduction

This chapter is about efficiently and effectively harnessing tools for organization and movement of information associated with teaching, learning, and evaluation—inside and outside of the formal classroom. The chapter begins with an overview of RSS, information push and pull in and out of the cloud, and a brief explanation of the pragmatics of teaching, learning, and evaluation inside, outside, and between the classroom environment. This introduction is followed by connections to social learning theory and a description of how tools associated with information in the cloud can help transition from courses to communities of learning—leading into a transition from learning management systems (LMSs) to social learning networks (SLNs). Two courses conducted in the Spring 2012 semester at a California university are used as example cases for initial implementation of this pedagogical transition. These examples include course overviews, descriptions of tools used in each course, and an overview of the author's approach to evaluation of production work in each of these courses. The chapter wraps up with a section that provides reflections on this initial implementation in both courses, including student perspectives from both courses—based on end-of-semester surveys—as well as summative reflections from the perspective of the author.

12.1.1 Information and the Cloud

What, and where, is *the cloud*? Simply put: the cloud is the storage of user-generated information content on servers that can be accessed via the Internet. When it comes to organizing and moving information to, from, and within the cloud, RSS ("RSS Tutorial," n.d.) is considered to be the best mechanism for doing so in a way that is as accessible to as many people and machines as is currently possible. The acronym RSS has been attributed to several combinations of words associated with the technology, but Andrew King (2003) provides a concise definition and historical explanation:

> Rich Site Summary (RSS) is a lightweight XML vocabulary for describing metadata about Web sites, ideal for news syndication. Originated by UserLand Software in 1997 and used by Netscape to populate Netscape's My Netscape portal with external newsfeeds ("channels") RSS has taken on a life of its own and has become perhaps the most popular XML format today.

RSS is a form of extensible markup language (XML), which is, among other things, the foundation of Web 2.0 (e.g., Daconta, Obrst, & Smith, 2003; Kashyap, Bussler, & Moran, 2008). XML allows for people to mark up information using structure and semantics that are highly beneficial to both machines and humans and therefore a gateway for much better communication between the two (i.e., better human-computer interaction).

One good way to think about the communication activities that take place between humans and computers—especially those concerning movement of

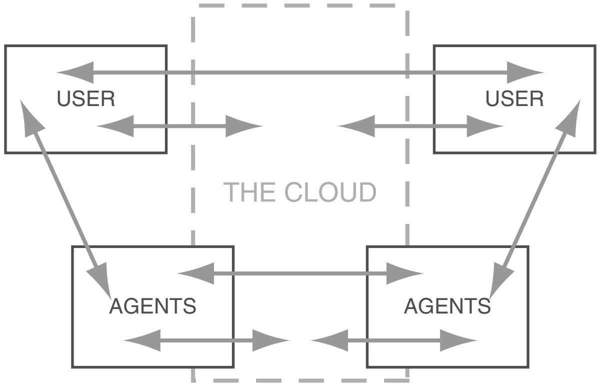

Fig. 12.1 Diagram of information push and pull

information into and out of the cloud—is information *push* and information *pull*. Cybenko and Brewington (1997) provide a basic explanation of push and pull:

> Loosely speaking, if a user requests and receives a very specific piece of information, this is information pull. If information is sent in anticipation of the user's need, or the agent's response includes information not directly solicited, then the situation is characterized as information push.

This explanation covers part of the equation: the user can pull information from the cloud, and intelligent software agents can push information to the user from the cloud. In fact, quite a few push, pull, and storage activities are possible! Figure 12.1 represents the myriad combinations of cloud-based information push and pull. Users can push information to the cloud—and share information with each other via the cloud—and intelligent bots can pull information from any number of users into the cloud and back to local machines, with or without direct intervention from humans.

It is tempting to try to simplify information push and pull to the production and consumption of information by the user. This can be a conceptual trap, though, since it is often the case that a user pushes information that he or she did not actually produce. For example, a baseball fan might gather the day's box scores (pulled from the cloud) and push them to another location in the cloud—merely moving information from one place to another. Considering such an example, how might information push and pull be useful to students and teachers inside, outside, and between the classroom?

12.1.2 Inside, Outside, and Between

What is the difference between activities for moving information that occur inside, outside, and between the classroom? *Inside* activities are those that take place during the time that students and teachers are gathered in one contiguous formal learning space (in a traditional brick-and-mortar classroom, via the Internet, or a combination of the two) that is set aside as a formal learning period (such as a single class meeting). *Outside* activities are those that take place during the time that students and teachers are out of a formal learning space, working independently or collaboratively in a more informal or spontaneous manner. *Between* activities are those that occur during the time that a student or teacher transitions to and from these inside (formal) and outside (informal) learning activities. The direction of a between activity is relative to the order of occurrence of inside and outside activities—and a between activity can also occur between two of the same type of learning activity sessions (i.e., inside → between → inside: such as when a student is rushing between two classes on campus). Essentially, between activities are those times that information is moving around for the benefit of the student or teacher and no active learning is necessarily taking place at the time (such as while the student sleeps).

There are three main types of activities that can occur regarding information push and pull in the inside, outside, and between periods of educational environments. Figure 12.2 shows the various types of activities in which teachers and students can engage while in the various periods. Teachers can conduct teaching, evaluation, and learning activities inside, outside, and between the classroom, with or without the assistance of intelligent software agents. Students can conduct learning and evaluation activities inside, outside, and between environments—again with or without the assistance of software agents.

Consider a hypothetical case as an example. Using the model pictured in Fig. 12.2 as a temporal guide, a chain of events involving the teacher and students pushing and pulling information for teaching, learning, and evaluation can be explored.

Prior to class, the teacher pulls content relevant to that day's curriculum from predefined search agents in her news feed reader application. This allows her to think about connections to the lesson that ground the experience in up-to-date information such as current events or recent experimental findings from the scientific community. Also prior to class, students may pull the lecture outline (or schedule of workshop activities, etc.) for the upcoming class section—perhaps downloaded to their laptop computers, smart phones, or tablets—in order to better prepare for the day's activities or, potentially, to complete last-minute pre-class activities. By the time class begins, additional relevant content has been delivered to the teacher (information push occurring as a between activity!) based on the intelligent agent's interpretation of the previous information pull request made by her news reader.

During class, students conduct learning activities in groups, in which they do several initial research inquiries on a particular topic—a series of information pull activities. Students create unique search agents based on successful inquiries within the topic area, allowing for continued information push by these agents as students leave class and transition to after-class learning environments (such as study time at the local public library). Additionally, the teacher conducts in-class evaluation activities—perhaps integrated directly into the collaborative inquiry activity as the generation of an initial blog post on the topic. While the teacher is in transition from the classroom to the home environment, these blog posts are pulled into her news reader—including any updates individual students may make in outside learning

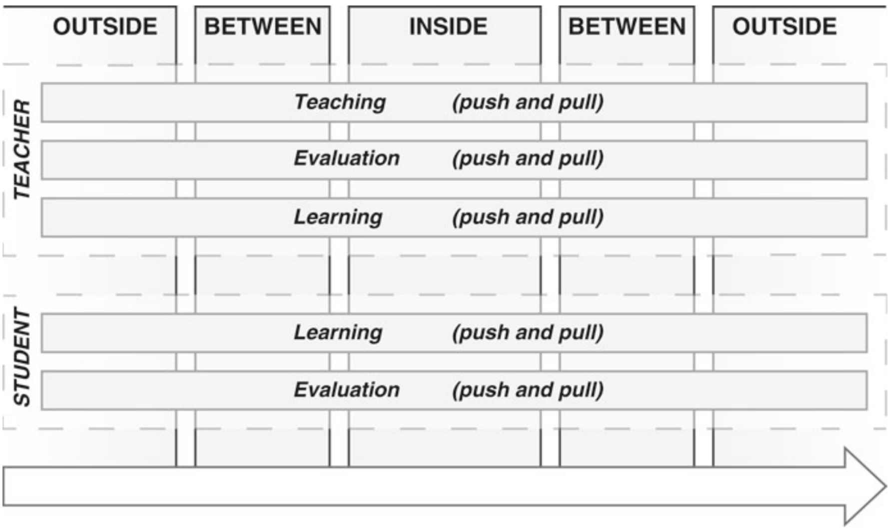

Fig. 12.2 Types of information push and pull in educational environments

environments based on new information they've had pushed by the unique search agents they created in class. As the teacher reads through these blog posts, she can immediately push comments back to the students based on the quality of the work—all as a supplement to in-class face-to-face feedback she's already given during the initial activities. One particular comment might be a key suggestion for refined searching to gather more sophisticated evidence for the argument presented in the students' blog posts. This suggestion, noted by one or more of the students, might lead to one last update of the unique search agents (or generation of new agents) before the student goes to bed for the evening. Thus the cycle of information push and pull begins anew.

Based on this one example of teaching, learning, and evaluation with information push and pull, there are many opportunities for a major shift in the space/time experience of these three types of educational activities. Specifically, this example can help to articulate the transition from traditional course models to an integration of information push and pull within a community of learning that implements just-in-time information for teachers and learners.

12.1.3 Course as Community

The idea of course as community, or a community of learning, is based on Wenger's (1998, 2000) theory of communities of practice, in which meaning is grounded in learning as experience, practice is grounded in learning as doing, community is grounded in learning as belonging, and identity is grounded in learning as becoming.

Johnson (2001) has conducted a review of the literature concerning current research in online communities of practice, identifying many case studies which can support the connections between communities of practice and course as community. Here, the focus is on the community aspect of social learning theory, and a community has three different modes of belonging: engagement, imagination, and alignment. According to Wenger (1998), engagement entails active involvement in mutual processes of the negotiation of meaning, imagination entails the creation of images of the world and seeing connections through time and space by extrapolating from various experiences, and alignment entails the coordination of our energies and activities to fit within broader structures and enterprises.

In a community of learners, these modes of belonging apply to both the teacher and the student. Take another look at the temporal diagram presented above as Fig. 12.2, and think about how engagement, imagination, and alignment activities might happen as teaching, learning, and evaluation activities inside, outside, and between the classroom. Back to the hypothetical case provided above, the initial collaborative in-class learning activity would be a form of engagement, the continued adjustment of unique search agents based on increased understanding of the topic could be considered a form of imagination, and the publication/dissemination of a polished version of the topical blog post as a contribution to a larger community could be considered a form of alignment.

Wenger (1998), however, gets much more specific as to what is entailed within the actual work conducted as the processes of engagement, imagination, and alignment unfold. The work of engagement involves conducting meaningful activities and interactions that typically lead to the creation of sharable artifacts (e.g., a blog post) that lead to—or are the result of—community building conversations and/or the negotiation of new situations. Two specific processes identified by Wenger as part of this work for engagement seem most relevant to the integration of information push and pull into a community of learning:

- A sense of interacting trajectories that shape identities in relation to one another
- The opening of peripheries to allow for varying degrees of engagement

The continued cross-pollination between teachers and learners implementing push and pull processes in an information-heavy digital cloud-based environment—coupled with the ability to continuously document and review the process of this cloud-based cross-pollination (via web search histories, news feed archives, and revision histories of collaboratively created documents, etc.)—can certainly help foster this sense of interacting trajectories inside, outside, and between the classroom. The varied levels of engagement required for creating and maintaining various search agents for information push and pull—ranging from highly active to rather passive engagement by the teacher and learner—across different ranges of time in varied spaces, places, and arrangements of people can foster many opportunities for legitimate peripheral participation (e.g., Gherardi & Nicolini, 2000; Lave & Wenger, 1991; Soden & Halliday, 2000; Wenger, 1998).

The work of imagination involves a consistent effort to "step back" from our engagement activities and look at them from other perspectives.

This disengagement both fosters and requires exploration, risk taking, and the creation of unlikely connections. As with engagement, two specific processes identified by Wenger (1998) as part of this work for imagination seem most relevant to the integration of information push and pull into a community of learning:

- Locating our engagement in broader systems in time and space
- Opening access to distant practices through excursions and fleeting contacts

The aforementioned continuous documentation and review inherent in the use of tools associated with information push and pull lends itself to the location of our engagement activities in the contexts of broader time/space systems. For example, the timeline for growth and maturation of a collaborative research inquiry blogging project about the nature of democracy by a group of ninth grade students in a civics class could be compared to a timeline (Blight, Pulham, & Torpey, 2012) of recent and current events happening in relation to the Arab Spring (also known as the Arabic Rebellion or the Arab Revolution). Similar comparisons could be made between an inquiry project on the topic of nuclear power generation with the unfolding of events surrounding the earthquake, tsunami, and Fukushima Daiichi nuclear disaster that occurred in Japan in 2011. In both of these examples, students and teachers alike could open access to distant practices through cloud-based interactions—utilizing information push and pull at various levels of engagement—to connect with students, teachers, and other community members situated within the nations involved in the Arab Spring or the Japanese disaster and recovery effort. If, for example, students from the United States of America were to engage in asynchronous push-pull conversations with Egyptian or Japanese students, quite a bit of the dialog would be fostered by agents acting in the between periods of learning environments—due to large time differences between the conversation participants.

Finally, the work of alignment requires an ability to coordinate perspectives and actions in order to divert energies to a common purpose, and the primary challenge is to connect local efforts for learning to broader styles and conversations in ways that allow learners to invest their energy in these broader styles and conversations. One of the processes Wenger (1998) identifies as part of this work for alignment seems relevant to the integration of information push and pull into a community of learning: negotiating perspectives to find a common ground. Moving beyond the imagination phase to a more purposed focus on alignment of ideals amongst the previously described asynchronous conversations is essentially a move to a meta-level view of the conversation, where teachers can foster an analytical perspective in students as they engage in these asynchronous (and synchronous) conversations. Teachers could also be expanding their own perspectives of alignment—being learners themselves as part of this work of fostering students' alignment.

Reiterating this concept of teachers also engaging as learners in the community helps to reify the transition from course to community through a more social approach to learning. With this transition comes a move beyond the traditional course paradigm and, in many cases, a move beyond the recently established (traditional) practice of web-based LMSs (e.g., Blackboard, Moodle) to a much more decentralized dynamic SLN.

12.2 From LMS to SLN

A learning management system, or LMS, is a web-based platform that is used to provide content for and communicate about courses offered by an educational institution, typically delivered at the enterprise level. Such LMS platforms are in use across the globe in most levels of education—from elementary to postsecondary. While there are many aspects of any LMS that are beneficial to the educational institutions that choose to implement them, there is a fundamental flaw in these systems that has—from the experience of the author and many others—manifest at the postsecondary level in the United States: the bloated nature of enterprise level LMS platforms precludes them from having the agility necessary to keep up with the pace of independently developed web-based media tools that are constantly appearing (and improving) across the socially driven Internet we now experience.

The pedagogical advantages of embracing these tools above and beyond the traditional LMS are numerous, especially considering the transition to a community of learning described above. Christian Dalsgaard (2006) summarizes this issue best:

> Using a management system, personal tools and social networks differs from the sole use of an integrated LMS. The approach differs in terms of focusing on empowerment of students as opposed to management of learning. An approach focusing on empowerment of students implies thinking in terms of tools rather than in terms of systems. The idea is first and foremost to provide students with a variety of tools for their self-governed and problem-based activities; to empower students, offering them tools for independent work, reflection, construction and collaboration.

From the perspective of educational technology—specifically a focus on the appropriate use of technologies for learning—Dalsgaard's (2006) approach makes sense. Instead of forcing learning to happen within the confines of an LMS chosen as a "best fit" by the administrators of an institution, the rather rigid boundaries of the LMS can be softened by implementing an approach to technological tool use that can continuously morph to fit the ever-changing digital situations of teaching, learning, and evaluation inside, outside, and between the twenty-first-century classroom.

Collectively, we can move beyond the LMS to a SLN. This concept aligns well with Seufert's (2000) definition of collaborative learning environments as meeting places of technology and social groups which cannot be separated. Let's call this transitional SLN approach a *techno-pedagogy*, which has been previously defined as "the practice of using technology and combining it with conversational pedagogy in education" (Coombs & Ravindran, 2003). For this chapter, the techno-pedagogy model is founded upon judicious implementation of personal and cloud-based tools for learner-driven content publication, consumption, and annotation—including teachers as learners. This techno-pedagogy fosters an awareness of evolving social media tools as a part of the conversation and activities of learning—infusing this awareness and engagement into the curricula that are associated with this pedagogy. The tools themselves are at the forefront of the techno-pedagogy, due to their ever-evolving nature, but these tools also work well enough that they can seamlessly fade to the background—simply working the way they're supposed to work—when they are used by learners to focus on content and context within and across topical inquiries and conversations. When these tools do malfunction, the developers of these tools (typically readily accessible via email, messaging, or forums) can actually become members of the greater learning community as well, through iterative cycles of user-driven tool improvement. Such communication between the learners and the developers of these tools could be considered the work of both imagination (opening access to distant practices through excursion and fleeting contacts) and alignment (negotiating perspectives to find a common ground) in a community of practice.

Consider this initial list of ways in which such a techno-pedagogy can benefit the transition to a community of learning in an SLN as opposed to the limited nature of LMS platforms:

- Course-oriented content that has been (and continues to be) identified by teachers and students for its topical or contextual relevance is *freed from the space-time boundaries of the semester-oriented LMS platform*. An ever-expanding archive of course-oriented content doesn't need to be "rolled over" every semester when a new version of the course is presented. Static courses can be deprecated.
- Students that are no longer enrolled in any course have *continued access to this growing archive of course-oriented content*, as they should still be considered valuable members of the community of learning that can actively contribute to the learning of newer students—as well as their own continued learning.
- The community of learning can be *as big or small as necessary*. The "host" institution fades into the background, and the community evolves in whichever direction best facilitates learning and belonging—in terms of engagement, imagination, and alignment.
- As teachers and students continue to join the community of learning over time, the evolving social media *tools that students and teachers are already using can typically be readily implemented* into the community. Not only does this take into consideration the factors of convenience and tool familiarity, but as members bring novel tools to the community that actually add value to the techno-pedagogy, these occasions of improved functionality can serve as opportunities for focused discussion and collective improvement of all members of the community of learning.

This list can and should grow. However, perhaps a better way to understand this transition to a techno-pedagogy is to explore examples of this transition in action.

12.3 Transition in Action: Exploring the Techno-Pedagogy

Two undergraduate courses taught by the author at California State University, Monterey Bay, were redesigned leading into the Spring 2012 semester to begin a transition to the techno-pedagogy: an introductory "Media Tools" course and an entry-level design and computer programming course. A major impetus for making this transition was to foster the engagement, imagination, and alignment of all members of the learning community—including the author—in a way that could soften not only the boundaries of the traditional LMS platform but also the boundaries of the traditional mentality of the courses themselves.

12.3.1 Media Tools

Media Tools is a 4-unit lecture/lab course in which students individually complete a series of topically connected media production projects that build upon skills acquired in the use of various media design software tools, such as bitmap and vector graphic manipulation, sound recording and manipulation, and interactive animated media. Following a "logo replication" activity that allows students to ease into the process of learning how to use available software tools, students complete three projects: (1) a brief section of an audiobook, (2) an educational poster, and (3) an interactive map—all utilizing digital artifacts found in the collections of the American Memory Project of the United States Library of Congress ("American Memory," n.d.).

Students were required to generate and maintain a blog as a portfolio for the course. These blogs contained multiple drafts and final versions of each project, as well as experiential reflections on the process of completing each project and critiques of various learning aids selected by the student. These blogs also served as a platform for in-class presentations at the conclusion of each project. Students completed the reflection for each project after conducting these in-class presentations and receiving summative feedback from other students in the class.

As a direct emphasis of the techno-pedagogy model, the use of tutorial systems ("Atomic Learning," n.d.; "Lynda.com," n.d.)—provided free to students by the university—was highly encouraged. Both of these tutorial systems offer high-quality, episodic tutorial videos assuming no prior knowledge from the learner. Specific to the techno-pedagogy, students were introduced to these systems as tutorials at a level of quality that would, in addition to helping them learn how to use the software tools, serve also as models for judgement of the quality of additional tutorials scavenged from the Internet. In this way, students were taught how to *learn how to learn software* as a fundamental aspect of the techno-pedagogy. Bielaczyc and Collins (1999) note that communities of practice should promote a culture of learning focused on ways of learning how to learn and developing mechanisms for sharing such knowledge of learning practices. To emphasize this approach, students were shown by the author how such an approach can benefit the community of learning: instead of wasting valuable in-class time to benefit a handful of students inquiring about a specific menu item or command to accomplish a simple task in a single software tool, these learning opportunities could be distributed amongst community members and in-class time could be spent focusing on broader issues of design—including individual feedback on project progress given by both the author and student peers in the community of learning.

Lectures for this course were redesigned to follow the flipped or inverted classroom model (e.g., Lage, Platt, & Treglia, 2000). Specifically, the lectures were rewritten—essentially as individual chapters in a practice-oriented coursebook. The content of the lectures was restructured to prepare students for relevant topical in-class discussion and activities intended to replace the traditional lecturing format. In many cases, following the discussion and activities for a particular "lecture" class period, students would work in groups to generate a collaborative blog post—based on prescribed prompts—describing and explaining the outcomes and artifacts of these small-group discussions and activities. The flipped classroom model aligns with Palloff and Pratt's (1999) recommendation that instructors in communities of learning act as facilitators nudging discussion and learning in the right direction, a sentiment echoed by many (e.g., Powers & Guan, 2000; Rogers, 2000).

These lecture materials were made available to students in PDF format, housed within the LMS for the class, a minimum of 1 week in advance of the assigned reading completion date. Each of these lectures is available on the author's website (Erlandson, n.d.).

12.3.2 Scripting for Multimedia

Scripting for Multimedia is a 4-unit lab class that allows students to explore the fundamentals of computer programming as they create a series of increasingly difficult interactive multimedia projects. For the Spring 2012 semester, students worked in teams of three to five to create three different projects that matched practice exercises and skills covered in the course texts: (1) a pong game, (2) a kinematic model simulation, and (3) a demolition derby game. The programming language chosen for the course was ActionScript 3.0 due to its accessibility to nonprogrammers—as this class is geared toward designers, not computer science majors. The two course texts (Peters, 2007, 2009) lend themselves well to such a course format based on chapter length, content structure, and the inclusion of ample iterative code samples throughout each chapter. Students were encouraged to download packages of functional code from the publisher's website to use as examples when writing their own code.

Students were required to generate and maintain a blog portfolio for individual work completed for the class. This individual work consisted of weekly experimentation with the code exercises provided in the course texts. Each student took three examples and manipulated the code beyond the examples provided in the book. Weekly blog posts included documentation of these three coding experiments, including the original code from the book, the new code with manipulations highlighted by the student, an explanation for why the changes were made (even if the experiments didn't work!), and a direct link to the compiled experiments. Additionally, a minimum of 3 times throughout the semester, students were required to conduct a "show and tell" session in which they presented the experiments they had done for the given week—using the blog as a mechanism for presentation—soliciting feedback from peers and allowing classmates to vicariously experience the individual experimentations of the presenting student. Students were encouraged to visit each other's blogs on a regular basis to keep up with each other's experiments and reflections.

Finally, teams used wikis (on the university-based Google Apps platform) to create collaboration hubs for use in and out of class as projects were completed. File management, scheduling, and team communications were conducted primarily through these sites at varying degrees of frequency for the different teams. Presentations for each completed project were conducted in class as friendly competitions, and a final reflective presentation covering the teams' growth processes across all three projects—successes, failures, challenges, solutions, etc.—served as the final exam for the course.

12.3.3 A Variety of Tools

As already indicated, many different technological tools were used in each of these two courses—some used in both and some used in one or the other. Both courses utilized iLearn (the university LMS, a version of Moodle) essentially as a centralized storage mechanism for all course documentation, such as syllabus, course schedule, assignments, as well as flipped lecture materials and associated media.

Both courses relied heavily on individually generated student blogs. For each course, the author generated a "bundle" (e.g., Hawkes, 2009) of RSS feeds for each student's blog and posted these bundles back within the iLearn dashboard for the course. This way, students could always have access to each other's blogs in order to provide commentary and peer support for projects. A big surprise associated with the blogs occurred in the Media Tools class. For the audio project, many students discovered and used the cloud-based service SoundCloud ("SoundCloud," n.d.) to host drafts and final versions of their audio artifacts. Students, under their own volition, figured out that SoundCloud integrated rather seamlessly with Wordpress, allowing them to stream their audio projects directly within the body content of the blog posts. This saved anyone viewing the blog post an additional step of having to visit the SoundCloud website, and these projects could be listened to directly while reading the students' explanations and reflections.

The university-hosted myCSUMB portal site was used in Media Tools as a mechanism for generating collaborative blog posts in class within a group established on this portal. Additionally, myCSUMB was used as a voting system—essentially, a discussion forum—for generating initial questions for each flipped lecture discussion. After reading the lecture materials for the week, students could post extension questions in the group and other students could vote them up or down. The top three to five vote-getters served as the discussion starters each week. Students were encouraged to continue these design-oriented discussions each week in the forum outside of class time. This practice ties directly to the work of engagement (the opening of peripheries for varying degrees of engagement) and imagination (locating engagement in a broader time and space).

Finally, students in the Media Tools course were required to turn in multiple drafts and a final version for each of the three projects completed (as well as the initial logo exercise). To provide evidence that original work was completed, students had to turn in all project source files as zipped archive files, and as the projects increased in complexity, these weekly archive files became increasingly large—too large for email or upload to the university LMS. As such, students were required to find their own means for transferring these large files to the instructor by the deadlines provided. Many students used the WeTransfer ("WeTransfer," n.d.) service suggested as an option by the author, and many were able to find other mechanisms for accomplishing this task, such as using Dropbox ("Dropbox," n.d.) or a similar free cloud-based storage service. Several students were already actively using these services for other purposes, and several students also noted that a simple Internet search for "large file transfer service" yielded several viable options.

Further, the author maintains a tumblr ("tumblr," n.d.) microblog (Erlandson, n.d.) as a mechanism for archiving and distributing content relevant to one or more courses taught—essentially, a process of *curation*. In addition to content harvested from various sites on the Internet, the author frequently used his smartphone to take high-resolution photos of whiteboard drawings generated during in-class discussions to be immediately posted to his microblog. Tags were used to mark up content posts in order to categorize them according to relevance for courses. For example, "cst201" is a tag used for content relevant to CST 201: Media Tools, while "interactive media" is a tag used for content that is relevant to any of the many interactive media courses taught (e.g., Scripting for Multimedia, Interactive Media I, Interactive Media II). The added benefit of this tagging system is that tag-specific RSS feeds (e.g., Erlandson, n.d.) can be generated for any tumblr feed by simply appending "/rss" to the end of the URL. These feeds can them be routed back into the university LMS dashboard for the course, allowing students to directly access the feed content without leaving what many students consider to be a more familiar environment. Of course, many of the students were already avid users of tumblr, so they were able to link directly to the tumblr feed itself or add the tagged RSS feed to their own existing news readers—potentially accessing all of this information on any number of mobile devices. This is one excellent example of providing multiple accessible pathways to the same content—and it should be noted that the process of generating these content feeds is extremely efficient for the instructor.

12.3.4 Efficiency in Evaluation

Another major impetus behind this techno-pedagogy is the goal of increased efficiency and effectiveness in evaluation of student performance—in this case performances of both design and production. The main reason the author oriented most of the course content (and student artifact generation) around RSS is that he used Google Reader ("Google Reader," n.d.) as his primary administrative dashboard for evaluation student progress across all courses taught (Fig. 12.3).

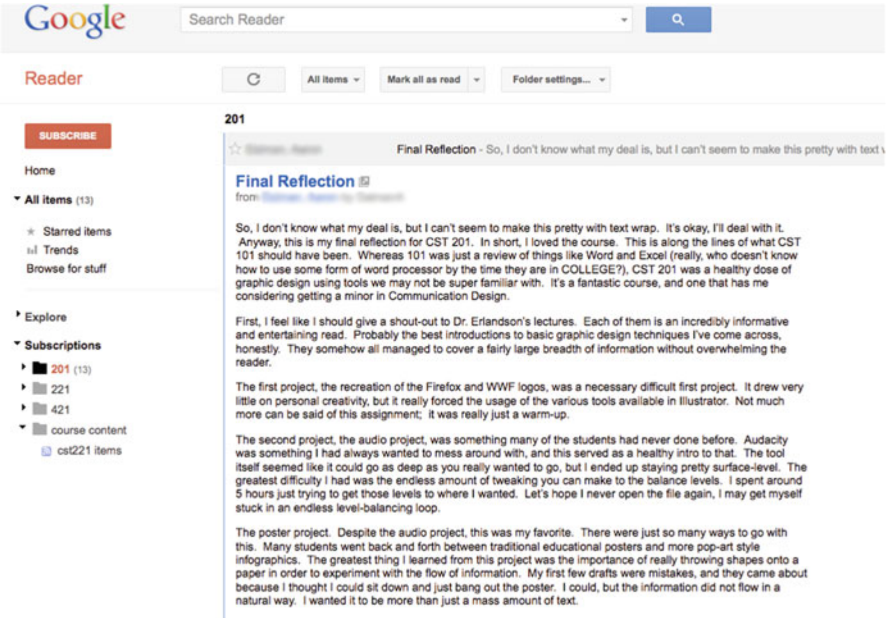

Fig. 12.3 Google Reader evaluation dashboard (viewing student reflection post)

On the left side of the screen image shown in Fig. 12.3, there is a Subscriptions column, in which one can create folders. Here the author has created folders associated with each course number (201, 221, 421) as well as a course content folder where the author can route the aforementioned tag-specific tumblr feeds for instant access when in this dashboard environment. Students' feeds are listed alphabetically, allowing for ease of entering individual grades into spreadsheets housed on the author's local computer hard drive. For every student feed, a view of each post contains the options to share the post on other social media (such as Facebook and Google+) or to click through to the original blog post and directly comment on the post from within the dashboard interface. Assuming a student gives permission for sharing such posts with larger social media networks, this is an example of imagination in action—engagement in broader time and space.

Closer to the top of the left side of the screen image shown in Fig. 12.3, there is a Trends button that allows one to see posting, reading, and click-through trends for each individual folder/course or across all courses—trends such as: typical time of day or day of the week that posts and reads are happening, frequency of posts and reads over the past 30 days, and which feeds one has actually clicked on to visit the original post. Visualizing these trends allows one to maintain a broader perspective of performance differentials amongst students—as well as one's own pattern of evaluation—at a glance as the semester progresses. This is a prime example of engagement (a sense of learning trajectories) in a community of practice, especially considering the teacher as learner perspective.

Finally, the previously described bundles of Google Reader can be generated from the folder structure set up by the user—essentially, a folder of feeds can be structured as a bundle of feeds. These bundles can be published as HTML code which can be pasted into any other application which accepts HTML—such as a blog post, a web page, or in this case, the dashboard page for each course in the university LMS—effectively looping the generation of blog posts into any other community that exists on the socially driven Internet.

Thus, the round-tripping of RSS is complete. Students create posts in their blogs and these are instantly reflected in the author's news reader and the appropriate course dashboards of the university LMS. The author posts curated content (and whiteboard photos) to his tumblr feed, and they are instantly accessible to students and the author in a variety of formats and locations. This cycle can continue indefinitely for the life of any course at any institution across any number of semesters.

12.4 Reflecting on Initial Efforts for a Transition

Near the end of the semester, students in both courses were asked to fill out a brief web-based anonymous survey concerning the initial implementation of this techno-pedagogy. Slightly different versions were administered specific to the software tools used in each course. These surveys were built and delivered via Google Forms, with links to the forms made available in the respective course sites in the university LMS. Both versions of the survey are provided as Appendix A.

12.4.1 Student Perspectives

Students were not required to participate in these surveys, resulting in a rather low number of responses for each course: 14 of 25 students in the Media Tools course, and 7 of 21 students in the Scripting for Multimedia course. As such, the statistics for individual ranking items concerning tool use are not reliable measures. However, many of the students' responses to the open-ended items can help to fashion an understanding of this initial exploration of the techno-pedagogy. Selected responses from each course—along with additional observations by the author—are presented below.

12.4.2 Media Tools

Based on in-class conversations, students were generally receptive to the idea of blogs as a techno-pedagogical tool, and this sentiment is best reflected in one student's survey response: "Blogging is a great way to put all your information in one place for everyone to see. Instead of sending files to everyone and carrying the files with a USB drive putting it on the web makes it so much easier." One piece of constructive criticism regarding the content of blog posts was provided by another student: "Very few students blogged in enough detail to be helpful. Shared tutorial links were the most useful."

Regarding the tag-based tumblr feed for the course, most students indicated that they did not pay much attention to the feed, despite its presence in the iLearn course dashboard. However, one student described its usefulness in a way that reflects a fostering of imagination and alignment as part of a community of learning: "It was interesting to see what connected in real life to what the class was about."

Most students stated that the use of iLearn in the course was sufficient, but a few wished iLearn was a more primary vehicle for the course (as it is in many of the courses taught at the university). One student's response summarizes this sentiment quite well: "I think that iLearn is a pretty effective site in regards to being able to find all necessary course information to get tasks done on time (without having to ask other students). If I ever had a question about one of the assignments, it was always available on iLearn." Another student's response provided a broader perspective for iLearn and blogging: "I like iLearn because it is one place to go for all my classes. It was annoying to have to use wordpress as well. Plus, the learning curve for wordpress took valuable time away from actual time spent working on projects."

Students generally had a positive initial response to the use of the university-hosted myCSUMB portal—and the lecture voting system implemented in the course group. One student made an interesting connection between the lecture voting and the use of the group-generated blog assignments posted to the myCSUMB group: "myCSUMB was a pretty good resource for our class group discussions, and I enjoyed looking at other peoples comments and ratings. I only wish that we had a little more class discussion about the blog posts." Another student's response indicates the relevance of this tool for community building: "I was able to see what other people were having problems with and the solutions that they came up with. It was a great way to communicate with everyone else in class."

The final item in the survey is an open-ended response item allowing students to make suggestions about tools that didn't work as well as expected as part of the community of learning. A response to this item was not required, and as such only two students provided a complete response. The first student provided constructive feedback regarding the implementation of lecture discussion voting as part of the techno-pedagogy: "I am a little up in the air about the myCSUMB discussion and ranking system, because I felt like not everyone participated all of the time. If there were a way to change this, or give some sort of incentive to give in depth discussion, it would be more interesting." Another student felt that the processing of blogging was a bit too taxing: "Yes, [stop using] the blogs. I found it annoying that we had to post our work prior to our work day (Thursday). I also found it to be a hassle because we had to turn in the zip file as well."

12.4.3 Scripting for Multimedia

Few useful responses could be gleaned from the limited number of respondents taking the survey in this course. However, from a techno-pedagogical perspective, there were a few responses that provide some rather useful feedback. One student rated the use of blogs in the course as a 6 (on a scale of 1–10, with ten being most useful) and had this to say about his or her choice of rating: "I chose this rating because I didn't really utilize the blog. I did most of the exercises, but I had a hard time keeping up with the wordpress blog. I think if we were allowed to use any blogging site (one we were more comfortable with), it would have been easier." This reflects the importance of allowing students to choose their own tools for the task whenever possible, a sentiment supported by Dalsgaard (2006).

Again, respondents in this course indicated that they did not check the tumblr feed too often, but found it useful when needed. One student's response provides valuable feedback that also reflects some future potential of this tool for fostering both imagination and alignment as part of a community of learning: "I didn't check it very often, but when I forgot something, I would see if it had been captured on the board pics. I think that if more resources from different sources were included it would be even better (other forums, blogs, sites, etc.)." Similar sentiments for community building were reflected in one student's response concerning the use of iLearn: "I used ilearn most for looking at other classmates blogs and what they did for assignments and what not." Another student felt that the combination of tools required for use in the course was superfluous:

> I am a fan of google sites, docs and most of the services that google provides, but because there was ilearn, the blog the google sites was just another website we had to access for the class. For most of our communication and saving of files my group used gmail and the space on our server. It might have worked better for other groups I'm sure. I feel it was just another thing that we had to keep updated.

Based on in-class and out of class experiences during this semester—and similarly reflected in students' limited survey responses—students seemed polarized about the usefulness of group wikis (Google Sites) as tools for collaboration. This polarization was reflected in the level of cohesion of the different groups: generally, cohesive groups found the wikis useful, and non-cohesive groups did not.

For this course, there were no responses to the two non-required open-ended items at the end of the survey concerning addition and removal of tools from the techno-pedagogy.

12.4.4 Instructional Perspectives

Knowing that quite a few logistical and pragmatic variables were affected by this transition to a techno-pedagogy, the author did not expect either one of these courses to run as smoothly as they had in previous semesters. In both cases the technological pursuits turned out as well as can be expected during an initial implementation.

A primary purpose of the use of blogs in each of these courses was for them to serve as a driver for community building around a common goal of learning—either design and media production or design and programming. The foundation of this community building is continued peer-review conversations (synchronous and asynchronous) surrounding artifact generation. The author assumed that the blogging format—coupled with purposed groupings of students into support teams—would lend itself naturally to fostering such conversations. Unfortunately, it seems as though students need more motivation than simply availability of tools. Short of assigning points for individual comments and quality conversations, additional instructional attention must be paid to fostering a conversational environment that can lead to better communities of learning which foster engagement, imagination, and alignment. Modeling the conversation—a process which did occur at the beginning of the semester in both classes—is a good start, but a singular modeling experience does not seem to be sufficient for this demographic of undergraduate students.

Another interesting point about blogging that occurred in several instances across both classes was the case of students running multiple blogs for multiple courses at the university. One student was enrolled in both of classes covered in this chapter, and at first she did well to maintain two separate blogs, but toward the middle of the semester she asked if she could consolidate her work to a single blog—which upon consideration was allowed. At least three other students in the Media Tools class were utilizing blogs in other courses. In two of these cases, the students became confused when posting, and several posts that should have been for the other courses ended up filtering through to the author's dashboard—and on a few occasions, posts for the Media Tools class were sent elsewhere. This issue highlights a need for attention by university faculty and administrators to the unification of the blogging process across the college experience as institutions move forward with experimentation and implementation of blogging as a techno-pedagogical tool.

Concerning microblogging by the author, many students in both classes indicated a lack of attention to the tumblr feed, and this sentiment was reflected in the fact that content from the tumblr feed rarely entered the conversation of the communities surrounding each course. This is likely due to the fact that the content of the tumblr feed is based entirely on the ebb and flow of two things: (1) scavenged content deemed relevant to one or more courses, and (2) whiteboards generated in courses. Both of these are highly irregular in nature, and irregularity in content posting seems to contribute heavily to inattention in undergraduate students. Additionally, there seems to have been an effect of tool overload, and the similarities between a regular blog (Wordpress) and the microblog (Tumblr) may not have been sufficiently distinguished conceptually for many of the students in these two courses.

Finally, due to the often tangential nature of Internet-based content posted to the microblog (tangential despite direct relevance to course content), this feed might have been seen as an unnecessary burden to those students maintaining the mindset of doing the minimum required work in order to move on to the next course. Ironically, one of the primary purposes of the Tumblr feed was to help students through this mindset by providing relevant content (as tangential as it might have been) delivered in a format and place allowing them to consume such content in a time and manner that best suited their individual needs. Apparently, this objective seems to have backfired. However, with the continued advancement of the quality of Wordpress and other tools as sophisticated blogging platforms fully integrated into the social and mobile webs, it may be that the aspects of Tumblr that appeared to initially have uniquely distinguished its value—namely, structured microblogging of various media formats and tag-specific feed generation for centralized content management—can be accomplished in these regular blogging platforms. Or, it could simply be that Tumblr was relatively new in the social media sphere and perhaps it just hadn't yet become well established with this demographic of the population.

Concerning the university-based LMS, students did not respond well to the minimal use of iLearn—especially in the Media Tools course. Students expected a more week-by-week delivery format, which is one of the two options in the Moodle platform (as opposed to the topic-based format which was implemented for these two courses). This preference seems to be a convenience factor to which students have become accustomed, which is indicative of an unfortunate transition to a customer service model that appears to be happening in postsecondary education in the United States. Students at other postsecondary institutions where this author has taught have generally responded well to a non-weekly (topic-based) content delivery approach in similar LMS environments, which contradicts the findings of this current implementation.

Finally, concerning the aspects of techno-pedagogy involving judicious implementation and awareness of evolving tools, the students enrolled in this courses seemed to lack the motivation to maintain such an awareness—with the exception of the SoundCloud experience. Across both courses, no students answered the survey question regarding suggestions for any other technological tools or platforms that might be useful for future versions of the class. This lack of response leads the author to believe that the techno-pedagogical model needs clarification in terms of fostering students' awareness and critical perspective of the tools they use and other tools that may be available—leading toward more proactive tool-users in twenty-first-century communities of learning.

12.5 Conclusion

There is much room for improvement in the transition to an SLN for these (and any) postsecondary courses. Here, three general avenues of primary improvement have been identified as a result of this techno-pedagogical exploration: discussion, legitimate peripheral participation, and trust.

Concerning discussion, Johnson (2001) has noted that a primary function of communities of practice is to establish discussion. While the flipped classroom approach is an excellent start, the fostering of discussion as the center of a learning community can be substantially improved. Palloff and Pratt (1999) recommend opening up discussion in a community environment by establishing goals and criteria, evaluating the goals and providing opportunities for peer and self-evaluation. These three practices could easily be directly woven into the techno-pedagogy for any such learning community.

Concerning legitimate peripheral participation, better integration of expert-apprentice relationships—through direct connections to the larger design community—could have happened in these learning communities with proper planning and tool integration. While most (if not all) students in the introductory-level design courses such as those explored here are limited in the amount of direct involvement, they are capable of having in real-world projects, connections with the professional design community should still be established, even asynchronously—such as occasional feedback on course project ideas posted in professional design forums. Further, while students may be novices in regard to the course content and procedures, they are likely experts (or advanced learners) in at least one other domain. Tapping into the existing expertise of students in the learning community can create opportunities for legitimate peripheral participation as a subject matter expert in the design process (in addition to direct participation as a designer).

Finally, fostering safety and trust during the development of a learning environment is of the utmost importance (e.g., Grisham, Bergeron, & Brink, 1999; Palloff & Pratt, 1999). Future versions of both of the courses explored here can be improved as learning communities in the future by developing explicit mechanisms—and allowing plenty of time—for assigned support teams to generate trust for each other early in the semester (and to continue building trust throughout). Further, as a part of the techno-pedagogy, these support teams should be allowed to experiment with a variety of tools (provided and/or discovered) that allow the continued building of trust within the teams.

In closing, Wenger (2000) provides the following advice for organizations: “In a knowledge economy, sustained success for any organization will depend not only on effective participation in economic markets, but, just as importantly and with many of the same players, on knowing how to participate in broader social learning systems” (p. 245). Concerning perspectives of commercial and industrial institutions (both outward and inward), postsecondary educational institutions have an increasingly flexible role to play in the knowledge economy, and an SLN seems to be an excellent platform for such flexibility.

Appendix A: Student Technology Survey (Media Tools Version)

Please take a few moments to answer some questions about the use of various technological tools and platforms during this course. Your answers will remain anonymous, and findings from this survey will be used to directly influence future versions of this course.

1. On a scale of 1–10, how useful did you find the process of blogging for this class?
   Why did you choose this rating for blogging?
2. On a scale of 1–10, how useful did you find the professor's tumblr feed for this class?
   Why did you choose this rating for the tumblr feed?
3. On a scale of 1–10, how useful did you find the iLearn site for this class?
   Why did you choose this rating for the iLearn site?
4. On a scale of 1–10, how useful did you find the use of myCSUMB for this class?
   Why did you choose this rating for the use of myCSUMB?
5. Please rank these four tools in comparison to each other (based on their use for this course), with 1 being the most useful of the four, and with 4 being the least useful of the four.
   (blogs) (tumblr feed) (iLearn) (myCSUMB)
6. Please use this space to make suggestions for any other technological tools or platforms that may be useful for future versions of this class, and explain a bit as to why they might be useful.
7. Based on your own personal experience in this class (working both individually and collaboratively), are there any tools that you would recommend be discontinued from use in future versions of this course? If so, please explain why.

Appendix B: Student Technology Survey (Scripting for Multimedia Version)

Please take a few moments to answer some questions about the use of various technological tools and platforms during this course. Your answers will remain anonymous, and findings from this survey will be used to directly influence future versions of this course.

1. On a scale of 1–10, how useful did you find the process of blogging for this class?
   Why did you choose this rating for blogging?
2. On a scale of 1–10, how useful did you find the professor's tumblr feed for this class?
   Why did you choose this rating for the tumblr feed?

3. On a scale of 1–10, how useful did you find the iLearn site for this class? Why did you choose this rating for the iLearn site?
4. On a scale of 1–10, how useful did you find the use of Google Sites for this class? Why did you choose this rating for the use of Google Sites?
5. Please rank these four tools in comparison to each other (based on their use for this course), with 1 being the most useful of the four, and with 4 being the least useful of the four.
   (blogs) (tumblr feed) (iLearn) (Google Sites)
6. Please use this space to make suggestions for any other technological tools or platforms that may be useful for future versions of this class, and explain a bit as to why they might be useful.
7. Based on your own personal experience in this class (working both individually and collaboratively), are there any tools that you would recommend be discontinued from use in future versions of this course? If so, please explain why.

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13.1 Introduction

Over the last decade, the traditional university lecture has come under fire. Whereas learning science encourages active cognitive engagement on the part of the learner (Bruning, Schraw, & Ronning, 1999), lectures—according to their critics—instead promote passivity. It is argued that the typical lecture provides either little or no opportunity for student participation or collaboration (see Folley, 2010), tends to bore students (Exley & Dennick, 2009), and reinforces an antiquated transmission model of teaching: that is, the authoritative sage on the stage (Laurillard, 2002). Exley and Dennick (2009, p. 3) highlight a famous yet anonymous quote in which lecturing is defined as "the transference of the notes of the lecturer to the notes of the students without passing through the brains of either." Biggs and Tang (2007, pp. 104–105) in turn suggest that universities are saturated with lectures not because they are effective but simply because they are expected:

> Many academics start from the assumption that their major activity is to give a 'lecture', which is after all what the timetable says they should be doing. University planners and architects accordingly design 'lecture theatres', equipping them with stage and spotlight, as if skilled performers are to provide some pleasing entertainment there… there are more effective ways of using the space in those large 'lecture' theatres.

Notwithstanding these arguments, broad-brush arguments to abandon lectures may not be the answer. First, lectures should not be viewed in isolation but as part of a holistic pedagogical approach. Where lectures are used effectively to scaffold students' construction of important conceptual and epistemological knowledge, tutorials and workshops can then be used to enable students' engagement in higher-order discussion, analysis, and decision-making about that knowledge, provide forums in which new procedural skills are practiced, and provide research-based extension activities that build on the preliminary base knowledge (see Bruning et al., 1999). The lecture in this context is therefore simply a springboard for further development. This is entirely different to a pedagogical approach in which the lecture is the only form of instruction available: an approach much more likely to fall prey to the threats of passivity and disengagement outlined above.

Of course, the appropriateness of lecturing in any curriculum design, even when paired with tutorials or other activities, will depend on the discipline. MacDonald (1994) draws a distinction between compact or *constrained* disciplines such as the sciences, with well-defined problem parameters and solution pathways, agreed-upon goals, and cumulative knowledge construction across the discipline, and *unconstrained* disciplines such as the humanities, with varied goals, interests, and methods, "diffuse" knowledge construction across the discipline and, in some cases, relativistic views of knowledge. In the former, lectures provide an important means of acquainting oneself with disciplinary knowledge, practices, and priorities (Friesen, 2011). These cannot be known intuitively: thus, some form of direct instruction—lecturing or otherwise—is pedagogically appropriate. In the latter, where explanation of observed phenomena gives way to careful interpretation of problematized constructs, lecturing will be less effective at conveying disciplinary practices and priorities than will activities that promote individual meaning making. Thus, the overall curriculum design and the discipline must each be considered.

Second, a *good* lecture, when delivered in a constrained discipline with agreed-upon goals and priorities, can and does engage students. Friesen (2011, p. 100) rejects the notion that universities are saturated with lectures due to "historical inertia," arguing instead that a good lecture captures the speakers' expertise, vibrancy, and creativity:

> [The lecture] allows the speaker to tie oneself to one's audience with a typewriter ribbon… using available media technologies or techniques colourfully but consistently to support vitality, action, or animation… to bring a body of knowledge alive in the minds of the student audience.

Folley (2010) too argues that lectures have the affordance of allowing complex information to be conveyed in an enthusiastic, engaging, and responsive way. In an online survey of 49 university students from the United Kingdom, he found that 32 % of students actually wanted more lectures, whereas 63 % thought the balance was about right. Only 5 % wanted fewer hours. He suggests that rather than abandoning lectures all together, the traditional didactic *style* of lecturing should change. Indeed, while the traditional "chalk-and-talk" lecture may encourage student passivity, there is much that can be done within lectures to cognitively engage students: inbuilt discussion topics, application activities, reflection points, and so on (e.g., Biggs & Tang, 2007).

Finally, it is not always possible to replace lectures with more interactive but staff-intense pedagogical approaches such as guided constructivist activities or discussion groups. In Australia, as in other higher education contexts, high student demand and underfunding necessitate a large cohort (see Murray & Summerlee, 2007; Nagel & Kotze, 2010). The pertinent question therefore seems to be not "should we abandon the lecture"—for the answer will surely depend on the kind of knowledge or skills to be constructed, the size of the cohort, and the overall curriculum design—but how, when the pedagogical goal is to acquaint large classes with specific background disciplinary content, can this be done most effectively?

13.1.1 Podcasting as a Possible Solution

Over the past 5 years podcasts have been recommended in educational technology literature as a potential alternative or supplement to the lecture (Folley, 2010; Taylor, 2009). In simple terms the podcast is an audio or an audiovisual presentation that users can either stream or download from the Internet (Van Zanten, Somogyi, & Curro, 2012: note that some researchers use the term vodcast when the presentation is audiovisual). Given its digital format, mass audience, and undetermined length, the educational podcast—whether audio or audiovisual—essentially offers a more portable and flexible means of engaging students in disciplinary content and activities that might otherwise be included in the lecture itself.

Higher education podcasting has most commonly been used to distribute full lectures online using web-based lecture technologies (WBLT) such as iLearn, Echo, and Lectopia (Chester, Buntine, Hammond, & Atkinson, 2011; Phillips et al., 2007), yet has also been used to distribute supplementary content in lieu of readings, to provide previews or recaps of the live lecture or to fulfill administrative roles such as test preparation or class announcements (Taylor, 2009).

Advocates of podcasting in the higher education classroom suggest several benefits: first, and perhaps most important, that the flexibility of podcasts enables the lecturer to better engage students; second, that any shift to podcasting may result in other changes to pedagogical style as a consequence of enforced pedagogical reflection; and third, that podcasting technology enables lecturers to better respond to student requests for more information, resources, and support to be provided to them (Hew, 2009; Parson, Reddy, Wood, & Senior, 2009). With reference to this latter point, a distinction between the provision of student support and the use of didactic, teacher-centered pedagogy is critical. According to a cognitivist view of learning, "spoon-feeding" is undesirable in any discipline, constrained or otherwise: what is critical for learning is a learner's active cognitive engagement in the disciplinary content (Mayer, 1992). A passive learner who is given no opportunity to practice and extend new skills and knowledge will not learn as deeply as one who is given these opportunities (Biggs & Tang, 2007). Nonetheless, adequate support for students' cognitive activity must still be provided. Such support takes the form of discussion prompts, the provision of background knowledge, a requirement that the student regulate his or her learning attempts, the development of incrementally demanding activities and assessments, and so on (Mayer, 1996; Yates, 2005). There is the opportunity when using supplementary podcasts to provide additional scaffolding that would not otherwise be available.

The benefits of podcasting are considered particularly important for a changing student population. Greater numbers of Australians now attend university than ever before, meaning that, like the lecture, any new pedagogy must be effective for a large cohort. Furthermore, the majority of university students now fall into the so-called net generation, Generation Y. Chester et al. (2011) describe Generation Y learners as digital natives, whereas Mikat, Martinez, and Jorstad (2007, p. 15) refer to the "new generation of technology-savvy student." Ennis and Gambrell (2010, p. 115) state that Generation Y, or "millennials," is "able to complete multiple tasks simultaneously due to interaction with technology at a young age." The clear implication of such commentary is that new students want, expect, and learn best when digital technologies are incorporated into learning. Finally, and notwithstanding the large numbers of Generation Y students at university, the student population is now more diverse than ever before. Parson et al. (2009, p. 226) argue that our lecture-tutorial model of pedagogy must evolve accordingly:

> Current students have more challenges facing them than has traditionally been the case. Many are mature students; almost all students have part-time jobs. Accordingly, teaching facilities need to become more flexible in their approach to providing education to students in these situations. Podcasting and vodcasting is one way in which this is possible, their portability as a medium is a very important and popular factor

Despite these potential educational benefits, little research has empirically examined students' own experiences of podcasts when used to replace or supplement traditional instruction (Orton-Johnson, 2009; Parson et al., 2009). Analysis of student attitudes toward podcasting only began appearing in literature in 2006 (Chester et al., 2011): at which time more than 50 % of university students still reported having never downloaded a podcast for recreational or educational use (Kennedy et al., 2007). Across the past 5 years, the preliminary findings produced have been equivocal.

In a trial of podcasts as the primary method of instruction in political science, for example, Taylor (2009) found equal numbers of detractors and enthusiasts amongst the student cohort. In this study, 11 half-hour podcasts were used. Parson et al. (2009) similarly found a muted response to professionally produced podcasts amongst their psychology cohort. Simple PowerPoint slides were rated by students to be more enjoyable and more useful than podcasts. Finally, Beylefeld, Hugo, and Geyer (2008) found mixed results when 148 first-year histology students were invited to listen to a podcasted lecture on muscle tissue: one of the more difficult course topics that many students had failed in previous years. Seventy-one percent of students indicated that they would like to see podcasts used in other courses too. Perplexingly, however, two-thirds of the cohort also indicated that they would rather have learned conventionally from the lecturer's notes. The authors argue that "[this] false dichotomy should be attributed to students' well-established dependency on spoon feeding in the form of lecture notes" (p. 954); however, this seems only one of several possible explanations. It is just as likely that students consider any additional provision of resources beneficial as long as it does not replace other resources. In support of this latter interpretation, Folley (2010; also see O'Bannon, Lubke, Beard, & Britt, 2011) found strong student support for the prompt "Podcasts could be used to enhance my lectures in some way" (average agreement rating 4.03 out of 5), but not for the prompt "Podcasts could be used to replace my lectures" (average rating 2.58 out of 5).

Of the research into student experiences of podcasts that *has* been conducted to date much either describes the implementation of podcasts in the classroom (Hew, 2009) or simply asks students whether or not they would like podcasts made available. In the most comprehensive review of podcasting in education to date, for example, Hew (2009) uncovered 153 articles and conference proceedings across both K-12 and higher education. A total of 123 were discarded as opinion pieces, reviews, or nonempirical descriptions of program implementations. Of the 30 remaining articles and proceedings, five discipline groups were represented: engineering and sciences, computing and IT, language, business and law, and education. Importantly, significant disciplinary differences were apparent: in the disciplines of engineering and science and computing and engineering, podcasts had been used in the classroom in 33 % of cases. In the discipline of education, with the lowest usage rate, podcasts had been used in just 3 % of classrooms.

There are two potential causes for the disciplinary differences in academics' adoption of podcasts in their classrooms. First, the increased use of podcasts in science, computing, and engineering may reflect the constrained nature of these disciplines. Given the importance of building disciplinary background knowledge in the constrained discipline, podcasts may be seen as an appropriate tool by which such knowledge can be shared and built (see Yates, 2005). This is particularly so given the constrained disciplines' acceptance of direct instruction as a useful pedagogical approach (Mayer, 1996). Nonetheless, this explanation does not account for the very low rate of podcast use in education, where subdisciplines such as educational psychology are also constrained. Second, it may be that scientists and engineers—professionals who frequently use digital and/or technical equipment in their research—are simply more comfortable in engaging with digital tools such as podcasts for teaching. Thus, although podcasts are more *common* in the sciences, they should be just as *appropriate* in educational psychology and in other constrained disciplines.

13.1.2 Project Aims and Objectives

Given the recent pedagogical trend toward podcasting across higher education, the mixed findings regarding student experiences of podcasts, and the very low uptake of podcasts in education—despite the constrained nature of many educational subdisciplines—there remains a need to investigate students' experiences of podcasts in education classrooms. To address this gap, a small case study was conducted in an undergraduate educational psychology class. The aim of the project was to examine education students' experiences of podcasts when used to supplement, rather than change, a constrained curriculum. Podcasts were used to recast traditional lecture material used in the class.

In order to investigate students' perceptions of the podcasts, an action research approach was taken. At its most basic, action research is a cycle of studying a problem and planning its solution, taking action to implement the solution, and reflecting critically on the efficacy of the solution using evidence collected during or after implementation (Biggs & Tang, 2007; Riel, 2010). Action research is used not only for knowledge building more generally but also for finding solutions to a local problem (Heikkinen, Kakkori, & Huttunen, 2001; Zambo, 2007). This problem-solving approach was important for two reasons. First, it allowed a model of best practice podcasting to be developed and tested for possible use in the class. Second, it meant that any design flaws that may initially have hindered students' positive perceptions of podcasts could be examined and rectified. Once one action research cycle was complete, reflections were then used to frame the next cycle (Zuber-Skerritt, 2002).

13.1.3 Project Context

The study was conducted across three cohorts of a second-year undergraduate class titled *The Learner*. *The Learner* is an educational psychology class offered by the School of Education at a metropolitan university in Sydney, Australia. Students learn about the nature of educational psychology research and the importance of evidence-based practice; about children's memory, motivation, and concepts of self; and about learning skills as they develop across childhood. Students come from a wide range of educational and vocational backgrounds and include undergraduate school leavers, mature-age undergraduates, and graduates who have returned to university to retrain after experience in industries including finance, law, science and technology, and marketing.

In Year One, 309 students enrolled in the class. Students' ages ranged from 18 to 66 ($M=25$). In Year Two, 471 students enrolled in the class. Students' ages ranged from 18 to 63 ($M=23$). In Year Three, 479 students enrolled in the class. Students' ages ranged from 18 to 66 ($M=23$). In each cohort approximately 85 % of students were "internal" (in Year One, 82.21 %; in Year Two, 83.85 %; and in Year Three, 85.56 %). Internal students were enrolled in two 1-h lectures and a 1-h tutorial each week across 13 weeks. External students instead listened online to podcast recordings of the live lectures and were enrolled in 2 full-day weekend tutorial classes. All students completed an in-class test, a research report, and a final exam.

13.2 Cycle One: The "How to" Podcast

In Cycle One, students' perceptions of three purpose-built supplementary podcasts were considered. Each podcast was designed to support students' understanding of the major written assignment: the research report. Evidence-based practice in schools requires that teachers critically reflect on and apply emerging research and theory (Everton, Galton, & Pell, 2002). Thus, the goal of the research report task was to build students' capacity for critically reflective classroom practice. Students were asked to conduct a literature search using the library databases ERIC and PsycINFO, to collect child interview data, and to write a report analyzing their findings. Consistent with other constrained disciplines, a strict report-writing procedure was followed (see MacDonald, 1994).

13.2.1 Framing the Problem

Notwithstanding the importance of research engagement in education, preservice students notoriously report finding research tasks irrelevant and difficult (Deemer, 2009). In order to enhance students' engagement with the research assignment, scaffolding was provided in a 1-h *How To* lecture; however, the lecture format was poorly suited to the task. When developing procedural knowledge, students need opportunities to engage in the procedure itself (Biggs & Tang, 2007; Mayer, 1996). Practice is critical (Bruning et al., 1999; Mayer, 1992, 1996). During the lecture, no such opportunities were possible.

Given the challenges inherent to the *How To* lecture, it was hypothesized that students would find purpose-built scaffolding podcasts more useful. First, podcasts allow for shorter delivery. Lee and Chan (2007, p. 206) advocate for "bite-sized" podcasts as a means of engaging students in learning that is naturally integrated into other day-to-day activities, whereas Roberts (2008) interviews with students suggest that podcasts should be between 5 and 15 min long. Folley (2010, p. 96) highlights the success of shorter podcasts in the educational and popular media, stating: "whether by design, market forces or simple necessity these websites [TED, iTunes education, YouTube education…] have hit on the golden time limit for a learning object in the form of a podcast being 10–20 minutes." Critically, shorter podcasts allow students to practice each skill in turn, without becoming overwhelmed by content (Bruning et al., 1999). Because many of the literature search and report-writing skills addressed were computer based, students could also open a second browser and practice these procedural skills simultaneously. If students felt they had missed a critical step in the procedure, they could repeat the podcast as necessary (see Van Zanten et al., 2012).

13.2.2 Procedure

In Year One students were delivered the original *How To* lecture. In Year Two, three podcasts consisting of slides and audio were created using the voiceover function in Keynote. In the first podcast the purpose and ethics of research were outlined. In the second podcast, students were guided through the literature search process. Screenshots of the library homepage and the databases PsycINFO and ERIC were overlaid with arrows and boxes highlighting important procedural steps (see Fig. 13.1). In the third podcast, the components of a standard research report—abstract, introduction, method, results, and discussion—were outlined. Each podcast was 7 min long and was uploaded to Blackboard. The original *How To* lecture was not delivered.

During the final lecture anonymous student surveys were distributed to internal students. During the same week, a link to an online version of the anonymous surveys was e-mailed to external students. In Year One, before the implementation of the three podcasts, students were asked two open-ended questions: "What did you like best about the course" and "what could be improved?" A text box was provided for them to write or type responses. There were 137 internal respondents and 30 external respondents. In Year Two, after the three podcasts had been implemented, students were instead asked: "What were the most positive aspects of the course?" and "what could be improved?" There were 115 internal respondents and 12 external respondents.

13.2.3 Results and Reflection

When asked "What did you like best about the course?" in Year One, only 2.6 % of students referred the major assignment and assignment resources. In contrast,

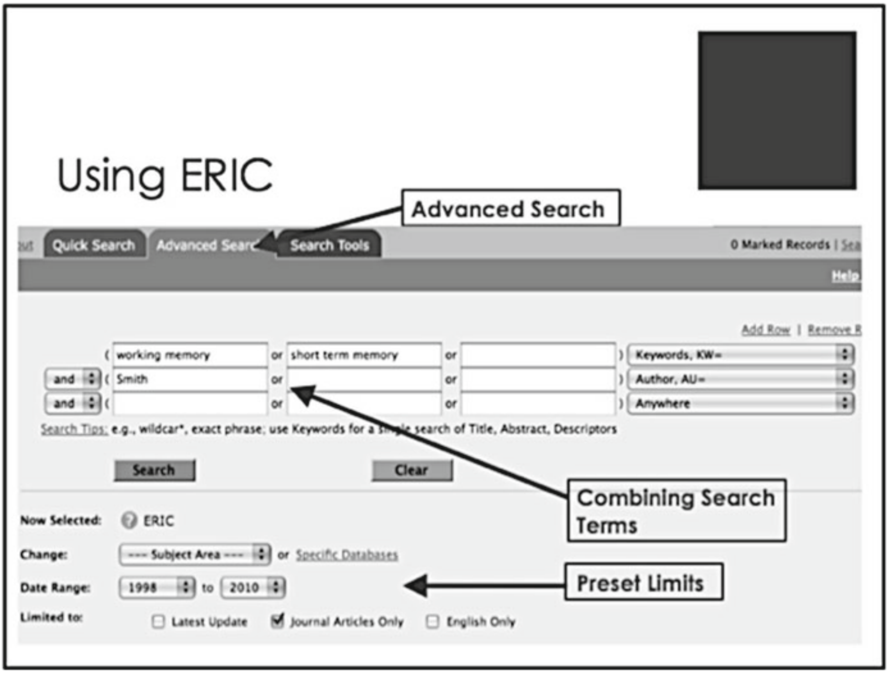

Fig. 13.1 A screenshot from the second podcast, "how to conduct a literature search"

23.3 % of students referred to the assignment when asked "What could be improved?" Open-ended responses revealed that many students did not perceive themselves to be well enough equipped to complete the tasks. For example, one student stated "I found the actual assessment tasks very daunting. More scaffolding is needed here to facilitate learning for all students," whereas another said: "not enough information was given on how to write and research a report and it was very vague." This call for additional support was common: students stated "there should be some assistance prior to the assessments" and "[We need] more explanation for the research assignments, especially for those who have no experience doing them."

In Year Two, after the three podcasts were implemented, increases in students' research engagement were observed. In responses to the prompt "What were the most positive aspects of the course?" the research assignments were referred to in 11.1 % of cases. Support for student learning was referred to in a further 40.7 % of cases. Students agreed that "plentiful help and guidance were made available to us" and "the resources available on Blackboard were great, lots of extra resources." In particular, support for the research assignment highlighted:

> The support and information given for preparation of assignments was highly valued and made clear what was expected, especially in regards to the presentation and structure requirements for assignments.

In response to the prompt "What could be improved?" only 12.0 % of responses referred to the assignments—a decrease from the 23.3 % of responses in Year One—whereas 20.0 % said "nothing."

Comparing Year One and Year Two outcomes, podcasts appeared an effective means of recasting procedural knowledge that had traditionally been delivered in lecture. Students did not just prefer the purpose-built podcasts: they also felt better equipped to succeed. There are two reasons that this might be the case. First, as highlighted by Folley (2010) and Roberts (2008), the brevity of the podcasts may have been important. Students could listen repeatedly and could learn a new skill before quickly moving on to practice that skill. Second, as highlighted by Taylor (2009) and Van Zanten et al. (2012), the flexibility of the podcast format may have been important. The podcast carried with it options to listen when and where convenient, to pause the recording, to work simultaneously on their assignment, and to rewind if they missed a step.

13.3 Cycle Two: The Full-Lecture Podcast

In Cycle Two, students' perceptions of full-lecture podcasts were examined. All lectures in the Education Department are recorded using iLecture, a WBLT audio capture program embedded within the Learning Management System Blackboard. By using iLecture, external students can download or stream the lecture without the need to attend class. Likewise, internal students who miss the traditional live lecture for work, illness, or personal preference can instead access the podcast recording. Finally, internal students who are present can use the podcast as a revision and study tool.

While the purpose-built podcasts used in Cycle One were well received by students, the WBLT-supported podcasts differed in two ways. First, while the WBLT-supported podcasts offered the same flexibility as the purpose-built podcasts in Cycle One, they do not offer the same brevity. Second, the purpose of each podcast was different. The Cycle One podcasts offered supplementary assignment support with a focus on procedural skills. The Cycle Two podcasts instead offered content delivery with a focus on declarative knowledge.

13.3.1 Framing the Problem

Research examining students' experiences of content-delivery podcasts has focused on podcasts used to complement or replace traditional lectures. In other words, a podcast designed to address the same content as a lecture is either made available alongside the lecture itself or made available in lieu of the lecture. Typically the podcast made available alongside the lecture is recorded from the lecture using WBLT, whereas the podcast made available in lieu of the lecture is purpose built (as in Cycle One) and may be shortened or adapted (e.g., Beylefeld et al., 2008;

Taylor, 2009). No studies to date report an instance where students who had previously been provided with both a live lecture and podcast have the live lecture option removed.

The question of student perceptions of podcasts when live lecture options are removed—with no commensurate, tangible increase in the provision of other resources—is important for two reasons. First, there is disagreement in the higher education literature regarding the extent to which students embrace podcasts, with no data available from education students. On the one hand, it is argued that podcasts are likely to appeal to the current crop of "digital native" learners (e.g., Chester et al., 2011; Parson et al., 2009). On the other hand, student support for podcasts appears strongest when they are provided alongside lectures (Folley, 2010; O'Bannon et al., 2011). Lecture removal, like lecture replacement, may be interpreted less favorably by students: particularly when the avenues by which curricular content can be accessed by students are actually decreased.

Second, the removal of live lectures is likely to become more common with time. Due to funding pressures, technological advances, and a wider range of students now studying at university, there are increasing calls for "innovative" online content delivery (Folley, 2010; Mikat et al., 2007; Nagel & Kotze, 2010; Taylor, 2009). Concurrently, the prevalence of WBLT to accompany live lectures has increased dramatically over the past 5 years (e.g., Chester et al., 2011; Phillips et al., 2007). Given that many classes now have stored a full set of recorded lectures from previous years, some may well respond to the increasing pressures for online delivery by uploading the same lecture podcast series that had previously been recorded live. At the university department in question, for example, one large undergraduate education unit has already moved from live lectures with WBLT-supported podcast recordings of the lecture to a trial of previously recorded WBLT-supported podcasts only. Several postgraduate education units are also being taught with podcasts.

13.3.2 Procedure

To examine students' perceptions of lecture removal, a target lecture, *Learning Styles*, was selected. This lecture forms part of a module on cognitive development and is scheduled to come toward the end of the module as an example of contentious issues in education today.

In Year Two, all lectures were (1) delivered live and (2) made available in podcast form using iLecture. In Year Three, all lectures but the target *Learning Styles* lecture were again delivered live and made available in podcast form using iLecture. The target *Learning Styles* lecture was not delivered live. Instead, the lecture podcast from Year Two was uploaded again in Year Three. Students were told during lecture 2 weeks prior that the *Learning Styles* live lecture would not be held and they should download or stream the podcast via iLecture. Students' anonymous lecture ratings for each lecture podcast were captured using iLecture. Scores ranged from 1 to 5, where 1 was the lowest rating and 5 was the highest rating. Ratings for the

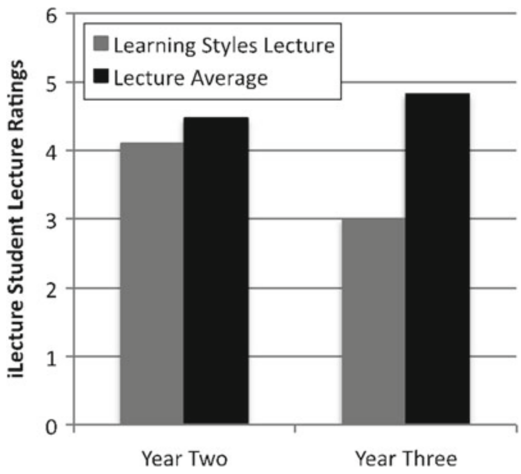

Fig. 13.2 Student lecture ratings for the target Learning Styles lecture podcast and for all other lecture podcasts, averaged, across Years Two and Three

Learning Styles lecture podcast were then compared to ratings for the remaining lecture podcasts, both in Year One and Year Two.

As lecture ratings were made anonymously, it was not possible to control or match the students who rated each lecture podcast using iLearn. Not surprisingly, given the absence of a live *Learning Styles* lecture in Year Three, hit counters showed a sample size of 448 for the WBLT-supported *Learning Styles* lecture vs. an average of 315 for the remaining podcasts. In Year Two, when all lectures were presented both live and in podcast form, this difference was not as large: 316 for the *Learning Styles* lecture podcast vs. 297 on average for the remaining lectures.

13.3.3 Results and Reflection

In Year Two, when all lectures were available in both live and podcasted form, the difference between the target *Learning Styles* lecture podcast rating and the remaining lecture podcast ratings was only 0.37 (see Fig. 13.2). In Year Three, however, when the target *Learning Styles* lecture was available in podcast form only, students rated this podcast considerably less favorably than they did the remaining lecture podcasts. The difference between the *Learning Styles* lecture podcast rating and the average lecture podcast rating was 1.82. Although these findings are tentative, given that only one lecture was varied, this pattern nonetheless suggests that students prefer podcasts that are used as lecture supplements to podcasts that are used when lectures are removed.

The difference between Year Two and Year Three student ratings of the *Learning Styles* lecture podcast is particularly salient when it is considered that the same podcast was used each time. That is, the podcast that was recorded and subsequently rated in Year Two was also uploaded in Year Three. Unlike studies of lecture replacement—in which student perceptions of a live lecture are compared to perceptions of a purpose-built replacement podcast (e.g., Beylefeld et al., 2008; Parson et al., 2009; Taylor, 2009)—the observed difference in student ratings cannot relate to changes in the content of the podcast, the length, or to the way it is delivered.

Unfortunately, the anonymous student ratings collected in Cycle Two did not allow an investigation of the *reasoning* underpinning students' rating scores nor did they allow individual students' ratings to be traced across lectures. Consistent with both Folley (2010) and O'Bannon et al. (2011), students may have rated the *Learning Styles* lecture more favorably in Year Two than in Year Three because they appreciated the provision of multiple resources. Despite listening to and rating the *Learning Styles* podcast online, students in Year Two nonetheless knew that the live lecture was available: indeed, some may have both attended the lecture in person and listened online later. In Year Three, this choice was not possible. Alternatively, given that the live *Learning Styles* lecture was not available in Year Three, the lower rating in this year may be a function of the increased number students rating the lecture podcast (448, compared to 315 for other lecture podcasts). Students who were motivated to attend live lectures when available may simply be more discerning or prefer the "theatre" of a live lecture (Friesen, 2011; Kazlauskas & Robinson, 2012). Thus, when instead forced to listen to the *Learning Styles* lecture in podcast form, this select group of students may have given the podcast a particularly low rating. Finally, it may be that students who would typically have chosen to attend a live lecture were simply less familiar with the podcasting technology. They may therefore have expressed their frustration with the *Learning Styles* lecture podcast through lower scores. In order to examine *why* the podcasted *Learning Styles* lecture received lower scores in Year Three, Cycle Three used a participatory approach to investigate student perceptions.

13.4 Cycle Three: A Participatory Approach

Cassell and Johnson (2006) describe four kinds of action research: experimental (or quasi-experimental), inductive, participatory, and deconstructive. In Cycle Two, a quasi-experimental approach was used to compare alternative content-delivery modes. Student lecture ratings, the dependent variable, were "neutrally collect[ed] from an independent social reality so as to empirically test causal predictions deduced from a priori theory" (Cassell & Johnson, 2006, p. 790). While the quasi-experimental design allowed causal predictions about students' preferences for different delivery modes to be tested, however, it did not allow the reasons behind those preferences to be investigated. *Participatory* action research, in contrast, attempts to break down the power imbalances inherent in researcher-participant relationships in order to give participants greater voice (Gaffney, 2008; Smith, Rosenzweig, & Schmidt, 2010). This approach, in which the research is conducted *with* rather than *on* students, capitalizes on students' "inside knowledge" to investigate both the problem and the solution from multiple angles (Vessey & DeMarco, 2008).

13.4.1 Framing the Problem

Because many research designs do not empower students to articulate their own experiences, the causes underpinning positive and negative student perceptions of learning and teaching provisions are often not well understood (Vera & Speight, 2003). In Cycle Two, anonymous student ratings showed disengagement from the target *Learning Styles* podcast offered in Year Three, but did not offer any definitive explanation for this finding. Specifically, it was unclear whether *all* students felt disengaged from the lecture podcast, and therefore rated it lower than they did other podcasts, or whether a *select* group of students—those who would usually have listened to the lecture live, when available—simply preferred the podcast format less. Moreover, it was also unclear what factors drove these preferences: particularly when the purpose-built assignment scaffolding podcasts in Cycle One had been well received. To more deeply investigate students' perceptions of podcasting technology, a participatory approach is critical.

Focus groups are frequently used in participatory research (Chiu, 2003) as a way of investigating open-ended problems from the perspective of students. Focus group practices have transformative potential in that, like participatory research more broadly, students are empowered to offer solutions shaped to their own interests and concerns (Chiu, 2003; Vessey & DeMarco, 2008). Using a focus group design, therefore, the aim of Cycle Two was to learn from students (1) what drives their engagement and disengagement from podcast technology and (2) in what ways podcasts should be used to enhance learning and teaching.

13.4.2 Procedure

The opportunity to participate in a focus group was advertised on the class Blackboard page. The advertisement stated that the aim of the group was to determine student views about (1) teaching and learning and (2) research preparation within the first half of the semester. It further stated that the session would last approximately 90 min. Twenty-three students responded via e-mail to express their interest in participating, and of these, 12 were able to participate at the time specified. Participants ranged in age from 20 to 38 years and included ten females and two males. All were internally enrolled, and seven stated that they regularly attended lectures in person.

The focus group was held during the mid-semester break, 3 weeks following the target *Learning Styles* lecture. Initially students were asked one open-ended prompt question: "What are the sorts of things that are going well in the unit so far, and what suggestions might you have?" In order to maximize student voice, the researcher did not contribute to the ensuing discussion other than to confirm student contributions. When the discussion had finished, students were asked six follow-up questions in turn. These questions addressed both (1) teaching and learning and

(2) research preparation and included: "Are there any resources provided in the course or outside the course that you find particularly useful?" and "Do you think conducting educational research is useful or valuable for education students? Why or why not?" To avoid demand characteristics, students were not prompted to discuss podcasting directly. Only one follow-up question related directly to the *Learning Styles* lecture. This question asked: "Out of all the lectures so far, some students have stated that they did not the Learning Styles lecture as much. Why do you think that might be?"

Field notes were taken throughout the session. To ensure that all data recorded in the field notes was both accurate and credible, member checks were conducted at the conclusion of each session. Participants were presented with the field notes and asked to verify that their meaning had been accurately represented. In the absence of formal reliability and validity measures, this strategy serves to establish the credibility of the qualitative data (Krefting, 1991). Participants were not paid or offered any course incentive for participating; however, they were offered refreshments at the conclusion of each session.

13.4.3 Results and Reflection

The student focus group identified two key factors driving their perceptions of podcasts: (1) the provision of choice and (2) lecturer intent. Note that other teaching and learning themes unrelated to podcasts also emerged; however, these are not discussed in this chapter.

First, the provision of choice was important. All students in the focus group reported valuing the WBLT-supported podcasts highly. Indeed, while five students exclusively used iLecture, the seven students who regularly attended lectures also appreciated the opportunity to "catch up if I have to miss the lecture for any reason" and to "juggle life better when I have lots of assignments." These findings are supported by previous research: students report using full-lecture podcasts both to consolidate material they may have missed live and as a support when other commitments mean that they are unable to attend (e.g., Phillips et al., 2007; Roberts, 2008; Van Zanten et al., 2012). Notwithstanding their positive perceptions of WBLT-supported podcasts, however, all students also wanted live lectures to continue. Although only seven students regularly attended lectures live, 11 stated that they enjoyed lectures "…if they're done well." Furthermore, four of the five students who did not regularly attend lectures attributed their reliance on WBLT to practicality rather than enjoyment: employment demands, clashes with other classes, and, in one student's case, "poor time management." Only one student did not enjoy lectures, stating: "I know I should go to them but I just can't… um, I can't engage that way and I always find myself nodding off… but they're good I suppose for people who do want them."

Second, lecturer intent was important. The focus group was in unanimous agreement that uploading podcasts from previous years "makes it look like the lecturer doesn't care as much." Not only is the choice between attending in person or listening later removed, but, according to the focus group, the effort that lecturers should be making to support student learning is also absent. For example, one student who regularly attended lectures commented that "it doesn't feel like the lecturers put in any effort [when lectures are removed]," whereas another, who reported not attending live lectures personally, stated: "it kind of feels like a cop out." Students also raised the question of lecturer intent when referring to the purpose-built assignment scaffolding podcasts, suggesting not only that "it really helped to be able to sit down with the podcast open at the same time as ERIC [a literature search database]" but also that "it showed that you care and want us to learn."

In the primary and secondary school years, the student-teacher relationship is characterized by closeness, support, conflict, and dependency (Hamre & Pianta, 2001; Murray & Murray, 2004) and is a strong predictor of students' school engagement and future academic success (Midgley, Feldlaufer, & Eccles, 1989). Although student-teacher relationships have not been examined for these same characteristics in the higher education setting, Pratt, Collins, and Selinger (2001) do nonetheless draw a distinction between transmissive, developmental, social justice-oriented, nurturing, and apprenticeship concepts of teaching. It seems plausible that some degree of closeness and support, consistent with a nurturing perspective, would remain important to university students too. For example, a key source of university students' disengagement from very large lectures is the lack of personal contact between lecturers and students and not the lecture itself (e.g., Charters, Gunz, & Schoner, 2009; Wanous, Procter, & Murshid, 2010). Where lecturers of very large cohorts used alternative methods to increase the perception of closeness and support, however, such as welcome e-mails to the class, motivation and academic performance subsequently increase (Legg & Wilson, 2009).

It is worth noting here that students in the focus group were self-selected and therefore likely to be more strongly engaged than other students (Vessey & DeMarco, 2008). It is therefore unclear the extent to which perceptions of the focus group will mirror those of other students: for example, those who are already disengaged or those who were unable to participate in the group (external students, students with class or work clashes, and students with family commitments). Furthermore, the lecturer who had delivered the lecture series also led the focus group, thus potentially limiting students' willingness to criticize some elements of the course. The findings nonetheless offer a useful socio-emotional explanation for students' engagement and disengagement from podcasts. That students' dissatisfaction with lecture podcasts may stem not from podcasting as a medium but from their perceptions of lecturer intent has not previously been considered.

13.5 Conclusion

The present findings suggest that podcasts are a useful lecture supplement to traditional educational psychology lectures. Where the goal was to develop students' procedural knowledge for an assignment task, as in Cycle One, short purpose-built podcasts represented an effective way to scaffold student learning. Where the goal was to scaffold discipline-specific lecture content, as in Cycle Two, then both lectures and podcasts appear appropriate. Indeed, students expressed a strong preference for both options to be provided. Cycle Three offers two explanations for these findings. First, having both a live lecture and a WBLT-supported lecture podcast provided the opportunity for choice. Given that the content of the live lecture and WBLT-supported podcast was identical, students did not like the idea of being restricted to one format only. Second, students expressed dissatisfaction at the perception that the use of the WBLT-supported podcast was less effortful for the lecturer than was an equivalent live lecture. The podcasts in Cycle One were deemed effective not only because they allowed for procedural skills to be practiced simultaneously but also because they had been purpose built. Students stated that time and care appeared to have gone into their construction.

Given the constrained nature of the educational psychology curriculum, these findings may not generalize well to unconstrained disciplines. Constrained disciplines emphasize the importance of hierarchically developed disciplinary knowledge and skills, thus making assignment scaffolding and content-delivery podcasts pedagogically appropriate (Yates, 2005). Unconstrained disciplines, in contrast, do not emphasize content delivery (MacDonald, 1994). Notwithstanding this potential limitation, the findings nonetheless offer useful information for podcast implementation in constrained disciplines. A carefully designed podcast may take considerable expertise and time to develop, with some universities now turning to professional production staff to assist in the process (Folley, 2010). Nonetheless, much of this work occurs behind the scenes. When students believe that podcasts have been implemented to save time for universities or for lecturers, they are likely to disengage. When students believe that podcasts are pedagogically appropriate, however, their engagement is strengthened.

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14.1 Introduction

The rapid evolution of digital technologies has taken place with unprecedented effects on the ways in which people communicate, get informed, conduct their everyday exchanges, and learn. Available tools and services that have emerged as the result of ongoing technological advancements provide individuals with unique opportunities to access a vast number of digital resources, anytime they want them, create and share their own content, as well as interact with people who are geographically dispersed. Furthermore, there are a number of critical socioeconomic factors such as the globalization and the emergence of the knowledge economy, which have caused significant changes in today's societies. The emerging landscape presents formal education with a number of challenges that needs to be addressed by undertaking and performing the necessary reforms. These reforms need to penetrate all kinds of services provided by formal education establishments and especially target at the transformation of offered educational services and existing pedagogical approaches (Becta, 2009; Kearney, 2009). Technology has the potential to make available a range of tools that can be exploited with the aim to implement pedagogical innovations either fitting into existing curricula or leading to the design of new ones.

The aim of this chapter is to provide an insight into the potential of a specific category of technological tools, namely, digital games, for driving changes within the context of formal education. To this end, we present issues related to the learning effectiveness of digital games, describe topics and findings that emerge from existing research efforts, and make suggestions for further research based on critically reflecting on current state of the art.

14.2 Digital Games as Effective Learning Tools

14.2.1 The Digital Game-Based Learning Research Context

Digital game-based learning is an emerging research field in technology-enhanced learning and has attracted significant interest by both the research and educational community (Chen & Chan, 2010; Kirriemuir & McFarlane, 2004; Sandford, Ulicsak, Facer, & Rudd, 2006; Sandford & Williamson, 2005; Torrente, Mera, Moreno-Ger, & Fernández-manjón, 2009, pp. 1–18; Van Eck, 2007, pp. 271–307). Early attempts to define digital game-based learning focus on describing it as a process of integrating learning content in computer games with the aim to achieve the same or better results in comparison to traditional teaching methods (Prensky, 2007, pp. 145–146). Similarly, Connolly and Stansfield (2006) define digital game-based learning as "the use of a computer games-based approach to deliver, support, and enhance teaching, learning, assessment, and evaluation" (p. 466). More recently, Chen and Wang (2009) have stressed the importance of facilitating processes of knowledge construction and thus have defined digital game-based learning as "an effective means to enable learners to construct knowledge by playing, maintain higher motivation and apply the acquired knowledge to real-life problems" (p. 274).

The increasing popularity of digital games, as evidenced by the wide range of game players' ages and the continuous growth of the gaming industry (ESA, 2012; ISFE, 2010), has stimulated research interest toward investigating ways and methods of utilizing digital games as learning tools. There are a number of key structural characteristics that digital games incorporate, which differentiate them from other forms of play and make them motivating and engaging. More specifically, digital games are rule based and goal oriented, have rich narrative elements and storyboards, present players with challenges, allow for interaction (player-to-player interaction, as well as interaction between the player and the game's interface), and offer players with opportunities to experience the outcomes of their performed actions by providing "just-in-time" or "on-demand" feedback (Klopfer, 2008, p. 14; Prensky, 2007, pp. 118–125; Whitton, 2010, pp. 22–32). Within this context, digital game-based learning research focuses, among others, on a systematic investigation of the potential use of digital games in formal and/or informal learning settings (Kirriemuir & McFarlane, 2004; Sandford & Williamson, 2005; Van Eck, 2006). More specifically, ongoing research efforts are mainly concerned with issues of designing, implementing, and evaluating appropriately designed learning activities, fully or partially supported by digital games, in terms of achieving well-defined generic, subject-domain specific, or cross-domain specific learning objectives.

14.2.2 Facilitating Active Learning Processes with the Support of Digital Games

As opposed to a number of early definitions of digital games, which consider them as software applications that are able to be executed with the use of the appropriate technological infrastructure (e.g., ELSPA, 2006; Kirriemuir & McFarlane, 2004; Sandford & Williamson, 2005; Smed & Hakonen, 2003), Juul (2003, pp. 30–45) adopts an approach that focuses more on the gaming activity dimension and, thus, defines (digital) games as "rule-based formal systems with a variable and quantifiable outcome, where different outcomes are assigned different values, the player exerts effort in order to influence the outcome, the player feels attached to the outcome, and the consequences of the activity are optional and negotiable." According to Juul's definition, there are a number of six defining characteristics of (digital) games, which can be summarized to the following points:

1. Digital games are *rule based*.
2. Digital games have *variable*, *quantifiable* (through feedback provided to players) *outcomes*.
3. Players *assign* (positive or negative) *value to* achieved *outcomes*.
4. Players are making *efforts to achieve* the intended *outcomes*.
5. Players are emotionally *attached to* achieved *outcomes*.
6. Actions performed by players lead to specific *outcomes*, which are not necessarily the same each time the game is played.

A similar definition is also provided by Klopfer (2008), who defines (digital) games as a "purposeful, goal-oriented, rule-based activity that the players perceive as fun" (p. 14), with rules being sets of instructions, embedded into the design of the game, that define legitimate actions (Prensky, 2007, pp. 119–120; Whitton, 2010, p. 27) and goals or outcomes determining the reasons for engaging in game play (Whitton, 2010, p. 26).

Typically, digital games present players with complex and ill-defined problems (Prensky, 2007, pp. 157–163; Whitton, 2010, pp. 50–51), which must be identified and confronted through a process of devising strategies and undertaking specific actions (Jørgensen, 2003). Thus, there is potential for applying and developing a range of higher-order cognitive skills related to problem-solving, such as strategic thinking and planning, communicating, analyzing, evaluating, negotiating, data handling, team working, and group decision making (Kirriemuir & McFarlane, 2004; Whitton, 2010, pp. 35–53). Gee (2007a, pp. 71–111) advocates the capacity of digital games to foster problem-solving skills by describing a four-step process, in which players actively engage when trying to confront in-game challenges. More specifically, this process, which is described as the "probe, hypothesize, reprobe, rethink cycle" (Gee, 2007a, pp. 87–92), involves the engagement of players in the following actions:

- The player explores the virtual world of the game and tries to discover meanings embedded in virtual objects ("probe the virtual world").
- The player formulates a hypothesis as a result of his/her reflection on the actions that were performed during the exploration of the virtual world of the game ("form a hypothesis").
- The player engages again in an active exploration of the game world with the aim to test the validity of the formulated hypothesis ("the player reprobes the world").
- Based on provided feedback, the player "accepts or rethinks his or her original hypothesis" and re-engages in the above-described sequence of actions.

A similar approach is held by Garris, Ahlers, and Driskell (2002) who propose the "Input-Process-Output Game Model" of exploiting digital games for the purpose of achieving (formally described) learning objectives. The input phase of the model is concerned with the learning content to be delivered, as well as the game characteristics that are needed to inform the process of designing the game-based learning activities; the output phase is related to the achieved learning outcomes; and the process phase of the model describes a pattern of actions in which users are engaged as part of their involvement in the game-supported learning activities. More specifically, the process phase of the "Input-Process-Output Game Model" (Garris et al., 2002) is a circular process that includes:

- The engagement of the user in making judgements about the virtual world of the game ("user judgements").
- The undertaking of specific actions as manifested by observable behavior ("user behavior").
- The refinement of judgements and actions with the help of provided feedback ("system feedback").

Both the "probe, hypothesize, reprobe, rethink cycle" (Gee, 2007a, pp. 87–92) and the "Input-Process-Output Game Model" (Garris et al., 2002) are aligned with Kolb's model of experiential learning (Kolb, Boyatzis, & Mainemelis, 2001, pp. 193–210), which constitutes a four-phase circular process (namely, "concrete experience," "reflective observation," "abstract conceptualization," and "active experimentation") describing how perceived learning experiences can trigger cognitive processes of developing abstract concepts through the necessary engagement in reflection activities.

Typically, in-game actions are situated within authentic and meaningful contexts (Van Eck, 2006; Whitton, 2010, pp. 35–53) within which players are able to adopt virtual identities, explore the virtual world of the game, interact with virtual objects in an attempt to discover meanings embedded in them, discuss and negotiate with other virtual characters, investigate cause and effect relations, resolve conflicts, search for relevant information, and make decisions with respect to the problem at hand (Kim, Park, & Baek, 2009). By applying trial-and-error approaches, there is potential for experimenting and learning from mistakes (Prensky, 2007, pp. 157–163) within virtual spaces where performed actions have no real-life consequences (Dumbleton & Kirriemuir, 2006, pp. 233–240; Kirriemuir & McFarlane, 2004; Whitton, 2010, pp. 22–32). As a result, players are provided with ample opportunities to construct their own personal meanings of the virtual world of the game by incorporating perceived experiences into existing knowledge schemas or creating new knowledge schemas with the aim to resolve the experienced "cognitive disequilibrium" (Van Eck, 2006, p. 20).

Furthermore, digital gaming is an inherently social activity (Gee, 2007a, pp. 179–213) with players engaging in joint and coordinated actions as part of their efforts to confront challenges presented within the virtual world of the game (Klopfer, 2008, pp. 147–149). Digital games are the artifact that mediates and supports players' actions with their goal-oriented and rule-based character (Klopfer, 2008, p. 14) facilitating players' engagement in active exploration and experimentation as part of their involvement in coordinated joint activity (Gee, 2007a, pp. 71–111 and 179–213). However, apart from the actions that take place during the gaming activity, there is also a network of actions and interactions evolving around the gaming activity, such as reading books and magazines related to games, visiting relevant websites, posting comments to forums, and creating and exchanging virtual artifacts and other resources (Prensky, 2006, pp. 96–100). Such systems of game-related activities are described by Gee (2007b, pp. 87–103) as “affinity spaces” and are characterized by the commitment of players to a common endeavor in a network of seamlessly interconnected tools and human actors (Gee, 2007a, pp. 179–213, 2007b, pp. 87–103). This can be exploited in supporting learning communities, communities of practice, and communities of identities (Sedano, Sutinen, Vinni, & Laine, 2012).

14.2.3 Educational Digital Games: From Edutainment to Serious Games

The need to take advantage of the motivation that commercial-off-the-shelf digital games offer along with their capacity to facilitate learning through doing is considered a key reason behind the increased research interest in developing specially designed educational digital games (Hense & Mandl, 2012; Kirriemuir & McFarlane, 2004). The development of the first generation of educational games, which are often referred to as “edutainment” (Klopfer, 2008, p. 24; Whitton, 2010, p. 120), was based on the premise that by introducing educational content as part of a game-like scenario, learning would take place in a more entertaining, and thus more effective, way as compared to traditional instructional approaches (Kirriemuir & McFarlane, 2004). However, this first generation of educational games did not have the impact that was expected with regard to engaging their users and facilitating learning, because of the following:

- Their simplicity in comparison to general-purpose commercial digital games both in terms of audio and graphics quality, as well as challenges presented within the game world (Kirriemuir & McFarlane, 2004).
- Their failure to maintain the motivation and interest of users, who perceived within game tasks as “a slightly easier to swallow version of drill-and-practice learning” (Klopfer, 2008, p. 24).
- The limited range and poor design of presented tasks with no potential to facilitate the development of higher-order cognitive skills (Kirriemuir & McFarlane, 2004).

According to Whitton (2010, p. 122), commercial-off-the-shelf digital games are primarily designed for entertainment purposes with presented tasks and challenges being fully aligned with the game’s goals. As an example we can refer to “The Sims,” which constitutes a typical example of a popular commercial digital game. According to developer’s official website (http://thesims.com/en_US/what-is-the-sims), the game simulates life in a small town and thus provides its users with the opportunity to cope with a number of social issues by allowing them to create and customize their own virtual characters, make choices for their virtual characters’ lives, and help them fulfill their dreams and aspirations. On the other hand, in most cases of educational digital games, there is no alignment between gaming activities and intended learning outcomes with the former being offered as a reward for successfully completing presented learning tasks within the context of the game (Whitton, 2010, p. 122). "Math Blaster" constitutes a typical representative of this first generation of educational digital games, in which the user is presented with simple math problems and has to jump up to platforms in order to grab the right answer that appears on the sky (Klopfer, 2008, pp. 23–24).

The rise of the "serious games" movement can be regarded as an attempt to diminish deficiencies of the first generation of educational digital games by developing games that target mainly at post-secondary education contexts and are capable of providing users with authentic and meaningful learning environments capable to facilitate the development of higher-order cognitive skills and the application of domain-specific knowledge. Michael and Chen (2006, p. 10) define serious games as games "in which education—in its various forms—is the primary goal, rather than entertainment." The official website of the LUDUS project (http://www.ludus-project.eu/), which is a project concerned with the "creation of a European network for the transfer of knowledge and dissemination of best practices in the innovative field of serious games," presents a number of areas of interest regarding the employment of serious games such as education, politics, engineering, city planning, and health care. Within this context, Prensky (2006, pp. 122–125) presents a number of serious games, which have been developed for the purpose of fostering healthy nutrition habits to young people (e.g., the "Squire's Quest" game (http://www.bcm.edu/cnrc/consumer/archives/videogames.htm)), helping users cope with serious health problems (e.g., the "Re-Mission" (http://www.re-mission.net/) game developed to help teenagers and young adults who have cancer), as well as addressing mental health issues (e.g., the "Earthquake in Zipland" (http://www.ziplandinteractive.com/) game that targets at providing support to children who encounter family problems).

14.2.4 Exploiting Digital Games for Educational Purposes: Issues Emerging from Existing Research

As mentioned earlier, the utilization of digital games in formal and/or informal learning contexts has attracted a considerable amount of research interest primarily because of the digital games' popularity and the affordances for learning that they provide. However, the use of digital games in formal educational contexts and their capacity to facilitate the achievement of standard curricula learning objectives can be fully understood only if we take into consideration the general aims and objectives of different educational levels and the implications that these aims can have with respect to the exploitation of digital games.

More specifically, higher education establishments need to provide both general education that will help young people become active and responsible citizens, as well as career-specific, targeted education with the aim to facilitate the acquisition of domain-specific knowledge and skills (UNESCO, 1998). On the other hand, school-based education targets at the development of basic skills, such as literacy and numeracy, as well as skills, competences, and attitudes that are considered as necessary for personal fulfillment and development (UNESCO, 2005). Although the education that is provided at both levels targets at the development of higher-order cognitive skills and competences, there are significant differences in the subject-specific educational objectives that are intended to be achieved. This fact, along with a number of differences that characterize provided education at the institutional level (e.g., available infrastructure, time constraints, use of assessment methods), can have considerable implications with respect to the integration of digital games into everyday educational practices.

As far as school-based education is concerned, there is a need for a direct alignment between the content of the game and the educational content that is intended to be delivered (McFarlane, Sparrowhawk, & Ysanne, 2002), which leads to the use of digital games that can support the achievement of lower-level cognitive skills related to subject-specific educational objectives. Furthermore, motivation is regarded as one of the primary reasons for considering the use of digital games in a classroom setting (Whitton, 2010, p. 6), whereas existing time constraints and the emphasis on test-based assessment pose significant limitations to the types of games that can actually be used (McFarlane et al., 2002). On the other hand, the type of learning outcomes that are intended to be achieved within the context of higher education, the need for a direct relevance between the game and real-world applications, as well as the existence of a greater flexibility in assessment allow for the use of more "sophisticated" digital games, which have the capacity to enhance the acquisition of higher-order cognitive skills (Whitton, 2010, pp. 5–6). At this point, it is also important to stress that there is potential to achieve a variety of learning outcomes with the use of the appropriate game genres and that there have been research efforts to provide typologies of digital games based on the types of learning outcomes that they can produce. Dondi and Moretti (2007) present such a typology according to which:

- Quiz games and puzzle games that include drill-and-practice activities can facilitate the acquisition of factual knowledge.
- Sport games and action games can provide meaningful environments for the application of already-known concepts and rules.
- Strategy, adventure, role-playing, and simulation games are considered as appropriate for the development of problem-solving and decision-making skills.
- Strategy, role-playing, and simulation games can engage their users in social interactions and facilitate the development of ethical values.

Given the above-described context, we present a number of research efforts that have taken place at both educational levels with the aim to highlight differences in the learning outcomes that can be produced. To this end, we have focused on game-based learning research efforts, which have been published during the last 10 years and are concerned with the investigation of potential effects on the achievement of both subject-specific and general educational objectives and learning outcomes. Factors that have been reported to be critical for the effectiveness of game-based learning approaches are also presented. The issues that emerge from the review of the available research will allow for proceeding to a critical analysis in the following section.

As far as school-based education is concerned, there is a substantial amount of research, which has focused on the impact that digital games can have on the achievement of standard curricula educational objectives and learners' motivation (e.g., Annetta, Minogue, Holmes, & Cheng, 2009; Bottino, Ferlino, Ott, & Tavella, 2007; Egenfeldt-Nielsen, 2005; Ke, 2008; Kim & Chang, 2010; Panoutsopoulos & Sampson, 2012; Papastergiou, 2009; Robertson & Miller, 2009; Smith, Majchrzak, Hayes, & Drobisz, 2011; Tao, Cheng, & Sun, 2012; Tüzün, Yılmaz-Soylu, Karakuş, İnal, & Kızılkaya, 2009; Williamson Shaffer, 2006). The games employed in many of these research efforts (e.g., Bottino, Ferlino, Ott, & Tavella, 2007; Ke, 2008; Papastergiou, 2009; Robertson & Miller, 2009) are specially designed educational games including drill-and-practice activities, which target mostly at the acquisition of factual knowledge. Available evidence indicates that appropriately designed game-supported learning activities can be at least as effective as non-gaming approaches with respect to achieving formally described, subject-specific educational objectives. Nevertheless, very few attempts have been made to investigate potential effects of digital games on the development of higher-order cognitive skills, as well as to highlight specific game affordances or learning design factors that can significantly contribute toward this direction.

More specifically, Bottino, Ferlino, Ott, & Tavella (2007) provide evidence, from a long-term experimental study that was conducted in Italy with the participation of primary school students at the ages of 7–10 years old, indicating that active involvement in long-lasting learning activities, fully supported by specially designed educational puzzle games, has the potential to facilitate the development of strategic thinking and reasoning skills, which are directly related to the ability to engage in effective problem-solving. Game features that are reported as important for the development of these skills are feedback provided to players, gradual increase of the level of difficulty, backtracking functionalities (i.e., the capacity of the software application to allow for retracing performed actions in the game), as well as functionalities related to providing tips to users during game play.

Similarly, Williamson Shaffer (2006) conducted a research study based on the use of a specially designed educational digital game (namely, the "Escher's World") and with the participation of 15 American middle school students. Study participants were assigned the role of graphic artists and were asked to produce designs by making use of basic geometry concepts. With the support of provided evidence, the author shows that role-playing educational games (referred to as "epistemic games") can facilitate the mastery of abstract (mathematical) concepts and the development of higher-order cognitive skills, by providing their users with the opportunity to act as professionals within specific domains. Moreover, with the use of specially designed, role-playing educational games, in the context of which performed activities are fully aligned with the intended learning outcomes, there is potential to retain acquired knowledge over longer periods of time.

Nevertheless, apart from the needed alignment between in-game activities and intended learning outcomes, it is also necessary to engage learners in debriefing and reflection activities, as part of any game-based learning approach, so as to ensure that in-game learning experiences will indeed facilitate the acquisition of domain-specific knowledge and/or higher-order cognitive skills. To this end, Ke (2008) describes an experiment that took place with the participation of 15 elementary school students and was based on the use of role-playing educational games that targeted at the development of mathematical skills. Provided evidence indicates that there can be no positive effect with respect to achieving the defined learning objectives if performed activities are not aligned with the game narrative as well as that students are not engaged in debriefing and reflection activities unless they are provided scaffolding and support toward this direction. Thus, it is imperative that students get engaged in the necessary debriefing and reflection activities so as to enhance the learning potential of the employed digital game. The importance of implementing appropriately designed game-based learning activities with the aim to support the development of both subject-specific and general educational objectives is also stressed by Panoutsopoulos and Sampson (2012), who conducted an experimental study with the use of a popular commercial business simulation game (namely, "Sims 2—Open for business") and with the participation of 29 high school students at the age of 14. The authors point out that by involving learners in processes of describing intended actions and anticipated results, as well as justifying experienced outcomes based on provided feedback, there is potential to achieve higher-order cognitive skills aligned with the upper levels of Bloom's taxonomy of educational objectives (namely, "comparing," "explaining," and "critiquing judging") (Anderson & Krathwohl, 2001, pp. 67–68).

Having described a number of issues that emerge from research conducted within the context of primary and secondary education, we continue with the presentation of attempts to utilize digital games in higher education settings. The first of these efforts has taken place in the Manchester Metropolitan University in the UK, where a web-based educational digital game (namely, "Marketplace" (http://marketplace-simulation.com/)) was used as a core part of a marketing course. Participating students had to work in groups with the aim to establish virtual companies and undertake actions related to performing market analysis, devising marketing strategies, as well as designing appropriate products for development. Within a competitive environment that was fostered by the design of the game, groups of students had to "compete against one another for market share and position" (Whitton, 2010, p. 171). Students' performance was assessed through presentations that were held by them, worksheets that included details about decisions, as well as individual assignments conducted after the completion of the game-supported learning activities. The implemented game-based educational approach was evaluated by employing both qualitative and quantitative methods, with students reporting that they were given the opportunity to apply theoretical concepts to a real-life situation as well as that they were able to receive immediate feedback on their performed actions. However, they also reported that provided feedback was limited and that "did not explain exactly why actions had led to certain consequences" (Whitton, 2010, p. 174). In the same university, a similar approach was held with the use of a web-based educational digital game (namely, "The Retail Game" (http://www.retail-game.com/)) that targeted at familiarizing students with decisions that need to be made and actions that need to be undertaken as part of managing a retail outlet store. Students were able to adopt roles, handle data regarding the store's status and market needs, make decisions with respect to their store's management, and finally provide a rationale for each of their decisions. By this way they were given opportunities to develop an "understanding of marketing principles and retail operational issues," as well as to apply communication and interpersonal skills (Whitton, 2010, p. 185).

Another relevant effort that is worth mentioning was conducted in De Montfort University in the UK with the participation of students studying politics and international relations. Within this context, a commercial digital game (namely, "PeaceMaker" (http://www.peacemakergame.com/)) was used with the aim to enable students to investigate "the interplay between ethical concerns and international politics" (Whitton, 2010, p. 174). More specifically, students had the opportunity to become familiar with the Israeli-Palestinian problem by adopting the role of either the Israeli Prime Minister or the Palestinian President. Results of assessment, which was based on presentations and reflection activities, showed that there was potential to "appreciate the complexity of the issues that are faced in the region" (Whitton, 2010, p. 175) with students demonstrating "emotional responses to the game" (Whitton, 2010, p. 177). Furthermore, as made evident by discussions that took place after the implementation of the game-supported learning activities, there was a deeper understanding of the problem at hand, with the students seeming to be able to understand the complexities of the issue and the barriers to finding a final solution.

14.3 Discussion

As made evident from the review of existing literature, the exploitation of digital games within the context of higher education provides unique opportunities for the development of higher-order cognitive skills that are regarded as necessary. As opposed to the stiff school curricula, both the general aims of higher education and the specific educational objectives of provided courses allow for the adoption of game-supported pedagogical innovations that have the potential to present students with the practices of professionals and experts in a range of domains. Thus, in order to take full advantage of the learning affordances that digital games can provide, we need to assess the development of higher-order cognitive skills based on the use of rigorous assessment methods. However, a conclusion that can be drawn from the review of existing research is that in most cases assessment is based on subjective measures rather than objective ones. More specifically, while the achievement of subject-specific educational objectives can be measured with the employment of standardized tests, the degree to which higher-order cognitive skills have been developed is mostly assessed by measuring the perceptions of involved actors (i.e., instructors and students).

Providing evidence with respect to the perceived level of learning can indeed serve as a measure for the effectiveness of game-based educational approaches but in no case as the only one. Apart from that, there are cases in which the assessment of the development of higher-order cognitive skills is based on artifacts (e.g., presentations, written or oral reports, portfolios) that learners produce as part of their involvement in the game-based learning activities. The assessment of these artifacts allows for useful insights into the outcomes of these activities and thus can provide evidence for the learning that has taken place. However, in most research efforts, the assessment of produced artifacts appears to be arbitrary and thus needs to be based on rigorous assessment criteria, fully aligned with the kind of skills that need to be developed.

Another point that has not been adequately addressed within the context of already conducted research, and needs to be stressed, is the use of digital games as tools for assessing the development of higher-order cognitive skills. As mentioned earlier, digital games present their users with authentic and meaningful environments in the context of which there is potential to develop a range of skills. Thus, digital games could not only be used as learning tools that can facilitate the development of a range of necessary skills but also as tools that can facilitate their assessment. However, such an assessment approach needs also to be based on well-defined criteria that can provide us with reliable evidence for the learning effectiveness of digital games and at this moment there is a scarcity of research efforts toward this direction.

14.4 Conclusions and Suggestions for Future Research

Digital games have the potential to be exploited as learning tools that can facilitate both the acquisition of subject-specific knowledge and the development of higher-order cognitive skills. However, there are few research attempts that have targeted at a systematic investigation of the effects of digital games on the development of higher-order cognitive skills and competences. To this end, we need more empirical evidence for the effectiveness of digital games toward this direction. As an example we can refer to entrepreneurship[1], which is according to the Commission of the European Communities (2005, p. 18) one of the key competences for lifelong learning, personal and professional development and fulfillment, as well as social inclusion and active citizenship. Digital games can play a decisive role to its development with existing research efforts (e.g., Fonseca et al., 2012; Lainema & Makkonen, 2003; Williams, 2011) highlighting digital games' potential to facilitate the achievement of learning objectives related to entrepreneurship education, as well as the development of an entrepreneurial culture among young people.

[1]According to the Commission of the European Communities (2005, p. 18), entrepreneurship "*refers to an individual's ability to turn ideas into action. It includes creativity, innovation and risk taking, as well as the ability to plan and manage projects in order to achieve objectives. This supports everyone in day to day life at home and in society […], and is a foundation for more specific skills and knowledge needed by entrepreneurs establishing social or commercial activity*."

Evidence from research efforts that have already been conducted both at the school-based and higher education levels provides some insights into the capacity of digital games to enhance the acquisition of higher-order cognitive skills. However, the lack of rigorous assessment methods makes imperative the need for undertaking research toward this direction. More specifically, it is necessary to develop appropriate assessment frameworks that can be exploited for the purpose of assessing skills developed with the support of digital games. Given that digital games can be used as tools capable of mediating learners' interactions, by embedding specific meanings into their design, their effectiveness can be measured by drawing on performed interactions and their outcomes as evidenced by demonstrated behaviors and articulated by produced artifacts. Furthermore, the use of digital games as tools for assessing the development of skills should also gain momentum within the context of digital game-based learning research. Digital games can provide their users with authentic and meaningful environments that can be successfully exploited for the application of already possessed knowledge and skills and thus for their assessment. By this way, digital games will not be treated as "black boxes" and there will be potential to provide in-context evidence for their learning effectiveness in a variety of learning contexts and domains.

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Chapter 15
Problem Solving Through Video Game Creation

Research, Models, and Implications of Video Game Design

Dana Ruggiero

Abstract This chapter explores changing conceptions of learning brought about by technological changes and opportunities and examines more closely the potential of video game creation as a way to teach problem solving. A general background on video games for education is provided, followed by how video games teach problem solving skills. Problem solving skills are then examined in the context of game design with three empirical studies using three different models discussed. Each study explores how problem solving opportunities are presented, the properties of the models, and implications for game creation as a curricular enhancement. Four design models are analyzed for problem solving considerations and to conclude, implications for game design in education and future directions of problem solving through video game creation are examined.

Keywords Problem solving • Video game design • Learning

15.1 Introduction

In the United States alone there are more than 183 million active gamers (McGonigal, 2011). More than half the population of the United States log onto virtual worlds to plan virtual battles, engage in virtual conversations, save virtual damsels in distress, and wage virtual war against inequalities like famine and poverty. Is spending hours immersed in the virtual world of video games a waste of time? What can video games offer that the real world doesn't and how can we link the two? Video games "fulfill genuine human needs" (McGonigal, 2011, p. 4) and teach, engage, and bring together diverse populations to complete missions that save virtual worlds. We can

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take the immersive power of video games and turn it to solving real world problems that affect millions on a daily basis and the first step on this journey is understanding how problem solving can be taught with video game creation as a twenty-first century curricular model.

This chapter explores changing conceptions of learning brought about by technological changes and opportunities these afford. In this chapter the understanding of video game creation as it relates to learning, specifically problem solving, through critical analysis of current research is discussed in reference to twenty-first century skills. Video games are a powerful learning tool (Bogost, 2007; Gee, 2003) and the learning involved with video game playing and creation using curricular models is examined. Additionally, operational and critical aspects of problem solving, game design models, and tools specifically designed to teach video game creation are critically examined.

Designing and creating video games is a reality for some students in classes looking to relate to the Net generation. One of the most important issues in designing video games is to facilitate reflection and critical thinking while learning, and still create enjoyable games (Prensky, 2001, 2006). In this chapter three cases are discussed in relation to using game design as a teaching tool for problem solving. Moreover, this chapter discusses how different design models teach problem solving through phases of game creation and their relation to twenty-first century curricular models.

15.2 Background

The term "video game" has an elusive and highly contested definition within the field of education. While there are many varieties of video games it is widely recognized that all games have the following characteristics to a certain degree: story; gameplay; sound; interface; and graphics (Robertson, 2011). Given the complexity of these overlapping components, it is easy to see video game design and creation as a rich potential for learning. Learning itself is a complex term to define, and for the purposes of this chapter "learning" encompasses activities that enable people to acquire and apply new knowledge, to adapt to changes and challenges, make choices, and most importantly solve problems to create new learning opportunities. Learning is most commonly gained by experience or instruction.

Video games support learning by providing opportunities for exploring and manipulating virtual objects. Educational technologists such as Jonassen (2000) and Jonassen, Howland, Moore, and Marra (2003) applied these learning theories to the implementation of educational technologies. Jonassen concentrated on the use of technology to support intentional rather than incidental learning. Currently there is little argument that a great deal of incidental learning takes place in video games (this is the presumption behind the fear that video games will make children more violent); it may also be possible to employ the technologies of video games to increase and measure intentional learning in formal learning institutions, as Jonassen employed the incidental learning that occurs when browsing the internet for intentional purposes. There is a breadth of literature on the use of video games in education. Prensky (2001, 2006) demonstrated how video games are being used for training in the corporate and military spheres; moreover, he explained to parents and teachers what students can learn from several genres of video games. Gee (2003, 2007) explored 36 principles of learning that good games embody that many classrooms lack. Furthermore, he discussed ways in which video games could be better for student's academic performance than traditional teaching methods. Aldrich (2005) focused on the benefits of simulations and built a simulation to help players develop leadership. Shaffer (2006) conducted research to help students develop new identities using games and simulations, focusing on professional identities that involved innovative ways of thinking. Moreover, there have also been dissertations dedicated to examining learning in video games. For example, Squire (2004) researched the use of *Civilization III* with high school students, and Steinkuehler (2006a) explored the learning by apprenticeship that happens in massively multiplayer online role-playing games (MMORPGs).

The increasing popularity of video games, combined with the learning potentials of gameplay, has led to educational systems implementing the inclusion of technologies, such as video games into the classroom from elementary to post-grad. Just as we are redefining what it means to learn through video games (Gee, 2003; Steinkuehler, 2006b), we are also redefining what it means to be a gamer, with baby boomers and middle age executives engaged in video games like Sudoku (Cummings & Vandewater, 2007; Morris, 2006). Currently video games can be played on computers, cell phones, PDAs, smart phones, newspapers, schools, adult training courses, iPads, and tablets (Lopez, Harris, Moses, & Williams, 2007; Robinson & McNellis, 2011) Research on media has found that 90 % of US households with children had rented or owned a video game (Cummings & Vandewater, 2007), while other studies have shown that children are not the only demographic interested in games. A 2008 Pew study found that 53 % of Americans age 18 and older play video games and about 1 in 5 (21 %) play everyday or almost everyday, while a 2011 study found that over half of adult cell phone owners have game applications on their devices and 63 % of adults age 18–46 own a game console (Zickhur, 2011).

Video games are an important part of our social climate (Aldrich, 2005; Bogost, 2007; Gee, 2003; Lenhart et al., 2008). From daily interactions on *Facebook* applications to international gaming tournaments involving thousands, video games have become a substantial part of current society. Playing games can impart information and teach skills (Gee, 2003; Jonassen, 2000; Jonassen et al., 2003; Papert & Harel, 1991; Prensky, 2006; Shaffer, 2006; Squire, Barnett, Grant, & Higginbotham, 2004) in the cognitive (e.g., content knowledge) and psychomotor (e.g., hand eye coordination) domain. Moreover, these sometimes simple games, often browser-based and free, are constructed to engage the audience in interactive, digital representations of real world problems. Typically, the impetus behind these games, and the intended outcome of gameplay, is to urge users to learn about, be attentive to, and act responsibly regarding the topic. With over 97 % of US adolescents reporting that they play everyday (Lenhart et al., 2008), video games are a high interest media that allow learners to experience virtual problem solving.

15.3 Video Game Play and Problem Solving

Video game play, design, and creation provide spaces for powerful and meaningful learning through problem solving. In 2010, world-renowned video game academic Jane McGonigal told Technology Entertainment and Design (TED) audiences that, "playing games can change the world" (McGonigal, 2010). She went on to detail that games could bring us together as a civilization, encourage social cultures, and solve worldwide problems. Games have been helping people and animals practice both survival and practical skills for millennia (Huizinga, 1955) and have moved from the purely physical domain to the virtual one in recent years. The advent of affordable home computers as productivity and entertainment systems has led to a boom in the video game industry with more than 183 million Americans playing video games daily (McGonigal, 2011). The affordances for games to help students learn are evident in the claims made by proponents about what games can do for people and in larger terms for society. Simply put, games are idea changers that can manifest psychological and physiological realities (Foster & Mishra, 2009; Mishra & Foster, 2007).

The affordances for games to help students problem solve are evident in the claims made by proponents about what games can do for people and in larger terms for society. An example of this is the *Bronchi the Brachiosaurus* study (Lieberman, 2001) where young children with asthma learned rescue asthma skills on a computer game and were able to retain the skills they had virtually practiced and discuss the implications of knowing those skills. Another example of a problem solving game is EVOKE (2010), developed as a crash-course in changing the world. While no empirical study has been published on the EVOKE movement, it was created by Jane McGonigal (2010) to showcase "the kind of resourceful innovation and creative problem solving that is happening in sub-Saharan Africa to collectively imagine how the lessons from those scenarios can transfer, scale, and ultimately benefit the entire planet" (EVOKE, 2010, para. 2). Changing the world is achieved through virtual teamwork on challenges that range from providing fresh water to creating bank schemas for small business owners. Teams worked together for 9 weeks, creating scalable possibilities with real data. Unlike other games that focus on winning, EVOKE focused its players on the opportunities that they could create using shared knowledge.

Games with clear problem solving goals have explicit content. One example of this is *Sim City*, a computer game in which the player is the creator of a city that they build from the ground up. The player sets the taxes, decides on the type of industry available, develops strategies for city growth, and must consider their approval ratings. By developing their city, players learn to respond to citizen demands with caution, balance the city budget, and deal with emergencies such as fires, job shortages, and educational reform. Another example of a game with specific content in relation to problem solving is *Civilization IV*, a popular video game readily available both online and in stores. Players in this game begin with an undeveloped piece of land that had a small group of settlers. They play the overall leader and have to make decisions about how to build a city, where to scout for resources, and how to develop protectors for the city. The game is linear and players begin in the Stone Age and move to the twenty-first century. As time goes on they have to make decisions that affect the civilization as a whole such as introducing reading, what religion to choose, and use of new tools such as the printing press or medicines. Throughout this process players have a chance to learn not only about the civics of leading a civilization but also the dynamics of economic, political, and legal systems. Engaging in these learning opportunities allows players to practice and develop problem solving skills in a specific context (Robertson, 2011). The nature and design of a good game experience although are not the sole domain of professional game designers, students can engage in game design and learn problem solving skills.

15.4 Problem Solving Opportunities from Video Game Creation

Game design has increasingly been used to engage students in various subject matter learning such as computer science, teacher education, and professional development. There are many claims about the benefits of using games in education including how game design can promote problem solving skills. Given the high interest in video games and the ability to create games aimed at promoting any agenda, plus the availability of game creation software, learners creating their own games to enhance problem solving skills has begun to appear in recent literature on learning design. Recent studies have found that adolescents who learn to develop their own video games learn skills such as problem solving and team work in conjunction with higher order thinking skills like analysis and processing (Hong, Fadjo, Chang, Geist, & Black, 2010; Ormsby, Daniel, & Ormsby, 2011; Robinson & McNellis, 2011). However, participation in game design does not automatically lead to better learning outcomes overall. The educative values of game design can only be realized when it is appropriately developed according to pedagogical goals and characteristics of the learner. Thus, to more effectively use game design as a way to teach problem solving, we need to have a deeper understanding of the key components of effective game-design learning environments as well as the problem solving processes triggered by game design.

15.4.1 Rationale for Change

From a constructivist perspective, there are theoretical reasons for believing that creating video games can be academically beneficial. Kafai (2006) argued that when making games, learners also construct knowledge and their relationship to it.

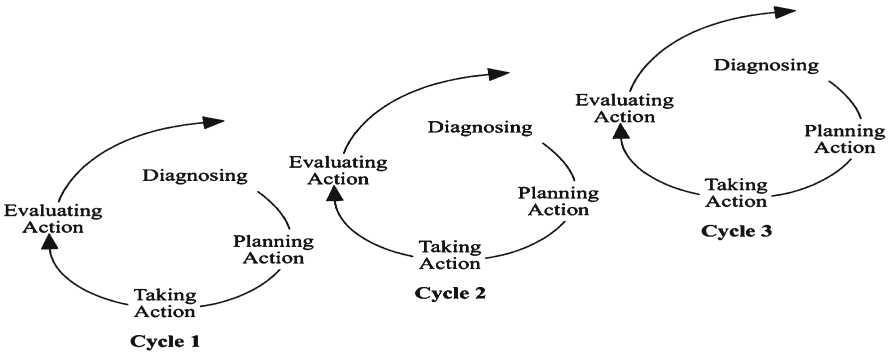
She goes on to describe that the learner is involved in all design decisions and begins to develop technology fluency. The fluency that develops in technology involves not only knowing how to use new technological tools, but also knowing how to make things of significance with those tools. This encourages development of new ways of thinking based on the use of those tools thereby promoting problem solving skills (Good, 2011; Robertson, 2011). As technology has moved to Web 2.0 tools, 3D graphics, and open source, computing opportunities have also arisen to develop problem solving skills and new media literacy through game creation. In the last 25 years, notions of media literacy have developed beyond the written word, moving more toward the visual (Buckingham & Burn, 2007; Jewitt, 2008). Theorists have highlighted the differences between traditional problem solving skill building through potential nonlinear visual, audio, and moving image elements as well as the written word. A major challenge in the use of game design to teach problem solving skills is that compared with other multimodal texts, computer games offer added complexity for both player and designer, including the challenge that the player (and what the designer must accommodate) can travel around the world of text and experience it from more than one visual, spatial, and textual perspective.

The process used by learners to create video games is important because it can assist in understanding variations in the game product and skills needed to make game design a successful part of the curriculum. Game creation is a complex design task. Game creation has the potential for learners to exercise a wide spectrum of skills such as devising game rules, creating characters, visual design, programming, and creating content. It is also authentic because making the game actively engages learners in a "mental workout" where they are faced with a stream of both long- and short-term decisions and must plan problem solving strategies which involve monitoring a series of complex tasks (Robertson, 2011; Robertson & Howells, 2008). Unlike passive learning where the teacher presents information to the students, game creation allows the students to engage in learning by probing, hypothesizing, reprobing, and rethinking (Gee, 2003). Throughout this cycle the learner is engaging in reflection where he or she thinks about the effect their design choices have on the game world, the content, and the underlying rule structure. Recent studies (Good, 2011; Robertsson, 2012; Vos, van der Mejiden, & Denessen, 2010) indicate that creating games is motivating, bolsters esteem, and develops technical programming skills as well as storytelling.

Game creation can be seen as a type of user-generated content, which is created and published by end users rather than media companies. Used in a learning context, these types of activities can empower learners by enabling them to express their creativity and share it with a real audience. However, the activity of game design and creation is more complex than publishing in other media because it involves the creation of an interactive element. Designing digital content that responds to user input through a series of rules requires specification of conditions, sequences of behaviors, and overall consequences. These rules are not always obvious to the novice game designer and require instruction to be implemented correctly. In the following three subsections empirical studies are discussed that analyze learning these rules and problem solving skills through game creation.

15.4.2 Game Design as a Compelling Learning Experience

Qui and Zhao (2009) explored the nature and design of game as a compelling experience. Thirty-six college juniors in the software engineering program participated in a semester-long project to design games for Chinese language learning using design-based research (DBR). The DBR paradigm enabled the researchers to create productive learning conditions and localized principles for others to apply to new settings. The project was designed to help engineering students understand educational and other issues in designing educational games.

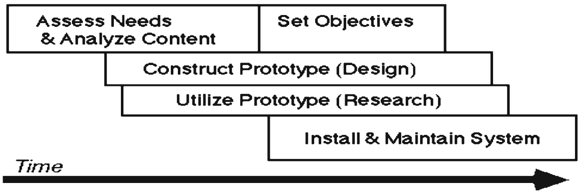


Design-based research paradigm demonstrating the iterative process of action and reflection

Qui and Zhao (2009) show that game design expanded students' perceptive capacity; enhanced their subject matter understanding, problem solving skills, meta-learning ability, and motivation; and facilitated students' reflection on themselves as well as their environments. Factors that affect the success of game design as a way to teach problem solving include authenticity, clear goals, dialogue, collaboration, and formative evaluation. Implications that can be drawn from this research are twofold; there are technological aspects and learning aspects. Technology wise, students mastered the two skills of problem solving and support seeking, as intentionally designed by the instructor. Without much structured help on the technical issues from the instructor, students developed problem solving skills by actively participating in broader social networks, seeking group support, and using internet resources. Learning implications focused on learning new skills as the students worked on the project. Adaptability and problem solving skills were seen in how students learned to identify their skill gaps and build up individualized learning plans to close those gaps. The reflection on their own learning processes led students to rethink their design knowledge, learning, and career preparation in a larger context.

15.4.3 Preservice Computer Teachers as 3D Educational Game Designers

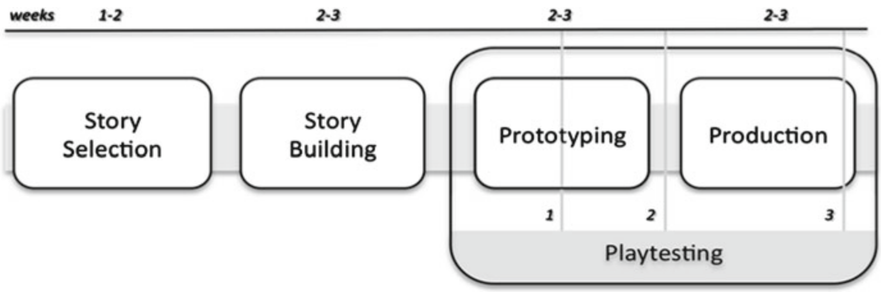
Yildirim and Kilic (2009) explored the prospective computer teachers' perceptions of and experience in goal-based scenario (GBS)-centered 3D educational game development process. Twenty-six preservice computer teachers enrolled in a Design, Development and Evaluation of Educational Software undergraduate course were a part of this case study and they, in groups, developed 3D educational games. The researchers qualitatively evaluated data through evaluation checklists, interviews, and formative tests. The findings indicated that the preservice teachers preferred the GBS-centered games to traditional games. The most important feature of educational games to the preservice teachers was their contribution to motivation, attention, and retention. Difficulties occurred for the preservice teachers in creating realistic scenarios and missions. Students went through design, development, and evaluation processes of effective educational software and used the Rapid Prototyping Model (Tripp & Bichelmeyer, 1990) in the development process. 3D games include clear and realistic goals, immediate feedback, and challenging missions. Designing the game was seen as a lesson in problem solving for the participants. As most of the participants in this study become computer teachers or work as instructional designers after graduating, their learning throughout this process may cause them to be more critical of the games created. Preservice computer teachers were exposed to game creation that may be carried to their future positions and possibly help a new generation of practitioners to recognize the value of game creation as a curricular tool.



Rapid prototyping model used to create the educational games

15.4.4 Game Design as a Model for Professional Development

Halverson, Blakesly, and Figueiredo-Brown (2011) examine how video game design can be structured to facilitate professional learning through a project titled Interactive Case for School Leadership (ICSL). They developed a five-step ICSL design process to structure the learning environment.



ICSL five-step design process

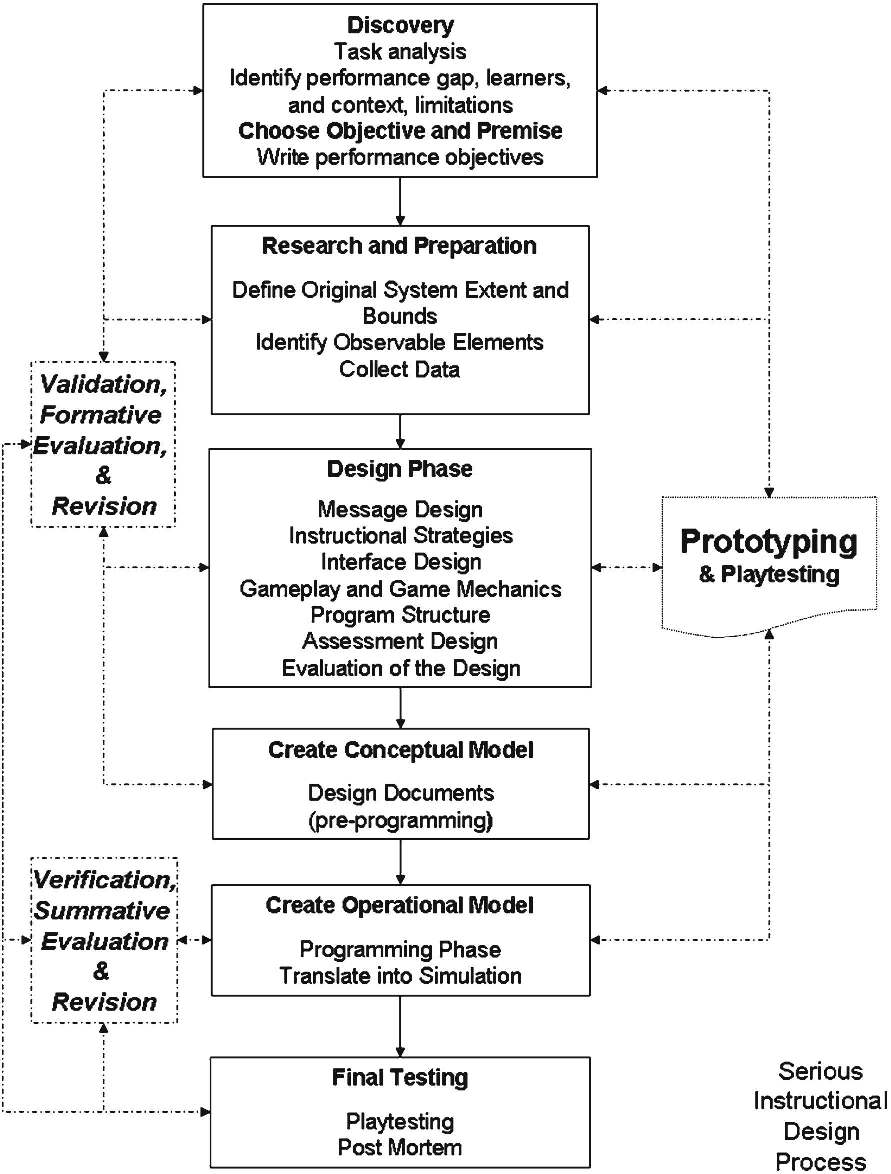
Two graduate level classes in Educational Leadership served as the participants for a study on how to feasibly implement game design as a scalable model for professional learning while using common technologies. Researchers provided templates for organizing student activities, elicited the requisite expertise to develop and test emergent game designs, and regularly assessed student learning using purpose built measures. Students followed a five-step plan (ICSL five-step design process) involving topic selection, narrative development, scripting an interactive narrative, playtesting, and postproduction activities. Students were able to use the ICSL design to integrate theory and practice while producing playable, reusable learning games. Halverson, Blakesly, and Figueiredo-Brown found that students were able to use problem solving skills to complete the game creation process by basing the process of video game design in the wider context of DBR (Barab & Squire, 2004). This study specifically focused on building branching narrative games for professional learning (i.e., interactive virtual fiction games). The researchers faced some problems in engaging students in an educational leadership class in game design and the game creation project. Another problem was that few students had any experience with technology design and so the game design process was confined to using PowerPoint with hyperlinking connections across slides to simulate a branching narrative game environment. Findings indicate that game creation provided opportunities for learners to test theoretical concepts in multiple, plausible, and relevant ways. The ICSL modeled detailed ways to scale back the technical requirements of game creation while still providing students the opportunity to make playable learning experiences. The researchers found that most students thought the game design project challenging but reported high satisfaction and enthusiasm at the end of the semester. Implications for this research are that game design activities have a place in professional development. Game creation enables students to generate and use feedback, develop problem solving skills, and engage throughout the design process.

15.5 Game Design Models with Problem Solving Elements

With the invention of interactive and networked tools for video game creation, the capability now exists for designers of all competencies and ages to create video games. Educational research scholars have linked a range of positive learning outcomes to learner participation in game-making activity across time. These outcomes include increased engagement, motivation, and meaning-making, as well as systems-oriented thinking and computational skills (Robertson (2011) and Robertsson (2012)). However, without frameworks and game design models to lay theoretical and practical background for game creation curricula, these outcomes remain nebulous in the academic world. There are game design models and instructional design models that have increased the technological opportunities for using game creation to teach problem solving. Three models are discussed below that have been proposed as ways to design and create video games.

15.5.1 Serious Instructional Design Process

Becker and Parker (2011) developed the Serious Instructional Design Process as a synergy between the simulation, game, and instructional design processes. Becker and Parker write, “Often, a commercial game design is built up from a single core idea—something (either some activity or some premise) the designer finds amusing or entertaining. Simulations on the other hand are built up to answer a question (or series of questions in a coherent domain), and educational interventions are built up from identified performance gaps” (Becker & Parker, 2011, p. 3). This synergistic compilation between simulation, game, and instructional design models demonstrates key considerations of all three design disciplines that can be uniquely adapted to teaching problem solving through game design. To start the discovery phase is meant to encompass the needs analysis and the choice of the objective. Second, the research and preparation phase focuses on collecting data from other games or simulations and deciding on what is relevant to the instructional goals. The design phase is where the simulation or game is created, maintaining the connection between the overarching goals with the gameplay. In the conceptual model phase the designer is forming the primary delivery method and problem finding and solving for the design process should be complete. The outcome of this phase is the design document for the next two phases. The operational model phase consists of creating a working prototype and playtesting it with users. Given feedback, the designer then revises and completes the final product. A key feature of this model is that validation and evaluation occur at every phase as well as prototyping. When using this model to teach problem solving, an instructor can use this process with simulation, instructional, or game design. If learners are novices in design, there will need to be scaffolding throughout the process in order to ensure success throughout the process.

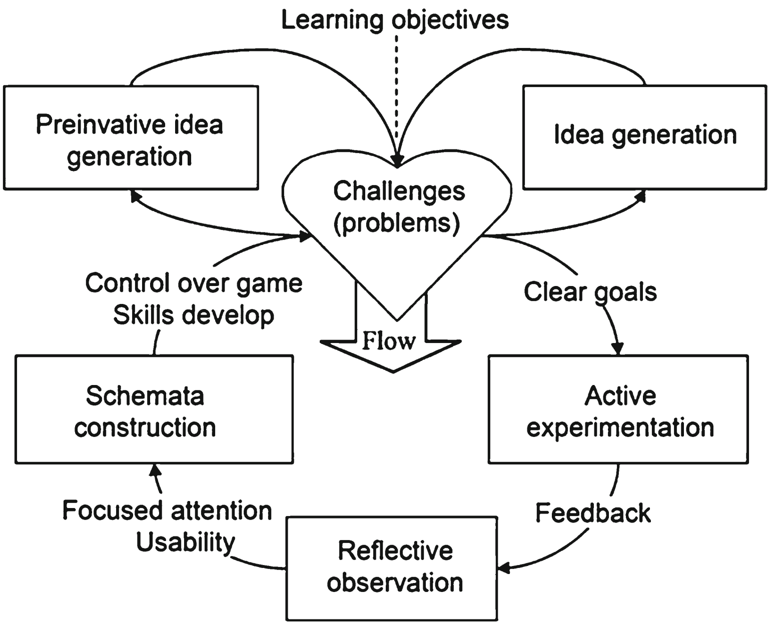


Serious instructional design process featuring game, simulation, and instructional design features

15.5.2 *Experiential Game Design Model*

Killi (2005) designed the Experiential Game Design Model as both constructivist and pragmatist learning, focusing on both cognitive and behavioral learning. This model can be used to design and analyze games with challenge featured as the central problem solving skill. Killi merges game design with educational theory and has also included theories related to motivation in game design. This circular process involves a set of three interconnected loops that focus on the challenges derived from learning objectives driving the game creation process. In order to increase motivation (flow) game designers are directed to have clear goals that lead to active experimentation, and with feedback from playtesting, create a schematic to develop the game.

Unlike the other models discussed herein, the Killi (2005) model does not include phases on the programming or evaluation of the game. Instructors using this game design model for novice game designers should note that this model focuses on the creation of game design documents. These documents are focused on learning objectives rather than the complete process of creating a game from concept to product.



Experiential game design model focusing on both game design and analyzing game features

15.5.3 Video Game Design (Crawford, 1982)

Designing a video game involves more than wrapping instruction in a game, and that game cannot be seen as merely the truck that carries and delivers the instruction. Game design is a highly complex process, and in the model proposed by Chris Crawford in his 1982 book, The Art of Computer Game Design, he outlines seven main phases in the design process:

- Choose a goal and topic
- Research and prepare
- Design
  - Interface
  - Gameplay and mechanics
  - Structure
  - Evaluation of the design
- Preprogramming phase
- Programming phase
- Playtesting phase
- Postmortem

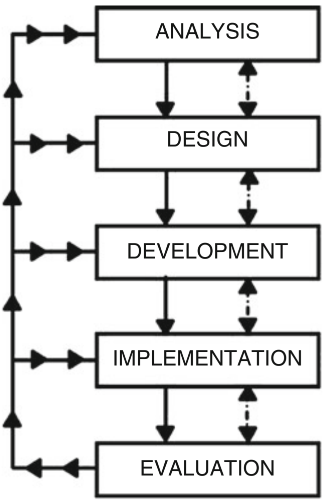
This process focuses on the goal or objective and refers mostly to what the player must do to get to the end and win the game. Learners who use this process to design games will find problem solving opportunities in all seven phases as each is fairly self-structured. After selecting a goal the learner will research and prepare, this refers to both looking for information about the premise and researching other games for comparison. The design phase is broken into four subparts. The interface is what we see on the screen, but it is also what controls the game and the information presented to the player. Mechanics and structure are the mechanisms by which the player achieves the goals of the game and the underlying structure by which all the gameplay is designed around. According to Crawford (1982), all of the above is what is included in the game design document and can be used as the "bible" that will guide the creation of the game itself. Preprogramming phase concentrates on problem finding and problem solving as a part of design evaluation. After the programming is complete, playtesting involves having people play the game and provide the designer with feedback. This helps uncover flaws and misconceptions. After the designer polishes the game, the final phase of the design process is a critical examination of the entire process written up as a postmortem. This game design model is the basis for game design models used in college level classes and focuses on the game as a product. Learners using this game design model require a teacher or peer mentor to navigate this process if they lack prior experience.

15.5.4 ADDIE

In the field of instructional design there exists a general understanding that no one method can work in all situations. Experts who make use of these models often use them as rough guides and practitioners new to the field may use these models as a support system. The well-known ADDIE template often forms the basis for these models and serves as a reasonable base for all. The acronym is popular and well known, and it remains a very popular model in professional training. It has also been used in teaching game design as it uses an iterative process that focuses on problem identification and solving as a part of the instructional design process. The five parts of the ADDIE model are outlined below (Dick, Carey, & Carey, 2001):

- Analysis: defining the desired outcome.
- Design: determining how desired outcomes are to be achieved.
- Development: establishing required systems and acquiring needed resources to achieve desired outcomes.
- Implementation: implementing design and development plans in the real world.
- Evaluation: measuring the effectiveness of the implemented system and using the data to close gaps between the actual and desired gaps.

The ADDIE model can be used as the basis for basic game design in order to teach basic problem solving skills and low level programming. As stated above ADDIE serves as the base model for most instructional design models in existence today. As designers become more proficient, they will be able to use this as a touchstone rather than a roadmap for creation.



The ADDIE model includes five iterative steps that are the basis for most instructional design models

15.6 Conclusion

> Tell me and I forget. Teach me and I remember. Involve me and I learn.
>
> –Benjamin Franklin

This chapter presented a critical analysis of game design as a way to teach problem solving. Video games for learning were discussed and problem solving in video game play analyzed as it relates to the design process. Three distinct cases were examined for problem solving features and the models they used discussed. Each case was explored for implications affecting video game creation in education. Four design models were examined, with phases of each process discussed and analyzed for how learners could use the model to create a game that would also teach the problem solving skills so implicit in game design.

Do the design models reviewed in this chapter involve fundamentally different elements? The answer to this question is no; all the models incorporate some of the same elements, some models include elements that are not common among others, and no model includes elements that are inherently contrary to the theoretical and applicable elements described herein. These models do differ. The vocabulary used to describe the models and elements varies significantly, but a detailed discussion of these differences is beyond the scope of this chapter. These models emphasize different elements that in turn emphasize different principles of game design. Becker and Parker emphasize the interconnectivity of games, simulations, and the instructional design process. Killi stresses the experiential nature of games through both design and play, while Crawford emphasizes the nature of the story in the problem solving process. Finally, the ADDIE model serves as the basis for all of the above models, working as an infrastructure to build more complicated models on.

15.6.1 Issues and Implications

Video games are not going away. Academics, industry, and education professionals are challenged to find new ways to incorporate this engaging and encompassing technology into learning opportunities for students. Not every design experience is necessarily a good one, and one of the most pressing implications of using game design for problem solving in education is that empirical research, including qualitative analysis and feedback from professionals in the field, is needed to evaluate the learning effectiveness and retention that occurs as students learn to design video games.

15.6.2 Future Developments and Directions

Video game creation has shown to encourage a powerful learning environment, a chance for students to produce and engage in the design process rather than simply consume. It can serve as a means to learning more about themselves as problem solvers and game designers and teaches skills that are transferrable to any industry requiring authentic problem finding and solving. Future developments in game design are occurring every year. Free game development software is widely available on the Internet, colleges offer degrees in game creation, and higher education has begun to recognize that the game creation process can teach twenty-first century skills in an engaging and authentic manner.

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Chapter 16
Immersive Simulation: The Replication of Environments to Practice Problem Solving

Jill E. Stefaniak

Abstract Simulation is a form of instruction that has been used in a variety of different industries including clinical training for physicians and nurses, aviation, department of defense, weather, and customer service. Simulations have evolved throughout the decades from role-playing exercises, dramatizations, and task trainers to immersive simulations where exact replicas of real work environments are created for the sole purpose of training. This chapter explores the theoretical instructional design foundations that are helping revolutionize simulation in the fields of aviation and health care.

Keywords Simulation • Immersive learning environments • Complex problem solving

16.1 What Is Immersive Simulation?

Technological innovations are changing the way education is delivered. With instructional media evolving at an exponential pace, instructional designers and educators have a variety of options when deciding what tools are best for delivering their instruction. Media is defined as being the physical means in which instruction is delivered (Reiser, 2007). Since the 1970s, fields including aviation, military, and medicine have turned to immersive simulation as an instructional medium to provide realistic training environments where learners can practice and experience complex situations that are not always suited for on-the-job training. Deliberate practice has been regarded as being a key component to mastering any skill and being able to perform a task to a level of automaticity (Krackov & Pohl, 2011; Rosen, 2008).

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Simulation is an instructional strategy in which elements of the real world are integrated into a replicated environment to be used for instructional practices (Gaba, 2004). Immersive simulation is the recreation or imitation of an environment that the learner is expected to perform in during training. This type of learning involves recreating an environment, including equipment and resources that the learner would typically have if they were performing in the actual environment, and providing the instructor with the opportunity to observe the learner interacting with and managing challenges that may arise.

Simulation in its most primitive form has been used for decades. Anatomical models have been used in health care, along with role-playing dramatizations and games of varying fidelity that have also been used in aviation and homeland security. When referring to simulated learning environments, the phrase *fidelity* often appears. A *high-fidelity* simulation is one that accurately depicts what the real environment is. The equipment will be the exact same, resources will be provided that would also be provided in the real environment, and the same protocols and procedures must be adhered to. Simulations range in fidelity depending on the tasks being trained and the budget constraints associated with recreating a work environment for sole training purposes. This chapter will explore how principles of instructional design are being used in simulated learning environment across several different industries.

16.2 Rationale for Change

Like many fields, aviation and health care are increasing the amount of information that their trainees need to master in shorter amounts of time. With the evolution of technology being able to bridge industries and provide faster conduits for communication, simulation is an instructional medium that can provide a safe environment to promote experiential learning and an opportunity for deliberate practice.

It comes as no surprise to educators and instructional designers that learners must engage in practice if they wish to master new skills. Learning theory informs us that opportunities for practice and feedback are necessary to reinforce and cement new behaviors. Bruner (1960) suggests the implementation of a spiral curriculum in which learners are presented with a topic and it is continually reinforced as they are introduced to similar tasks increasing in level of difficulty. Simulated learning environments provide an opportunity for learners to continuously practice (or rehearse) tasks over and over again in a safe learning environment where they are not imposing any harm to any patients, passengers, or team members and can receive feedback on their performance.

Rote memorization of knowledge can only extend so far with regard to how a learner or trainee performs a complex skill. It is not practical to assume that healthcare professionals, in particular, can memorize every theory, procedure, and piece of knowledge necessary to deliver excellent patient care. While it is important that professionals in the field have a solid foundation of knowledge and can recall necessary information in order to carry out their jobs, it is more important to be able to assess how they are able to apply their foundation of knowledge to solving complex problems within their respective fields.

In terms of professional development and maintenance of skill, many disciplines are turning towards credentialing and certifying bodies to ensure that professionals are performing at an acceptable standard or level of performance. The Accreditation Council for Graduate Medical Education (ACGME), the overseeing body of residency training programs in the United States, has begun implementing simulation in various residency programs such as internal medicine, anesthesia, emergency medicine, and general surgery. Simulated learning environments provide an opportunity to assess professionals and trainees of all levels through a learner-centered, yet standardized, assessment approach. This can provide credentialing bodies with a more accurate predictor of performance compared to a standardized multiple-choice exam. While multiple-choice exams test retention of knowledge, simulation provides the environment to assess application of knowledge and problem solving.

Educators in the healthcare field have embraced simulation as a viable teaching tool and performance measure. With increasing demands on physicians in training, nurses, and allied health professionals, there is an ongoing need for continuing education beyond the traditional educational training that healthcare professionals go through at the undergraduate or graduate degree level. With technology evolving at an exponential rate, the process in which one many have been taught to perform a task or procedure becomes obsolete as new medical devices are implemented within a healthcare system.

Another reason why aviation, healthcare, and homeland security have turned to using simulated training environments is that they can become very intense work environments and require their professionals to be able to manage crises. Rather than waiting for these infrequent events to occur, events can be created within a simulated learning environment so that trainees have an opportunity to experience what it may be like if a particular crisis or disaster were to occur in real life. Different levels of fidelity can be created in a simulated environment where it would be very difficult for a trainee to distinguish between what was real and what was simulated.

While many flights can run smoothly, there are times when pilots must be able to make emergency landings, manage flights where issues arise with dangerous passengers, and deal with failing aircraft equipment. The chances of a pilot having to make an emergency landing in a body of water are minimal, however; it is important that all pilots are trained to follow the appropriate protocol should they find themselves having to make an emergency landing. From a cost standpoint, it is more cost-efficient to train pilots on how to handle these emergency situations in a simulated environment rather than destroying aircraft or equipment to make emergency landings.

Power outrages and fires occurring in an operating room are not common due to the safety measures put in place by hospitals and backup generators that are used during bad weather, but accidents can happen and backup generators can fail. It is important that operating room staff is familiar with the policies and procedures in place to handle situations where the power may shut up or a fire may break out in the middle of a surgery. In order to ensure that the healthcare team understands what everyone's role is and what needs to be done to halt or triage the surgery and transfer the patient to a safe area, simulation can be used to recreate an operating room environment where the power is shut off or equipment fails.

While these things are not common, a passenger on a plane would take comfort in knowing that the pilot has been trained on how to make emergency landings or that their healthcare team is trained on how to ensure their safety should a problem occur within an operating room in the middle of a surgical procedure.

16.3 Theoretical Perspectives Underpinning Changes

The word "problem" is defined by Jonassen (2011) as "a question or issue that is uncertain and so must be examined and solved" (p. 1). Immersive simulations provide a high-fidelity learning environment where the learner is presented with an opportunity to practice and rehearse how they would approach solving ill-structured problems (problems that do not always have one solution) in a real time in situ case study experience. Rather than reviewing a case study and answering questions or brainstorming solutions, the learner is immersed in the case study and is expected to physically and cognitively demonstrate how they would solve the problem presented to them within the simulation.

Simulations are built upon two theoretical foundations in the field of instructional technology: constructivism and conditions-based learning theory.

16.3.1 Constructivism

Constructivist learning theorists purport the following three premises:

1. Learning results from interpretations of experience.
2. Learning is an active experience that occurs in realistic and relevant environments.
3. Learning results from exposure to multiple perspectives.

Referring to these premises and looking at first principles of instructional design, instructors can carefully select instructional media that help the learner apply new material, work in a collaborative learning environment, and engage in active learning. Taking the first above-mentioned premise, *learning results from interpretations of experience*, instructors are able to provide as little or as much support as needed during a simulation depending on the level of skill of the learner.

Simulation allows for the instructor to create a learner-centered instructional environment by responding according to how the learner manages constraints and interacts with others during the simulation. Scenarios can be altered based on the decisions that a learner makes and can provide for a rich learning educational experience where the instructor can debrief the student on how their individual actions impacted the scenario. Exposure to authentic simulated scenarios is an instructional strategy that has the potential to enhance a learner's capabilities of problem solving and reasoning (Levett-Jones, 2011).

For example, in a medical simulation, a human patient simulator's vital signs can be altered based on the treatment provided by the trainee. If a wrong medication is administered during the simulation, the vital signs will portray what an accurate reaction would be if as if it were a real-life scenario. The ability to recreate an environment that is an exact replica of an actual work environment can provide an experience for the learner where they can practice different procedures and solving medical cases with other constraints being edited by the instructor. Constraints that can be controlled by the instructor can include but are not limited to the number of individuals working on a patient case during the simulation, the amount of information provided to the trainee in terms of a patient history, the accuracy of information found within the patient chart, and whether or not confederates are placed within a simulation.

During a simulation, the instructor may choose to place confederates to assist with providing challenges to the trainee. Confederates are actors who are provided with a script or tips on how they should behave or respond to a trainee during a simulation. Confederates, sometimes referred to as standardized patients in a clinical environment, can be beneficial when evaluating a learner's ability to manage individuals while problem solving (Cantrell & Deloney, 2009; van der Vleuten & Swanson, 1990). Some examples of what confederates may be asked to do during a medical simulation include:

- A confederate acting as a nurse during a simulation who will question the medical resident every time they give an order or ask for assistance
- A confederate acting a patient's spouse who tries to hide that the patient has a drug addiction
- A confederate acting as a member of a healthcare team who will purposely make a mistake during the simulation in order to see whether or not the trainee is able to recognize the mistake and fix the situation before any harm can come to a patient

Depending on the skills being assessed during an aircraft simulation, confederates may also be used. Examples of what a confederate's role may be in an aircraft simulation could include:

- A confederate acting as a copilot failing to confirm the necessary callbacks during a simulation prior to takeoff
- A confederate acting as an air traffic controller who does not provide accurate directions or information prior to landing the aircraft

The constructivist framework allows for simulations to be tailored to the trainee's specific needs, allowing them to work on their skill development at their own pace. If it were identified during a needs assessment that a trainee was having

Table 16.1 Jonassen's (1997) steps for solving well-structured and ill-structured problems

Well structured	Ill structured
Review, prerequisite component concepts, rules, and principles	Articulate the problem domain
Present conceptual or causal model of problem domain	Introduce problem constraints
Model problem-solving performance using worked examples	Locate, select, and develop cases for learners
Present practice problems	Support knowledge-base construction
Support the search for solutions	Support argument construction
Reflect on problem state and solution	Assess problem solution

challenges with communicating with fellow team members, simulations could be created that would specifically target improving a trainee's communication skills. This could be done by creating simulation scenarios in which the trainee has to interact with other team members (or confederate team members) and rehearsing the same scenario over the course of several iterations until they are able to communicate with their team member in an acceptable manner.

16.3.2 Conditions-Based Learning

Jonassen's (1997) model for designing problem-solving instruction and van Merrienboer and Kirschner (2007) framework for complex learning lend themselves nicely to the premises constituting conditions-based learning theory.

Jonassen's model for designing problem solving realizes that learners' predispositions, prior knowledge, and characteristics will also have an impact on how a solution to a problem arrived at. Jonassen purports that differences within learners' mediate problem solving. He divides problems into two categories: well structured and ill structured. Well-structured problems are problems that are static and simple. Often times there is one correct answer and a specific approach to arrive at the answer. Ill-structured problems have multiple solutions and a variety of different ways to approach a situation. Table 16.1 distinguishes between the steps used to solve well-structured and ill-structured problems.

Both well-structured and ill-structured problems serve a place in an immersive simulated learning environment. As mentioned earlier in this chapter, depending on the goals of the simulation, the instructors may choose to provide an opportunity for learners to rehearse well-structured problems. This could be achieved by providing the learners with worked examples. If there are particular protocols and procedures that must be followed regardless of the situation at hand, using worked examples to teach the trainee could be a viable instructional strategy.

Worked examples are cases that are used as examples to demonstrate to a learner how a learner should typically arrive at a solution. Using worked examples within a training environment assists the learner with developing schemas so that they can apply the same approach to solving similar problems in the future (Jonassen, 2011). Worked examples provide a scaffolded approach that reinforces principles and rules to be followed when solving problems according to a set protocol. Examples of when worked examples could be used in a simulated environment could include:

- A nursing trainee or physician in training could benefit from the use of worked examples by practicing the appropriate protocol for checking a patient's vital signs in a critical care environment.
- A pilot demonstrating the appropriate protocol for communicating with an air traffic controller when trying to land an airplane.
- A pilot working with their copilot to ensure that the necessary safety checklist has been followed prior to taking off.

The guidelines for solving ill-structured problems are certainly used more frequently in simulated learning environments, particularly in the areas of assessing a trainee's ability to manage a patient's case, coordination of team efforts, and emergency management situations. When training on how to solve ill-structured problems, it is necessary for the trainee to have an opportunity to manage and manipulate constraints. The use of confederate actors during simulations who can impose certain problems onto the trainee can be very beneficial by providing the trainee with an opportunity to troubleshoot using different types of solutions to solve the problem.

Immersive simulation environments promote the principles of complex learning as identified by van Merrienboer and Kirschner (2007). The four-component instructional design model for complex learning categorizes ten steps into four components: (1) learning tasks, (2) supportive information, (3) procedural information, and (4) part-task practice. Table 16.2 demonstrates how the 4C/ID model corresponds with a simulated environment.

When a learner is placed in a simulated environment, it is necessary that the instructor is able to customize the simulated experience to their skill level. Following the tenants of the 4C/ID model, simulations should be constructed in a manner that builds upon the learner's previous experiences and allows them to construct solutions to the problems they are presented with. Novice learners should be introduced to tasks in a simulated learning environment that expand from simple to complex, sequenced in a manner that builds off of one another.

The use of worked examples can be very helpful with the training of novice learners, particularly when there is an opportunity to rehearse and practice repetitive tasks. Research had found that the use of worked examples can be much more beneficial to a novice learner as compared to shown examples (Atkinson, Derry, Renkl, & Wortham, 2000; Sweller & Cooper, 1985; Sweller, van Merrienboer, & Paas, 1998; van Gog, Kester, & Paas, 2011). Worked examples allow the instructor to provide guidance to learners during a simulation and gradually fade away until the learner is performing all tasks independently. Once a learner has mastered the tasks presented in the worked example, they can then be presented with scenarios that contain various challenges that they can practice addressing now that they have demonstrated a certain level of competency.

Table 16.2 Components of 4C/ID model aligned with simulation practices

Components of 4C/ID	Ten steps to complex learning (van Merrienboer & Kirschner, 2007)	Applications in an immersive simulation learning environment
Learning tasks	Design learning tasks	It is important that the trainee is aware of what the goals are for each simulation so that they have a clear understanding before and after the simulation as to what they were being evaluated on
	Sequence task classes	Worked examples may be used to teach a novice trainee how to manage particular situations
	Set performance objectives	Scenarios may be introduced to trainees with a gradual increase in level of difficulty
		Simulations should be aligned with expected level of competencies
Supportive information	Design supportive information	Job aids such as performance checklists to remind the trainee of protocols for emergent situations can be beneficial
	Analyze cognitive strategies	Lists of emergency contacts
	Analyze mental models	Posters may be displayed in both the simulated and actual work environment to remind the trainee of the importance particular standards and practices
Procedural information	Design procedural information	Performance checklists should reflect an accurate progression of the steps to be carried out in the actual work environment
	Analyze cognitive rules	Simulation evaluations should capture the trainee's strengths and weaknesses to performing procedures
	Analyze prerequisite knowledge	
Part-task practice	Design part-task practice	Drill practice
		Regularly scheduled simulation practice sessions. It is of particular importance for novice trainees to have frequent opportunities to practice newly acquired skills so that they can reach an expected level of competence

16.4 Evaluation of Outcomes

From an evaluation standpoint, simulation allows the instructor to standardize problem-solving scenarios while at the same time managing a learner-centered instructional environment. Instructors are able to recreate scenarios multiple times to ensure that each learner has an opportunity to solve the same simulation scenario. Learners can be presented with the same constraints and confederates (actors playing a role within the scenario) during each simulation. Simulation allows for realistic performance-based evaluations rather than mere knowledge retention examinations.

Table 16.3 Team performance observation tool

Team structure	Assembles team
	Establishes leader
	Identifies team goals and vision
	Assigns roles and responsibilities
	Holds team accountable
	Actively shares information
Leadership	Utilizes resources to maximize performance
	Balances workload within the team
	Delegates tasks or assignments as appropriate
	Conducts briefs, huddles, and debriefs
	Empowers team to speak freely and ask questions
Situation monitoring	Includes patient/family in communication
	Cross-monitoring team members
	Applies the STEP process
	Fosters communicate to ensure a shared mental model

Several methods are used to evaluate performance in a simulated learning environment. Referring back to the premise that conditions-based learning theory is built on in that different learning outcomes warrant different instructional strategies, the same premise can be used when selecting evaluative methods for simulations. Different learning outcomes warrant different evaluative methods. Depending on the skill that is being evaluated, common methods that are used to assess performance in a simulation include performance checklists, video analysis, global rating scales, debriefings, and self-reflection.

Performance checklists. Performance checklists are used to determine whether or not a trainee is able to perform all of the necessary tasks involved in a particular procedure or process. Steps of a procedure are broken down similarly to how they would be in a task analysis and the instructor or evaluator will refer to the checklist to make notes as to whether or not the trainee successfully performed the step and when it meets or exceeds expected performance. Performance checklists can be customized to evaluate the unique tasks that are particular to the simulated activity being evaluated (Gorter et al., 2000; Hales, Terblanche, Fowler, & Sibbald, 2007).

This assists the evaluator with being able to identify when a trainee is struggling with a particular step in the process and they can target that area to provide additional training and support. Providing learners with copies of a checklist can also serve as a useful job aid as they are studying and reviewing processes and procedures. The Agency for Healthcare Research and Quality developed a team training curriculum to be used in medical settings to promote team concepts among physicians, nurses, and allied health professionals. Table 16.3 includes a portion of a performance checklist that is used to assess how teams are performing. This checklist is a validated tool that is used when evaluating how teams perform in simulated learning environments (Agency for Healthcare Research and Quality, 2008).

1	Ability to perform cholangiogram	0 Fail (unable to complete even with guidance)	1 Poor (completes but requires guidance)	2 Fair (completes without guidance with fair performance)	3 Good (completes without guidance with good performance)	4 Excellent (completes without guidance with excellent performance)
2	Approach decision Prompt if transcholedochal: "Why did you choose this approach?"	0 Chooses transcholedochal approach without reason	1 Chooses transcholedochal approach due to misjudgment of stone location	2 Chooses transcholedochal approach due to misjudgment of stone size	3 Transcystic approach utilized after delay	4 Transcystic approach utilized without delay
3	Use of adjuncts prior to CBDE First prompt: "What other ways could you get rid of the stone?" Second Prompt: "Anything else you could try?'	0 Requires both prompts but fails to answer either correctly	1 Requires both prompts, but only answers one correctly	2 Requires both prompts but answers correctly	3 Attempts flushing, but requires second prompt	4 Attempts flushing and glucagon administration without prompting
4	Gaining and maintaining wire access	0 Fail (unable to complete even with guidance)	1 Poor (completes but requires guidance)	2 Fair (completes without guidance with fair performance)	3 Good (completes without guidance with good performance)	4 Excellent (completes without guidance with excellent performance)

Fig. 16.1 Example of global rating scale used in an OSATS assessment

Global rating scales. The objective structured assessment of technical skills (OSATS) was initially developed to assess surgical residents through a multiple-stationed examination in a simulated environment (MacRae, Regehr, Leadbetter, & Reznick, 2000). The OSATS consists of evaluating the learner using a performance checklist along with a global rating scale. A global rating score is used to evaluate the learner's overall performance in completing a task or a particular area of a task. Examples of global categories could include communication skills, ability to work with a team, use of personal protection equipment, and overall quality of task completion. Figure 16.1 is an example of a global rating scale that was used to evaluate surgical trainees' abilities to perform a laparoscopic bile duct exploration (Santos, Reif, Soper, Nagle, Rooney, & Hungness, 2012).

The global rating scale is of particular importance when evaluating novice learners. There are many cases in which a novice learner may have successfully complete a task but have failed to complete all of the steps listed in the performance checklist. Perhaps they failed to complete two or three steps but were still able to complete the overall task. Depending on the importance of the task and the degree of effect it may have on the overall procedure, the evaluator may allow for a select few steps to be missed and still be considered a passing grade. Combining the performance checklist along with the global rating scale as used for OSATS allows for the certification of competence among novice trainees.

Video analysis. Immersive simulation environments often have the capabilities and setup to video record a trainee's performance during a simulation. Sometimes we may be inclined to think that we are performing at a high standard until we actually see ourselves in action. Video analysis is a great evaluation tool that the instructor can use to point out a trainee's strengths and weaknesses during a simulation. It also provides objective feedback to the trainee and they can begin to identify areas that need improvement.

Facilitated debriefing. All immersive simulated activities must be accompanied by a facilitated debriefing led by the instructor. While a key advantage to a simulated environment is that instructors are able to replicate real-world environments, sometimes training situations can be very overwhelming for the learner as experiences may begin to feel as though they are real. A facilitated debriefing consists of the instructor reviewing with the trainee after the simulated experience what the goals were of the simulation and the trainee's level of performance. The trainee's strengths and weaknesses should be addressed during the debriefing as well as establishing an action plan to improve performance over time. The use of video analysis can be a very powerful tool during a debriefing in that the instructor and trainee can review the performance and highlight key areas that need to be addressed.

16.5 Conclusion

Immersive simulation promotes a safe learning environment for the learner to practice new skills and make attempts at solving complex problems without causing harm to themselves or others around them. As the field of educational technology continues to evolve into one that embraces technological innovations, it is important that all instructional interventions are grounded to a strong theoretical foundation. This viable instructional strategy promotes a standardized framework for learner-centered training in industries where complex learning and ongoing professional development is a necessity. As job responsibilities and demands continue to grow, particularly in the areas of clinical care, aviation, and defense, simulation is a strategy that can be customized and adapted to the individual needs of a job, unit, or institution to ensure competency of learners while providing a safe learning environment.

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17.1 Introduction

Virtual worlds (VWs), often called ‘multi-user virtual environments’ (MUVEs), are spaces where the most elaborate buildings can take shape within minutes or hours, and models of complex biological systems can be designed with impressive attention to detail. A simulation of a single living cell can be readily crafted with recreations of organelles, chemical messengers swirling around the cytoplasm; and receptors sitting on the cell membrane awaiting the hormones that will switch it off, switch it on or induce apoptosis (cell death). A learner could push her avatar through the cell wall and inspect these processes in real time; maybe alter every parameter to compare how each action alters the cell’s responses. In another part of the virtual world, nursing students could be treating a woman with a haemorrhage after a difficult labour. Should she lie down or be encouraged to sit up? Is it too soon to call for the doctor and how can her anxious husband be calmed down (Honey, Connor, Veltman, Bodily, & Diener, 2012)? Virtual worlds have been utilised successfully for education across the globe in the United States (Dickey, 2010), the UK (Bignell, 2011), Asia (Low et al., 2011) and Australia (Gregory et al., 2010). These case studies have all indicated that the levels of student engagement achieved using virtual worlds can be higher than those experienced in traditional learning environments and students are able to think deeply about and retain the information gained there.

For educators, the potential of virtual worlds is staggering (Stevens, Kruck, Hawkins, & Baker, 2010). The rich diversity of educational contexts afforded by these environments allows for multimodal communication between learners and provides a variety of experiences to accommodate the full range of learning styles (de Freitas, 2008, p. 4). Neil Fleming identified four sorts: (a) visual; (b) auditory; (c) reading/writing and (d) kinesthetic, tactile or exploratory, which when taken together form the acronym VARK (Bonk & Zhang, 2006, p. 250; Fleming & Baume, 2006, p. 6). Those learners born after the mid-1970s are often aware of their preferred style and expect that their learning will be accordingly tailored to it (Bonk & Zhang, 2006, p. 250). Kinesthetic learners are the most challenging to cater for and realistic activities in immersive virtual worlds may help to meet this need. Those tasks that compel learners to move, from time to time requiring considerable exertion, are well-suited to students preferring this style of learning (Begel, Garcia, & Wolfman, 2004, pp. 183–184). In this way physical actions transform into evocative mental symbols which Jean Piaget called ‘sensori-motor learning’ (Piaget, 1999, pp. 37–38). The recognition of the significance of hands-on learning is evidenced by the increasing popularity of lifelike and multifaceted simulations, responsive or adaptive scenarios and dynamic news stories (Bonk & Zhang, 2006, p. 251). There is little doubt that the social nature of virtual worlds signifies a marked progression from those tools commonly in use such as discussion boards. Virtual worlds can enable a broadening of avenues for communication to include those social and cultural customs operating in the real world, and introduce new customs that at this time are unique to the environment (Good, Howland, & Thackray, 2008).

Feasibly the most convincing reason for an educator to use a virtual world environment is to train learners to undertake tasks that are too dangerous, impractical or costly to perform in real life (Adams, Klowden, & Hannaford, 2001). Authentic, carefully crafted simulations deployed in these environments supply safe and inexpensive opportunities for authentic experience that can enable optimal learning. An example that can readily be understood would be learning to fly an aircraft in a flight simulator. Simulator training, when coupled with flying an aircraft, is reported to be significantly more valuable than just training with a helicopter or plane (Hays, Jacobs, Prince, & Salas, 1992). Another pertinent example would be learning complex surgical skills. In medical education, the literature shows that a student learns best when he or she can immediately see the effects of his or her own interventions (Gorman, Meier, & Krummel, 1999). These sorts of scenarios can be recreated in a virtual world at a fraction of the cost of the high-fidelity simulations currently used in medical and nursing programmes. The actual price tag of instructing chief residents in the operating room was projected to have run to around $USD 53 million dollars in the United States nearly 15 years ago. In today's terms, given the increasing sophistication of medical knowledge, equipment and advances in technology, the cost would be many times that figure.

Almost since the very advent of virtual worlds in the 1990s, there has been considerable hype around their purported affordances to facilitate learning in a variety of discipline areas. Though at first glance, VWs look as if they would provide an ideal environment for learning, in reality there are several factors that need be considered in relation to these claims. As social scientist Sherry Turkle cautions, even though new technologies provide opportunities for being and learning, there is a risk that because the virtual is deliberately compelling, we believe that we are achieving more than we actually are. Though learning experiences in virtual worlds can be immersive and engaging, they still may not be authentically educative for the user (Jackson & Laliotic, 2000; Turkle, 1995). As emergent learning environments, it is imperative that virtual worlds and the evolving pedagogies arising within them need to be researched and rigorously evaluated (Pereira, 2010, pp. 95–96).

17.2 The Potential Use of Virtual Worlds in Higher Education

With moves to significantly increase participation in higher education, the student cohort grows ever more diverse as those groups traditionally poorly represented in this arena enrol in a wide variety of courses and programmes (Hadley, 2012). With this diverse cohort comes the demand for increased flexibility in course delivery to accommodate the range of student lifestyles and challenges that have seen an increased pressure on both student and lecturer time (see Ritzema & Harris, 2008, p. 110). Consequently, the profile of the typical student is becoming harder to pin down.

A student may be working in a job full or part time, looking after aged parents, small children or an unwell spouse. The student may not be attending campus for face-to-face classes but may reside many hours from the nearest campus or may elect to study at his or her own convenience in the home, leveraging technology to facilitate learning at a distance. Much is made of the accessibility and flexibility that this mode of learning affords, yet many challenges remain for distance students including altered motivation, a perception of insufficient feedback and tutor or lecturer contact, difficulties accessing support services, isolation from peers and a pervasive feeling of being left alone to navigate the learning journey (Galusha, 2001). Emerging technologies can be leveraged to redress these challenges; virtual worlds in particular show particular promise for helping to overcome the functional isolation of learners from their peers and teachers (VWs) (de Freitas, 2008, p. 31; Garrison, 2000).

With the increasing access and capacity of computer hardware and the seeming ubiquity of high-speed internet, virtual world environments are becoming ever more accessible to educators and students. A lecturer's influence is no longer restricted to the geographical and physical confines of his or her campus, community or even country. And the shape of a curriculum need not be restricted by the physical resources of a single department, school or faculty. To all intents and purposes, if something is able to be imagined, it can be fashioned in a virtual world environment. VWs enable educators to leverage those social connections and learning methodologies to renovate basic approaches to both learning and communication. Historical, generational, professional or gender gaps are rendered obsolete in a virtual space where users cooperate to create knowledge and experiment with identity. Users develop the skills to solve problems by creating and modifying their own content. This endemic culture of participation, suffused with pervasive learning, makes VWs responsive and stimulating environments that facilitate learning (Ondrejka, 2008, p. 229).

But in spite of the obvious potential of VWs to address many of the issues around learning in a changing educational environment, the incorporation of virtual worlds in higher education has been piecemeal and haphazard. The implementation of a learning project using a virtual world environment is usually pioneered by an enthusiastic individual with varying levels of institutional support (Stewart & Davis, 2012). For example, the UQ Religion Bazaar Project in Second Life was the result of a Strategic Teaching and Learning Grant won by the project leader. The project ran from 2007 until 2009 with first-year studies in religion classes at the University of Queensland (Farley, 2011d). During this time, though various enquiries were made to the project leader, no other project was undertaken by University of Queensland staff in a virtual world. The project leader moved to another institution in 2010 and the Second Life island rented by the university was subsequently closed. In another example, the Virtual Birth Centre (VBC) was a project also located within Second Life which was one of two projects funded by the New Zealand Tertiary Education Commission in 2009. The VBC was intended to provide immersive experiences to midwifery students at two New Zealand polytechnics. After 2 years, though the VBC is still open it is no longer used by students.

The project leaders attribute this to a number of causes including lack of strategy for incorporating the VBC into a wider e-learning strategy, failure of senior leadership to embrace the project and a lack of resourcing to ensure continual updating and maintenance of the project build (Stewart & Davis, 2012). These examples are typical of those reported in the literature pertaining to virtual worlds and education. Many higher education institutions fail to maintain their virtual world presence beyond the duration of their typically small scale projects. This tendency was accentuated with the removal of the 50 % educators' discount on the cost of Second Life land rental in 2010 (Farley, 2011c). Many institutions left the environment at this time including the University of Auckland (Young, 2010).

17.3 What Is a Virtual World?

A virtual world (VW) is a three-dimensional virtual environment resembling a physical space that exists on a computer, some external storage device or server and is generally accessed via the internet (Pereira, 2010, p. 94). It allows users to create a virtual self which endures beyond the original session (Maher, 1999, p. 322; Ritzema & Harris, 2008, p. 110). The expression 'virtual world' was first devised in 1990 by Chip Morningstar and F. Randall Farmer (see Castranova, 2001, pp. 4–5; Morningstar & Farmer, 1991, p. 273).

Virtual worlds are inhabited by 'avatars' that are able to move around and interact with objects, the virtual environment and other avatars. An avatar may even have the capacity to interact beyond the confines of the VW if objects are linked to web pages or other external programmes (Tashner, Riedl, & Bronack, 2005, p. 6). This capacity becomes important in certain simulations, particularly if haptic feedback is being used. The word 'avatar' is adopted from Hinduism and used in its mythology to indicate the earthly shape taken on by a deity, usually Vishnu (Leeming, 2001). In VWs, this word signifies a character, manipulated by a distinct user. Some users will have many avatars; these are generally called 'alts' (for alternatives) which are used in different contexts or if a user wants to act anonymously in the environment. The choice of avatar may or may not reflect a player's personality, gender or ethnicity. For example, a learner may decide to take on a wholly different personality which in itself may constitute significant learning, particularly important in role-playing scenarios (Annetta, Klesath, & Holmes, 2008, p. 2). Role-playing is very common in virtual worlds as it is in Massively Multi-player Online Role-Playing Games (MMORPGs) such as World of Warcraft or Diablo III. Also, avatars can communicate with other avatars via voice (usually mediated via VOIP or Voice Over Internet Protocol) or via text typed into a chat window. Alternatively, communication can be asynchronous usually via podcasts or notecards (short text documents). An avatar can communicate directly with another using instant or direct messaging and in this way conversations can be private. Though there are many similarities between VWs and MMORPGs, what distinguishes the latter is the presence of an overarching narrative theme or plot-driven storyline (Jennings & Collins, 2008,

p. 181; Warburton, 2009, p. 416). Though these can be built into a virtual world by a single user or group of users, a narrative is not a necessary condition of its existence or functioning.

In line with other technologies, VWs have matured rapidly in response to user demand, developments in social networking applications and with improved performance of computing hardware. Other factors have also driven these changes including the emergence of new applications, a changing economic environment and an increased familiarity with comparable virtual environments such as those encountered in MMORPGs such as Star Wars: The Old Republic or RuneScape (Farley, 2011b).

17.3.1 Second Life

Most research about education in virtual worlds focuses on the use of Second Life (Pereira, 2010; Warburton, 2009, p. 417). Second Life has been in the public perception since 2003 when it was publicly released by the San Francisco-based Linden Lab. CEO Philip Rosedale was inspired by the Neal Stephenson's 1992 cyberpunk novel Snow Crash which prominently featured a persistent, ubiquitous metaverse where users could 'digitise everything', socialise, conduct business and collaborate in an environment that would be populated and crafted by those using it (Hendaoui, Limayem, & Thompson, 2008, p. 88; Jennings & Collins, 2008, p. 181). Second Life is the most mature and undoubtedly the most familiar VW because of the concentrated media it has attracted, but many others exist such as Jibe, OpenSim, Active Worlds, Kitely, IMVU, Twinity and Blue Mars.

17.4 Learning in Virtual Worlds

There is an increasing body of research directed towards learning in virtual worlds (de Freitas, 2008). Though virtual worlds are places where anything can be built or designed and experienced, the sad reality is that most educators using virtual worlds use the environment in much the same way that they use physical spaces (Salmon, 2009, p. 529). Second Life is littered with lecture theatres, classrooms and auditoriums with roofs in an environment where it does not rain and there is no wind. Lecturers often stand at the front of the group of avatars representing their class, showing a PowerPoint on a simulated screen and asking their students to raise a virtual hand in response to a question. Students sit on rows of evenly spaced seats, facing the front. For example, Cliburn and Gross (2009) describe a virtual lecture course for Human-Computer Interface (HCI) Design students. The Second Life classroom resembles its real-life counterpart, and the lecturer stands out the front, talking to his PowerPoint presentation. Learning in virtual worlds is frequently didactic and this is a frequent criticism of education in virtual world environments. Educators considering using virtual worlds in their teaching will need to rethink their teaching strategies to leverage the affordances of these unique environments. The environment can support constructivist pedagogies whereby learners are responsible for their own learning, linking old knowledge and skills to those newly acquired. For example, simulation and gaming are very effective strategies, provided they offer a high degree of interactivity. Studies around this topic have revealed that the entire brain is active when learners are playing games. By way of contrast, learners involved in formal, didactic contexts show limited brain activity (de Freitas, 2008, p. 9). Gamified design facilitates user immersion and hence presence; creating the conditions necessary to engender the optimal learning state of flow (Farley, 2011b). The following sections look at some types of learning that can leverage the affordances of virtual worlds for learning.

17.4.1 Authentic Learning in Virtual Worlds

With the emergence of virtual worlds for learning, educators touted the arrival of a computer-based environment that could enable authentic learning in a cost-effective and safe way. It was widely believed that participation in learning activities in these spaces could shrink reaction times, enhance hand–eye coordination and improve learners' self-esteem (Pearson & Baily, 2007, p. 1). In certain disciplines, the affordances of 3D virtual environments are self-evident. Burgeoning architects could walk around a building of their own design and business students could create, market and sell virtual goods in a real-life marketplace (Griffiths & de Freitas, 2007, p. 75; Salmon, 2009, p. 529). Authentic learning in virtual world environments would enable the learner to assimilate the skills and beliefs about a particular discipline or profession by placing the learner in an environment resembling that of the professional (McClean, Saini-Eidukat, Schwert, Slator, & White, 2001). This form of learning characteristically is focused on real-life problems and their resolution via role-plays, problem-based tasks, case studies or through involvement in online communities of practice.

Authentic learning promotes activities in which learners encounter those contexts and challenges they will face in their 'real-world' work or study rather than abstracted knowledge such as with scientific theory (Pimental, 1999). In addition, Duffy and Jonassen (1991) proposed that students should use tools to complete activities which are sufficiently similar to those found in their future professional fields. This sort of attention detail can be to some extent replicated in a virtual world such as Second Life. For example, fully equipped virtual laboratories can enable students to ponder and solve the tricky questions about genetics through applying appropriate tests to selected genetic materials and then allowing them to see the consequences of their testing immediately (see Rudman & Lavelle, 2011). Admittedly, these simulated tests will not be exactly the same as their real-world counterparts, but they will enable students to learn about procedural matters such as remembering to wear a lab coat before entering the laboratory or choose the correct order for a series of tests on a particular sample. The recreation of situations which let learners practice the competencies required by the professional environments in which they will eventually be working is of paramount importance (Rosenbaum, Klopfer, & Perry, 2007; Savery & Duffy, 1995). In this way, learners will progress from novices to experts with the ability to innovate, create and gain those other skills needed for jobs of the future (Mishra & Foster, 2007; Roussos, 1997).

17.4.1.1 Authentic Learning Using Simulation in Virtual Worlds

Relatively low-cost, carefully designed simulations in virtual world environments can facilitate authentic learning by reproducing the splendid complexity of real-world systems. In these spaces, learners can experiment by selectively altering simulation parameters or by taking a role inside the system and noticing how the outcomes vary (Rosenbaum et al., 2007). Learners are an intrinsic part of the constructed environment: each is more than a mere observer; instead they are actively participating, challenging and testing the parameters of the setting. The tasks the learners complete are authentic, emerging from spontaneous interactions within the simulated environment, rather than from predictable embedded prompts. Tasks that are genuinely authentic will be too challenging for a learner to complete by his or herself, but will be able to be tackled with support from tutors or peers, modelling suitable strategies (Jones & Bronack, 2007, p. 96). Well-planned simulations deployed in virtual world environments can supply authentic, safe and cost-efficient simulations that can promote optimal learning (Cram, Hedberg, Gosper, & Dick, 2011; Mason, 2007). Simulations are effective because mirror neurons are activated when an individual acts but also when that individual witnesses the action being performed by another. In other words, the individual's neuron mirrors the performance of the other as if he or she were the one performing the action. This may explain why visually rich simulations are such potent tools for learning (Ramachandran, 2000). Consequently, the forceful nature of learning from doing as well as learning with others is exploited in simulation (de Freitas, 2008, pp. 9–10).

To be successful in these situations, the learner is required to function at a higher cognitive level than is generally associated with the recognition and recall associated with traditional didactic methods. Instead, the learner needs to immerse in the setting and leverage both novel knowledge and already acquired skills to meet the presented challenges. Instruction that exploits the techniques of simulation is likely to capture the learner's attention for significant lengths of time (Rude-Parkins, Miller, Ferguson, & Bauer, 2005), facilitating the emergence of presence, and subsequently flow. In addition, by making the experience directly relevant, learners gain an emotional stake in the content, inducing their brains to release those neurotransmitters that are necessary for memory formation (Aldrich, 2009, p. 6).

17.4.1.2 Difficulties with Authentic Learning in Virtual Worlds

Even though the potential of virtual worlds to act as venues for authentic learning seems considerable, authentic learning conditions can be very difficult to recreate (Griffin, 1995). More recently, a number of authors, while acknowledging the claims made around the potential efficacy as Second Life as a venue for education and more specifically authentic learning, also point to the lack of empirical evidence to support those claims (Good et al., 2008; Mahon, Bryant, Brown, & Miran, 2010; Vrellis, Papachristos, Natsis, & Mikropoulos, 2010).

The difficulty with this sort of learning in virtual worlds is in making it sufficiently 'messy'. Authentic learning opportunities involve ill-defined problems together with real-life context (Kluge & Riley, 2008). Recreations of professional and disciplinary contexts may be missing those subtle cues that would lend them authenticity; moving beyond the simple visual recreation of a hospital ward or a lawyer's office. Barton, McKellar, and Maharg (2007) concur, maintaining that any effort to comprehensively replicate reality in virtual worlds can only fail. The real world is far too complex, random, uncertain and immediate and cannot be simply reconstructed. In reality, the necessary clues to solve a problem are rarely laid out and signposted as such yet in virtual world scenarios this is frequently the case. For example, an artificial intelligence agent or 'bot' (for robot) can only respond in fairly constrained ways to a nursing student taking a clinical history in a virtual world ward. All of the students' questions and the bot's responses must be anticipated, planned for and scripted. A bot would be unable to respond if asked a question that it was not programmed to answer. If the student questions fall outside those the bot recognises, it will generally ask for the question to be rephrased (Amundsen, 2011). In this virtual world context, the range of potential responses of the bot is limited by the way it is programmed. In a real ward, a person been questioned in this way would most likely have some sort of answer to any question, however inappropriate it may be.

In this domain, the difference concerning those problems that are well-structured and those that are ill-structured becomes important. Usually, in virtual worlds the former predominate and these sorts of problems have absolutely correct and knowable solutions (Cram et al., 2011; Kitchener, 1983). Unfortunately, there is little evidence that the ability to solve well-structured problems leads to the emergence of expertise in the learner (Schraw, Dunkle, & Bendixen, 1995). Consequently, those problems that are most useful for authentic learning in virtual worlds are those ill-defined problems having conflicting suppositions, dubious evidence and differing opinions that may lead a learner to a number of different solutions (Kitchener, 1983). In other words, to teach learners how to solve ill-defined problems they need to be engaged in solving complex problems that require both deductive and inductive reasoning (Reeves & Reeves, 2008). Though these problems can be mitigated in virtual worlds, it requires very careful planning which may prove to be too time- and resource-intensive to make it feasible. However, if the time is spent, the environment can be augmented and adapted over time, and reused in different contexts and with different cohorts. The potential for adaptation and reuse may make authentic learning in virtual worlds an economically feasible exercise.

17.4.2 Gamification in Virtual Worlds

Gamification has been found by educators and learning designers to greatly improve student motivation and engagement (Lee & Hammer, 2011; Pereira, 2010, p. 95). Gamification is defined as the incorporation of game elements into those settings that are not generally recognised as being game-like. Gamification can potentially engross and challenge the learner in a very direct and personal way. As previously mentioned, the learner must work at a higher cognitive level than the recognition and recall associated with traditional didactic methods if he or she is to succeed in these settings (Rude-Parkins et al., 2005). The learners must immerse in the situation and apply novel knowledge as well as skills learned previously to successfully meet the challenges set before them.

Central to the idea of gaming and simulation is the concept of 'interactivity', which is described as 'the extent to which users can participate in modifying the form and content of a mediated environment in real time' (Steuer, 1992, p. 84). The act of directly manipulating a virtual object produces clearer mental images and greatly improves information processing in comparison to information acquired passively, irrespective of the user's goal. Interactivity in learning contexts is considered to be an essential and fundamental process for the acquisition of knowledge and the attainment of cognitive and physical skills (Barker, 1990).

There are a number of gaming elements that can be incorporated into virtual worlds. The non-linear progression of goals enables learners to choose their own way through the environment, following their own inclinations and interests. It can be time-consuming to build in these sorts of choices but it might be as simple as allowing students to begin their journey through an activity at any point such that they will work their way through all loci before the end of the session. Another element adapted form gaming is what is called the 'flow channel' which is when challenges become increasingly difficult leading up to a major battle. The equivalent for learning would be the gradual ramping up of the difficulty of tasks leading to an assessment. In contrast to gaming, however, learners must be given the opportunity to consolidate their skills before taking the assessment (Raymer, 2011). The maximum learning is leveraged from gaming in virtual environments when it is combined with frequent feedback. This can readily be programmed into the environment such that when a task is successfully completed, there is some form of acknowledgement automatically generated by the game. This might take the form of a bot praising the learner or the gifting of a 'reward' such as some prized object or new outfit together with the appropriate notification (Raymer, 2011).

By incorporating interactive games in learning activities, educators are able to keep students engaged with potentially difficult tasks and supply many possible ways to secure success, enabling learners to select sub-goals within a larger task (Lee & Hammer, 2011). These techniques provide learners with distinct, actionable activities and proximate reward as opposed to nebulous, long-term benefits that can be difficult to envisage. Well-designed games frequently reward the solution of a difficult problem with an even more difficult problem (Gee, 2008). When the development of a new identity is a playful activity and is appropriately rewarded, learners begin to view their potential learning differently and contemplate what that learning might mean for them (Raymer, 2011). As a result, combining immersion in realistic 3D environments with gamification has the potential to provide an optimal learning environment that enables learners to maximise the acquisition of skills and knowledge and transform student perspectives on learning (Lee & Hammer, 2011).

17.4.3 The Creation of a Community of Learners in a Virtual World

In order to facilitate engagement with a programme, course or activity in a virtual world environment, it is necessary to generate immersion. Immersion has been defined as the 'the subjective impression that one is participating in a comprehensive, realistic experience' (Dede, 2009, p. 66), and is seen as a necessary condition for 'presence', the emergent psychological sense of actually being present in the virtual environment (Franceschi, Lee, & Hinds, 2008, p. 5). 'Social presence' is further defined as to the extent to which a learner's 'true self is projected and perceived in an online course' (McKerlich, Anderson, Riis, & Eastman, 2011, p. 324).

For an increasingly mobile cohort studying flexibly, one of the main complaints is that they feel isolated from their lecturers and peers in traditional online settings mediated through an institutional learning management system (LMS) or virtual classroom application. Given the ability of virtual worlds to facilitate synchronous communication through colocation in a virtual space, it should be possible for carefully designed activities to be able to alleviate these feelings of isolation by allowing both learners and teachers to meet in real time to form a learning community. This sort of meeting would engender 'social presence' in users, the ability to project themselves emotionally and socially (Pereira, 2010, p. 94). If other people in that environment recognise one's presence, it proffers affirmation that one actually does 'exist' in that virtual world environment. Social presence arises in response to communicating with others in any of a variety of ways. These may include using voice or text chat, using gestures, or by otherwise interacting with those in the environment (Sadowski & Stanney, 2002, p. 795).

Allowing for the substantial demands on the time of both learners and lecturers, and acknowledging that often not all participants will share a single time zone, synchronous meetings in a virtual world can be challenging to arrange. Though given the dangers of social isolation in distance learning, some effort should be made towards scheduling some synchronous activities even though asynchronous activities are easier to arrange. In addition, learners that have met in the physical world will become socially present sooner as compared to those who have not had that opportunity to do so and therefore, if possible, physical introductions should be made. Educators should be aware of the potential issues arising when some learners have met while others have not. This situation may lead to the formation of a clique which may be difficult for a remote learner to penetrate. Last, the use of voice chat can further heighten social presence. One way to minimise voice chat issues is by planning 'voice tutorials' whereby learners test their internet connection, hardware and mastery of the software before they engage in learning activities (Farley, 2011b).

There are a number of ways that social presence can be leveraged in virtual worlds. VW environments can act as meeting places for students that are geographically dispersed. They can also act as spaces where different cohorts can meet, for example, off-campus and on-campus students can come together to talk about a common course or programme. Guest lecturers or speakers that are in another place can meet with a class in-world and the prime example of this would be the in-world conference. The Encke Virtual University Collaboration is an example of a virtual world conference that engendered high levels of social presence, enabled by the fact that many of the participants had met each other at other real-world conferences (see Farley, 2011a).

17.4.3.1 Conferences in Virtual Worlds

Instead of delegates travelling across the world, they can sit at their desk and participate in conferences in the virtual world. VWs provide an inexpensive platform for communication and collaboration among geographically dispersed participants. In 2008, Imperial College London and Nature Publishing Group hosted a conference in Second Life with the aim of reducing the carbon footprint associated with international conferences and the travel they engender for delegates (Wadley, 2011, p. 5). In 2011, this concept was taken even further with the Encke Virtual University Collaboration which was hosted jointly by the Australian Digital Futures Institute at the University of Southern Queensland and Southern Cross University which was attended by postgraduate students researching virtual worlds, lecturers teaching or wanting to teach in virtual worlds and other curious onlookers. The collaboration began with a traditional 2-day conference with presenters from around the globe. This was followed by a series of meetings between delegates with similar interests with a view to working together on a number of projects coming from discussions around the conference sessions. These meetings were followed by a series of workshops and social events over a number of months. This kind of extended engagement with a cohort of conference attendees would not be normally possible in traditional conference settings. With the convenience of virtual worlds, this becomes feasible allowing for extended collaboration long after an event has finished (Farley, 2011a). Delegates were from a range of countries including the United States, Japan, Hong Kong, New Zealand and Australia and though they didn't share a physical space or even a time zone, they were able to meet, communicate and collaborate in a way not possible in the physical world.

17.4.3.2 Role-Playing

Role-playing is another way of leveraging the social presence that a virtual world environment can engender. An avatar can change his or her entire appearance just by dragging a folder across the screen. Gender can change, as can height, age, outfit, culture, occupation or religion (Ducheneaut, Yee, Nickell, & Moore, 2006, p. 294; Wadley, 2011, p. 114). This makes virtual worlds an optimal venue for role-playing. Real-world spaces can be simulated to enable recreations of scenarios in a secure environment (de Freitas, 2008, p. 5). This was the rationale behind the UQ Religion Bazaar project. This Second Life island, owned by the University of Queensland, boasted a number of religious buildings including a Zen Buddhist temple, a mosque, a church, a Hindu temple dedicated to Krishna, an Orthodox synagogue and a pagan grove. In teams of about five, students would role-play parts of religious rituals and then explain to the rest of the class the significance of what they were doing. The avatars of the students would wear appropriate attire that was made available to them and use the appropriate artefacts or implements. In this way students experimented with identity and religion, challenging their own preconceptions and beliefs (Farley, 2011d). Learners could adopt a particular perspective by being someone with that view of the world. This shifting of perspective enables empathetic understanding through contextual experience (Chen, 2009, p. 49). This role-play activity replaced a requirement for learners to go to real-life religious spaces to observe rituals. The new virtual world activity was much more time- and cost-effective and removed the ethical dilemmas surrounding observing practitioners during worship. Most importantly, students reported that the activity gave them a very personal insight into a particular religion and encouraged them to reflect upon it from an entirely different perspective (Farley, 2011d).

17.4.4 Some Further Examples of Learning in Virtual Worlds

Learning and instruction in virtual worlds encompasses a wide range of professions, disciplines and associated activities. A quick survey of the literature around education in virtual worlds reveals examples of firefighting and evacuation training (Buono, Cortese, Lionetti, Minoia, & Simeone, 2008), commerce education (Schiller, 2009), community nursing (Schmidt & Stewart, 2010) and the acquisition of preclinical skills for dental students (Phillips & Berge, 2009) all happening in Second Life. Some disciplines such as psychological counselling are heavily reliant upon developing effective verbal communication skills. The contexts in which these skills can be developed can be crafted with careful planning in a virtual world environment. Yet other skills require the acquisition of practical, physical skills such as with veterinary surgery, elite sports, dance or plastic pipe laying for road construction. The user interfaces which would make the acquisition of these skills possible by enabling tactical precision are yet to be made commercially available (Farley & Steel, 2009). Even so aspects of these professions could be taught in a virtual environment. These would include correct process, communication or client relations. Given the diversity of skills that need to be acquired across all disciplines, it is not possible to say with any degree of confidence that virtual worlds provide suitable environments for learning across all disciplines or for all activities.

Some discipline areas are especially suitable to using virtual worlds for authentic learning. The immersive quality of VWs engenders a compelling feeling of ‘being there’, which allows for more authentic and realistic social communication for language students (Pereira, 2010, p. 94). For example, a virtual world may offer support for learning English in the case of non-English speakers or for languages other than English. In many virtual worlds, there are communities where English is rarely used. Plaza Lingua was a virtual world designed specifically for language learners.

Unfortunately, it did not persist and the name is now associated with an iPhone app. Second Life has its own areas predominantly populated by native speakers of a variety of languages—and many groups exist in world which take advantage of this opportunity for authentic language learning (Cooke-Plagwitz, 2008). Many of these language-based sims offer contextually rich environments reflective of various cultures and countries. These virtual spaces hold many possibilities for authentic communication between language learners and native speakers of a target language (Dickey, 1999). In Second Life, residents of virtual Paris and virtual Morocco primarily speak French and native Italian speakers wander through the streets of a virtual Milan, pausing outside the famous Duomo. Where once it was necessary to physically travel to France or Italy in order to fully immerse to learn a language; now it is possible to learn from the desktop in the comfort of the home or office.

Asking someone for directions in Second Life is a real act of communication. The spatial environment is such that the act of communication becomes real. By way of contrast, in the classroom a learner merely pretends to be lost and then pretends to follow the directions once they are offered (Deutschmann & Panichi, 2009; Jauregi, Canto, de Graaff, & Koenraad, 2011). There is no opportunity to learn through genuine misunderstanding as the learner is not required to follow those directions in any verifiable way. Users can interact using a diversity of norms and can leverage the occasion to experience real-life social interaction which at the same time constitutes a meaningful learning activity (Thorne, 2008). Communication exchanges in a virtual world are often contextual and can be every bit as unpredictable as real communication (Jauregi et al., 2011). Howard Vickers who runs the online language school, Avatar English, has used this capacity for contextual communication with his students. He has adapted Bernie Dodge's original WebQuest model (Dodge, 2007) to the virtual world environment with his SurReal Quest (Vickers, 2007). By exploiting the communicative features specific to Second Life, Vickers sends his students on information quests throughout Second Life which require them to interact with native speakers of the target language, coupled with the pursuit of traditional internet research. Students are ultimately required to present their information in an audio or video podcast. This combination of web-based research and virtual social interaction allows learners to practice their language skills in a pedagogically significant manner (Vickers, 2007). This authentic aspect of communication in Second Life is recognised as one of the greatest benefits of using it for language education (Deutschmann & Panichi, 2009, p. 38).

Even though the potential for language learning in virtual worlds is promising, educators must remain aware of the fact that many non-verbal cues will be missing from interactions in these environments. Fine control of avatar movements and facial expressions is not yet possible. Though it is becoming progressively easier to move through and communicate both verbally and non-verbally in a virtual world as the client-side software is developed, many cues are missing including facial expressions, subtle body movements and those culture-specific hand gestures that may accompany speech. Potentially, the variables needed for effective language learning could be lost (Jackson & Laliotic, 2000). Some of these issues will ultimately be overcome with the incorporation of motion capture technologies such as the

Microsoft Kinect. Avatar Kinect is a multiplayer online game accessible via the Xbox 360 with the Microsoft Kinect sensor. The motion capture capabilities of the sensor enable the facial expressions and gestures of the users to be captured. Currently, a limited number of environments are available via Avatar Kinect but it is conceivable that the Kinect technology could be adapted for use in other virtual environments such as Second Life. This seems especially likely given that a version of the Kinect sensor with the capability of integrating with a desktop or laptop PC was released in February 2012 (Eisler, 2012).

17.5 Limitations of Virtual Worlds for Learning

Though it has been recognised since the very first appearance of virtual world technologies that they hold enormous potential for education, there are still considerable challenges in using them for some contexts and for some sorts of learning.

17.5.1 The Types of Disciplinary Skills Suitable for Virtual World Instruction

Some skills are very difficult to acquire in a virtual world. For example, it will be very difficult to learn physical or practical skills such as surgical incision without an appropriate user interface. In Second Life, there are many recreations of hospitals including operating theatres (see Patel et al., 2012). The instruments are laid out apparently ready for use. What these environments generally lack are natural user interfaces so that the actions of the user resemble those of his or her avatar. This degree of precision in movement would be necessary to enable the acquisition of surgical skills. It would also be very difficult to teach surgery without replicating the feel of a scalpel meeting flesh via haptic means, which remains very prohibitively expensive and technically difficult (Farley & Steel, 2009; Hayward, Astley, Cruz-Hernandez, Grant, & Robles-De-La-Torre, 2004; Luursema, Verwey, Kommers, & Annema, 2006). Haptic or tactile cues supply data about weight, surface structure, size, flexibility and shape (Luursema, Verwey, Kommers, & Annema, 2008). Even though there are considerable difficulties in bringing this degree of realism to a virtual world, there are examples of it being done successfully in single-user virtual reality environments (see Schreuder, Oei, Maas, Borleffs, & Schijven, 2011). The teaching of Minimally Invasive Surgery (MIS) is particularly fitting for this style of instruction, and though these simulations are not taking place in virtual worlds, it is not difficult to imagine that this will be the case in the near future. A number of projects are already exploring the potential of haptic feedback in these environments (Warburton, 2009). Virtual worlds can act as authentic environments for problem-solving but not necessarily authentic for developing practical skills (McClean et al., 2001).

17.5.2 Compromised Immersion

In order to promote student engagement with a programme, course or activity in a virtual environment, it is necessary to generate immersion. As discussed, immersion is as a necessary condition for 'presence', the psychological sense of actually being in the virtual environment (Franceschi et al., 2008, p. 5). Engagement generally refers to the focus of a user's attention on the task at hand. A virtual world environment that engenders sensory immersion will yield a greater experience of presence (Witmer & Singer, 1998, p. 228). Various technologies facilitate sensory immersion, thereby locating the experience in three-dimensional space. These technologies may provide visual stimulation. More complex virtual world environments also supply stereoscopic sound and haptic or tactile feedback, feeding back vibrations and forces to the learner (Dede, 2009, p. 66). It has been demonstrated that a greater sense of presence is engendered when more sensory information is present in the virtual environment (Franceschi et al., 2008, p. 6). In addition, as more sensory modalities are stimulated, the experience of presence is likewise increased (Steuer, 1992). If a simulation is more authentically realistic, the more emotions are stimulated in response to tasks and events within that environment. Students are more likely to experience tension, fear or frustration leading to a more authentic emotional environment. This has long being recognised as a factor facilitating authentic learning (Smith, 1987).

If the learner experience is compromised through lag due to insufficient bandwidth, poor technical skills, an exponential learning curve and so on, then the cognitive load of that learner will dramatically increase (Pollock, Chandler, & Sweller, 2001). Though this can be taken into account when designing a virtual world build in order to mitigate the effects, it generally isn't as it can be time-consuming and expensive. Lag can be a persistent problem which severely reduces the quality of the experience in a virtual world environment. For authentic learning to occur, the complexity in a scenario must be due to the ambiguous context inherent in the activity rather than because of difficulties associated with the user interface or the unreliability of the technology. Superfluous cognitive load is the direct result of unduly stressing learners with excessive information, such as requiring them to spend extra time trying to learn how to navigate through an unfamiliar learning environment in order to complete a learning task, thereby distracting them from the direct object of their learning (Pollock et al., 2001).

These factors may create sufficient distraction in the physical environment to decrease the feeling of presence in the virtual world. Facilitating more natural and intuitive movement based on real-world actions would go some of the way to overcoming these sorts of issues. By doing so, the inclusiveness and capability of these virtual world environments for education would be augmented. The lucrative consumer market has enticed gaming designers to reexamine the way users interact with 3D immersive environments. Generally speaking, until recently, speed, responsiveness and three-dimensional motion have not been facilitated by most user interfaces, significantly degrading the user's experience (Champy, 2007). The emergence of the Nintendo Wii and the Xbox Kinect has gone some of the way to redressing this deficiency. The capacity for haptic feedback further boosts the immersive experience, paving the way to heightened believability through interaction with solid objects (Butler & Neave, 2008). For university educators, being able to incorporate these attributes into virtual world environments would give learners the opportunity for authentic learning experiences that more closely resemble those in real life (Farley & Steel, 2009).

17.6 Conclusion

Virtual world environments have great potential to enhance the quality of student engagement, engender social presence and provide authentic learning opportunities for students studying in a range of disciplines and professions. Even so, careful planning is required to ensure that the environment is suitably complex and interactive. This may be achieved using gamification or simulation techniques. There are also other factors which may hinder immersion, presence and flow including difficulties with the environment caused by such factors as a complex user interface, counterintuitive controls and lag caused by insufficient bandwidth. Even so, these factors directly related to the environment will necessarily disappear with time given the commercial user demand for intuitive interfaces and the large amount of competition appearing in the virtual world marketplace.

Some 4 years ago when education in virtual worlds was first gaining traction, Adel Hendaoui and his colleagues outlined some questions that they believed needed to be asked:

- Will e-learning evolve to vlearning (virtual world learning)?
- How does learning in virtual worlds compare to e-learning and face-to-face learning?
- How can we design a virtual world classroom to promote effective learning?
- How do lecturers' roles change in virtual world classrooms?
- What are the effective ways to assess learning in a VW?
- How does the instructor's avatar—its design and appearance—impact a student's attention and motivation?
- What factors motivate teachers to adopt and continue to use VW as a teaching environment? (Hendaoui et al., 2008, p. 90).

As educators, we've been using these environments for teaching and learning for just 5 or 6 years. Hundreds of universities are teaching some of their courses or parts of them in virtual worlds. How much closer are we to answering those questions?

Will e-learning evolve to vlearning? Though much fanfare heralded the arrival of virtual worlds in education, there has not been widespread adoption by tertiary institutions. There are several reasons for this. The 50 % educational discount was removed from Second Life, the most popular virtual world with educators, making it too costly for many educators (Farley, 2011b). In addition, virtual worlds have failed to develop to a stage where the learning curve for users is sufficiently small to allow easy entry into the environments by educators and students alike. These environments are still difficult to navigate and there are few exemplars of good teaching. This is evidenced by the declining number of papers at the annual ascilite conferences, the most popular educational technology conference focused on higher education in Australasia, in the past 3 years (including 2012). The total number of papers, symposia, posters and workshops at these conferences is not growing but is in fact slightly declining (15 papers, symposia, workshops and posters in 2010 as compared to 10 in both 2011 and 2012) (ascilite, 2010, 2011, 2012). This is consistent with the recent claim made by the information technology research and advisory firm Gartner, which places virtual worlds just off the bottom of the Trough of Disillusionment on the Gartner Hype Cycle (Pettey & van der Meulen, 2012). Higher education institutions are more likely to invest in mobile learning or mlearning initiatives that leverage students' ownership of devices rather than in vlearning.

How does learning in virtual worlds compare to e-learning and face-to-face learning? The field of education in virtual worlds is relatively new. Second Life has been accessible since 2007. Prior to that, Active Worlds had gained some traction with educators. Even, the number of users for education has always been low. Consequently, there are few studies that compare the efficacy of face-to-face teaching or e-learning with teaching and learning in virtual worlds. In fact, most articles in this domain are descriptive and predominantly restricted to the disciplines of media arts, health and environment, though examples in other disciplines do exist (Hew & Cheung, 2010). Even so, an empirical rigour is beginning to emerge in the literature as evidenced in particular in the special journal issues dedicated to learning in virtual worlds (for example see Lee, Dalgarno, & Farley, 2012). Though results are encouraging, the small number of empirical studies and the nature of virtual world education make a direct comparison difficult. To date, Hendaoui and colleagues' question about the efficacy of learning in virtual worlds as compared to e-learning and face-to-face remains largely unanswered.

How can we design a virtual world classroom to promote effective learning? As we've already seen, much of the criticism of the use of virtual worlds in education stems from educators continuing to use old techniques in this new environment (Berge, 2008, p. 411). The efficacy of lectures and the didactic learning they promote is widely criticised outside of virtual worlds. Many educators prefer more student-centred approaches both outside of and inside of virtual world environments. Hence the posed question becomes redundant: to promote effective learning we don't design a virtual world classroom but rather an educational experience that promotes collaboration, interaction and communication (Ondrejka, 2008).

How do lecturers' roles change in virtual world classrooms? This question follows neatly from the previous one. With more student-centred approaches to teaching and learning, educators move from being lecturers and content-knowledge experts to being facilitators, mentors or coaches (Berge, 2008). Zane Berge asserts that lecturers using e-learning adopt four primary roles which are pedagogical, social, managerial and technical. These roles may not be all filled by the same person. In virtual worlds, lecturers still hold onto these roles, but the requirements of these roles change. Many of the changes are the result of the more student-focused activities that characterise much of the learning in this environment or around the cultural norms specific to VWs. However, there is a considerable shift in the technical role of the lecturer due to the highly complex technical environment both in terms of hardware and software. This is exacerbated by the environment being unstable and heavily reliant of the reliability of internet access. Virtual world software is frequently updated and without notice making it difficult to use in teaching labs. Consequently, educators are well advised to line up ICT support for all sessions and seek outside expertise in constructing complex builds (Berge, 2008, p. 409). Virtual world learning sessions can be quickly derailed without notice and educators would be well advised to have an alternative activity planned that can be implemented quickly (Farley, 2011d).

What are the effective ways to assess learning in a VW? While educators may be adventurous enough to teach in a virtual world, a much smaller proportion are prepared to assess students' work in this environment or may be forbidden to do so by the institutions they work for. Most assessment of virtual world activities takes place outside of the environment in the form of reflective assignments, essays or journals. An example of this would include the assessment of reflective journals at the end of a semester that were written by communication students and architecture students at the University of Texas, working on the creation of urban housing designs in Second Life (Lee, 2009). Difficulties with reliable access, hardware requirements and a diversity of student skills levels in dealing with a virtual world are all problematic when considering equitable assessment in virtual worlds. A student with poor technical skills may be so overwhelmed by a virtual world environment that he or she may never fully realise the opportunity to complete an assessment piece. Though it is to be hoped that a tutor or lecturer would ensure that the student does acquire the requisite technical skills, this would be much harder to monitor in students studying at a distance.

How does the instructor's avatar—its design and appearance—impact a student's attention and motivation? From personal experience, I can relate that a class of first-year students I was teaching, both face-to-face and in Second Life, were uncomfortable with my use of an avatar of a different gender. They expressed relief when I turned up to our Second Life meeting with an avatar that resembled my real-life self. This strategy is employed by many educators. For example, Sue Gregory, a lecturer at the University of New England, has created her avatar, Jass Easterman, to resemble her real-life self so that students could recognise and relate to her in Second Life (Gregory & Tynan, 2009). Most educators recommend that educators' avatars be professionally attired with avatar names that are not outlandish or controversial as these may be distracting (Berge, 2008).

What factors motivate teachers to adopt and continue to use VW as a teaching environment? This last question is the most difficult to answer and the converse is much easier to answer: *what factors dissuade teachers from adopting virtual worlds as a teaching environment*? These barriers to adoption are similar to those encountered when deploying any new technology in an educational setting. Rogers has identified a number of 'internal' and 'external' barriers. Internal barriers include educator attitudes or perceptions of the technology. External barriers include the availability of resources, technical proficiency of the educator and so on (Rogers, 2000). Part of the answer can be found in the changing roles of educators in virtual worlds. The technical barriers to adoption and deployment remain high. Educators are not the only ones to find the technical challenges overwhelming; students may find virtual world environments difficult to navigate and may disengage from the instruction providing a further disincentive to educators. Some of these issues can be mitigated by ICT support and instruction yet these are frequently not available due to budgetary and time constraints of support staff. In addition, teaching and learning in virtual worlds can be enormously time-consuming for both staff and students (Warburton, 2009). The design of virtual world lessons is more complicated due to the nature of the environment and because alternative lessons must be at least partially prepared to accommodate the unreliability of virtual world environments.

Largely those questions posed by Hendaoui and colleagues remain unanswered. Virtual worlds can be a place of discovery and wonder: anything that can be imagined, can be created. But they are also places fraught with danger. The most significant hazard is that we as educators will continue to do as we have always done in physical spaces: using new tools to teach in old ways; failing to plan for new cohorts, contexts and the changing workplace. By doing this we fail to leverage the considerable affordances of the environment to provide rich, engaging and student-centred learning. Incorporating teaching into virtual worlds requires considerable planning, resources in terms of time and money and commitment to win over the sceptics but it *is* worth the effort.

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Chapter 18
Trialing e-Portfolios for University Learning: The Devil in the Detail

Margot McNeill, Amanda Parker, and Andrew Cram

Abstract E-portfolios are among a suite of technologies heralded as having the potential to enhance student learning. In these web-based spaces students can capture and display their development of expertise in a wide range of skills and knowledge, whether specific to their discipline or more broadly applicable graduate capabilities. It is yet to be demonstrated, however, how readily these tools can be integrated within the university curriculum. This chapter reports on the results of a pilot of an e-portfolio tool in an Australian university, involving different curriculum contexts across two semesters. Using a mixed methods approach, feedback was gathered from students and staff in the participating units on their perspectives about the usability of the e-portfolio tool, the support provided, and its effectiveness for their learning. The results reinforce the need for e-portfolios, like any new technology, to be embedded into appropriately designed tasks, which are seen to be engaging, relevant, and part of a fully integrated curriculum experience.

Keywords e-portfolios • Technology • Curriculum alignment • Graduate capabilities • Assessment

18.1 Introduction

E-portfolios provide a web-based space where students can demonstrate their development of expertise in a wide range of skills and knowledge, whether in discipline knowledge or graduate capabilities (JISC, 2007). As suggested by Joyes, Gray, and Hartnell-Young (2010), an e-portfolio can be used for a range of purposes in the learning process, for different audiences, at different times, for example enabling

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learners to present evidence of their learning for diverse uses. These could include submissions to supervisors for feedback, markers for assessment, or as part of their preparation for transition out of university (McAllister, Hallam, & Harper, 2008; Yorke & Croot, 2004). A review of projects and case studies undertaken by JISC (2007) found that while e-portfolios could be set up for primarily summative assessment purposes, they were also used to encourage a more continuous and reflective approach to learning, including an emphasis on formative feedback from a variety of sources. Examples could include demonstrating evidence of reflections on learning during placements or practicum, for selective sharing with others such as teachers, peers, or prospective employers (Beetham, 2005). There were also examples of e-portfolios used to support and demonstrate the pursuit and achievement of personal or professional competences, with efficiencies gained from collecting the evidence in a central, web-based environment for easy access (Barrett, 2010).

Along with these examples of the benefits and efficiencies to be gained from the implementation of an e-portfolio system, other researchers report challenges such as the introduction of a new form of assessment and technology for students and staff to deal with (Butler, 2006; Darling, 2001; Tosh, Light, Fleming, & Haywood, 2005; Wilhelm et al., 2006). Joyes et al. (2010) surmise that in many e-portfolio trial case studies, project teams have held assumptions of time and resource savings for staff, students, and administrators. In reality, however, it was discovered that simply implementing an e-portfolio tool for students as a form of assessment did not necessarily lead to the expected benefits of reducing staff workload and increasing student engagement. Joyes et al. (2010) found that introducing a brand new concept and technology to staff and students can present additional challenges that need to be carefully balanced against the advantages, and the benefits of e-portfolios will not be realised unless the complex process of implementation is carefully managed. Tosh et al. (2005) warn of issues with engagement and motivation that can emerge if the attitudes and needs of staff and students who use the e-portfolios are not considered, pointing to the importance of training and managing expectations of those involved. In addition to these workload and engagement issues, Challis (2005) raises practical considerations for institutions in providing secure, ongoing storage for large and increasing volumes of data, along with copyright, privacy, and intellectual property concerns. Rather than a simplistic approach to the implementation of e-portfolios, Ellis and Goodyear (2010) and others (Gibbs & Gosper, 2006) advocate that the introduction of any new technology is most likely to result in positive student and staff experiences if an holistic approach to the curriculum is taken.

18.1.1 University Context

E-portfolios were identified as a priority for exploration in Macquarie University's Technologies in Learning and Teaching Plan (2009–2012) and a working party was commissioned by the Senate Learning and Teaching Committee to explore the current and future need for a centralised e-portfolio. Among the drivers for the exploration was the relatively recent introduction of a set of graduate capabilities such as critical thinking, problem solving, creativity, and effective communication, to be embedded in each program as part of a Curriculum Renewal Program. e-portfolios provide opportunities to capture the development of these higher order capabilities, which have typically been considered as difficult to assess (Race, 2001). Similarly, the University's sustainability policy encouraged lifelong learning, with particular reference to work-integrated learning. Learning portfolios can enable students to demonstrate the development of expertise over time, with permissions to enable different views for different audiences and a resume builder, which were seen as useful in transition to work or further study. A third factor was the requirement that all students at the University undertake a Participation and Community Engagement (PACE) unit as a component of their overall program of study, for example work placements, Internships, or practicums. e-portfolios were seen as potentially providing a centralised, student-designed space where they could collaborate with peers from the workplace and the University, flexible enough to be adapted to changing requirements.

In order to inform the University's decisions about whether to invest in a centralised e-portfolio tool for use across campus, trials were conducted in 2010. While several e-portfolio systems including commercial systems such as PebblePad and in-house developed systems such as Queensland University of Technology's Student e-portfolio (McCowan, Harper, & Hauville, 2005) are available, Mahara e-portfolio tool was chosen. Mahara as described on its website (mahara.org) is an open source personal learning environment which includes social networking tools to enable sharing between groups. This particular system was chosen for the trial because of its open source nature and its interoperability with the two learning management systems (LMSs) in use at the time, Moodle and Blackboard.

Two theoretical frameworks were used to guide the project. Collis and Moonen (2001) suggested a 4 E Model to guide decisions about integrating technology into learning, advocating consideration of the following:

- Environment—broader institutional policies and culture need to support the use of the tool.
- Personal Engagement—academics and students need to see the potential for the tool in order to allocate time and effort toward changing from their current behaviour.
- Ease of use—academics and students need to be able to focus on the intended tasks rather than the tools.
- Educational Effectiveness—both academics and students are time-poor and need to be convinced that the new tool will be effective for their learning context.

Building on the 4 E Model, Gosper, Woo, Muir, Dudley, and Nakazawa (2007) developed a Communications, ICT and Organisation (CICTO) framework which is used to evaluate educational technology pilots at the University. The framework is comprised of three parts:

Part 1: Teaching and learning context—identify the context in which the software is to be trialled.
Part 2: Software capability analysis—assess the effectiveness of the software in supporting the specified use.
Part 3: Environmental impact analysis—identify issues relating to the sustainability of its use within the University, for example training, support, compliance, workload, and risks.

18.2 The Study

This study was conducted as a case study of how an e-portfolio tool could be used in a University setting. To maximise the impact on student learning, staff were asked to volunteer if they considered the units they convened as being suitable for using an e-portfolio to capture and assess learning. Using a mixed methods approach (Creswell, 2003) surveys and interviews were designed to gather student and staff perspectives over two semesters in 2010. Collis and Moonen's (2001) 4 E Model and the CICTO framework (Gosper et al., 2007) were used as the theories underpinning the development of a survey to gather students' feedback at the completion of each semester. The survey included questions relating to the e-portfolio's usability, technical support, and overall effectiveness for learning. The online survey link was sent to all students in the participating units. The participating academics were invited to an initial meeting to discuss their priorities for the pilot. They were then encouraged to capture their reflections during the trial and individual interviews were conducted to explore how they experienced the e-portfolio tool, based on their initial priorities.

The study was conducted in two phases, each of which was one semester in length. This chapter reports findings from the phase two trial. Some results from the first phase are included as part of the discussion in this chapter; however, more details were published in an earlier paper (McNeill, Diao, & Parker, 2010).

18.2.1 Phase One

Phase one of the Mahara trial involved two units; an under-graduate Internship program with 82 students and a post-graduate higher education unit (EDUC) with 31 students. Both convenors had used forum tools to support dialogue among students in previous cohorts and were keen to explore the potential of an e-portfolio tool to enable students to store and share evidence of their learning, encourage reflection on the learning journey, and to streamline assessment and feedback processes. These participating convenors exemplified high levels of personal engagement as encouraged by Collis and Moonen's model and also were optimistic about the educational effectiveness of e-portfolios for their curriculum contexts.

18.2.2 Phase Two

Feedback from staff and students of the phase one units was used to inform a wider trial in semester 2, which included a first-year under-graduate computing unit (COMP) and a capstone EDUC as well as a repeat of the Internship unit (INTERNSHIP) from phase one. In Computing, first year students are encouraged to begin collecting evidence of their developing graduate capabilities at the outset of their studies at the University, thereby introducing notions of critical reflection and documentation from one of their first units. This cohort was a blend of on-campus and off-campus students, using the LMS, Moodle, with single sign-on access to Mahara. They were provided with the user manual but no dedicated training session.

The Department of Education capstone unit trialled the e-portfolio in phase two to meet one of the requirements of the NSW Institute of Teachers (NSWIT), that a schedule of professional standards is collected by graduates from teacher education programs before they can be employed as teachers. This cohort used the University's central LMS, Blackboard, and had 1 h tutorials each fortnight (six sessions) during semester dedicated to learning about how to use the software and maintaining their portfolios.

In the Internships program, only the Mahara e-portfolio system was used for the delivery of the unit, with no LMS environment. The e-portfolio design was improved for semester 2, 2010 in response to feedback gathered from semester 1, including more time for training, and clearer and more scaffolded tasks. Again, the participating convenors showed high levels of personal engagement and optimism about the educational effectiveness of e-portfolios for their curriculum contexts.

18.3 Results

Of the total 271 students from the three cohorts in the study, 105 participated in the phase two survey (38.7 %). This section presents the results of the survey.

The first question in the online survey asked students to select the option that best described how successful they were in accessing the Mahara e-Portfolio tool, as shown in Table 18.1.

Overall, 94.3 % of students responding to the survey were very successful or quite successful in accessing the Mahara e-Portfolio tool. However, seven students (6.7 %) were not able to submit tasks. One of these students, from COMP, was not able to log in at all. All Students from EDUC were very successful or quite successful.

Respondents were asked to rate the usability of the e-portfolio tool, using the scale (Strongly Agree = 1 to Strongly Disagree = 5), with results presented in Table 18.2.

Of all respondents, 36.6 % reported that the e-portfolio was generally easy to use; however, 39.8 % of all students disagreed or strongly disagreed with this

Table 18.1 Accessing the Mahara e-portfolio tool

Please indicate how successful you were in accessing the Mahara e-portfolio tool		
Answer options	Response percent (%)	Response count
Very successful—I managed to use the tool for the purposes of the unit	48.6	51
Quite successful—I managed to get in and do some of the tasks	45.7	48
Not very successful—I managed to log in to Mahara but could not submit the tasks	5.7	6
Very unsuccessful—I tried but didn't manage to log in at all	1.0	1
Answered question		105

Table 18.2 Usability

These questions are about the usability of the tool							
Answer options	S/A	A	N	D	S/D	Rating average	Response count
The e-portfolio was generally easy to use	5.4 % (5)	31.2 % (29)	23.7 % (22)	28.0 % (26)	11.8 % (11)	3.10	93
I had sufficient support to use the e-portfolio tool	8.7 % (8)	40.2 % (37)	32.6 % (30)	10.9 % (10)	7.6 % (7)	2.68	92
Technical issues limited my use of the e-portfolio tool	9.8 % (9)	25.0 % (23)	25.0 % (23)	31.5 % (29)	8.7 % (8)	3.04	92
Answered question							93

statement. Almost half (48.9 %) of all respondents reported that they agreed or strongly agreed that they had sufficient support to use the e-portfolio tool. Technical issues remained a significant impediment for students, with 34.8 % of all students agreeing or strongly agreeing that technical issues limited their use of the tool. Very few Internship respondents reported dissatisfaction with the level of support: only 5.1 % (3) Internship students disagreed or strongly disagreed that there was sufficient support. However, more Internship respondents reported that the e-portfolio was NOT easy to use (24, 40.7 %), than reported that the e-portfolio was easy to use (33.9 %). Therefore, for these students, the perception of support has not translated into increased perception of ease of use.

Table 18.3 Types of support

Which types of support did you utilise in learning how to use the tool?		
Answer options	Response percent (%)	Response count
Online instructions about the site, such as the user manual	44.0	40
Online discussions with other users	11.0	10
Individual guidance (email or phone) from the unit convenor	23.1	21
Individual guidance (email or phone) from other students	16.5	15
No support used—I just worked it out for myself	50.5	46
Other (please specify)		9
Answered question		91

Many comments reiterated concerns about the perceived difficulty of using Mahara, for example:

> the layout is very confusing and not user friendly at all.
>
> I needed directions on where each assignment should be submitted. (There were) WAY TOO MANY tabs.

Respondents were then asked to select as many options as appropriate to indicate the types of support used during the trial. Results are presented in Table 18.3.

Approximately half of all respondents (50.5 %, 46) did not use support, instead working it out for themselves. Relatively few respondents (11.0 %) used online discussions. A majority of COMP respondents (73.7 %) and EDUC respondents (71.4 %) worked it out for themselves. In contrast, only 37.9 % (22) Internship respondents used this method.

In a related question, respondents were asked about how helpful they found the types of supports they used, using the scale (SA = 1 to SD = 5). Results are presented in Table 18.4. N/A responses have been removed, so that percentages reflect only those who have responded to the question.

For each of these answer options (categories of support), more students have reported an opinion on how helpful the support was than the number of respondents who reported using the support in the previous question. Although we can only speculate, this may suggest that some respondents were reporting about what they thought would be helpful. Overall, students reported finding the support options to be helpful.

The next question asked respondents to rate their agreement with statements about Mahara's helpfulness in supporting collation of work for assessment, reflection, and integration of ideas during the unit, using a scale from Strongly Agree (1) to Strongly Disagree (5) and N/A. results are summarised in Table 18.5, with highest ratings are shown in bold text.

Of the respondents, 65.6 % agreed or strongly agreed that the e-portfolio was helpful in collating their work for assignment submission for the unit and just over 60 % agreed or strongly agreed that the e-portfolio tool helped them reflect on what they had learned during the unit. In contrast, 48.4 % of all respondents agreed or

Table 18.4 Helpfulness of the supports used

If you did use these supports, do you agree that they were helpful? (n/a responses removed)						
Answer options	S/A	A	N	D	S/D	Response count
Online instructions on the site	13.7 % (7)	43.1 % (22)	25.4 % (13)	13.7 % (7)	3.9 % (2)	51
Online discussions with other users	7.8 % (3)	39.5 % (15)	36.9 % (14)	10.5 % (4)	5.2 % (2)	38
Individual guidance from the unit convenor	21.7 % (10)	45.6 % (21)	21.7 % (10)	6.5 % (3)	4.3 % (2)	46
Individual guidance from peers such as other students	9.3 % (4)	53.5 % (23)	27.9 % (12)	4.6 % (2)	4.6 % (2)	43
Other (please specify)						1

Table 18.5 Agreement with the tool's helpfulness

Please indicate your agreement with the following statements. The tool helped me:								
Answer options	S/A	A	N	D	S/D	N/A	Rating average	Response count
Collate work for assessment	11.8 % (11)	53.8 % (50)	14.0 % (13)	8.6 % (8)	11.8 % (11)	0	2.55	93
Reflect on learning	17.2 % (16)	43.0 % (40)	11.8 % (11)	16.1 % (15)	11.8 % (11)	0	2.62	93
Integrate and make connections	10.8 % (10)	37.6 % (35)	19.4 % (18)	15.1 % (14)	17.2 % (16)	0	2.90	93
Answered question								93

strongly agreed that the e-portfolio helped them to integrate and make connections between the things they learned in this unit and other contexts but one third disagreed or strongly disagreed with this statement.

Comments relating to this question sometimes included provisos on Mahara's successful use, for example:

> I managed it successful but overall I think that Mahara is poorly structured.
>
> I do think that students should have just one ICT space per Unit.

Table 18.6 Overall impact

Overall impact of the technology								
Answer options	S/A	A	N	D	S/D	N/A	Rating average	Response count
Overall, was helpful for my learning	9.7 % (9)	40.9 % (38)	16.1 % (15)	16.1 % (15)	17.2 % (16)	0 % (0)	2.90	93
I consider it a useful experience learning how to use the e-portfolio tool	7.5 % (7)	38.7 % (36)	21.5 % (20)	14.0 % (13)	18.3 % (17)	0 % (0)	2.97	93
I think the e-portfolio tool will have other application	7.7 % (7)	38.5 % (35)	31.9 % (29)	7.7 % (7)	11.0 % (10)	3.3 % (3)	2.86	91
Other (please specify)								4
Answered question								93

One comment drew a distinction between the support and the usability of Mahara:

> Information was there, but simply was not intuitive enough, so spent long periods looking up each step.

Respondents were asked about the overall impact of the technology on their learning in the unit, as presented in Table 18.6. Ratings were against the five point scale, with Strongly Agree = 1 and Strongly Disagree = 5.

Half of all respondents (50.6 %, 47) agreed or strongly agreed that the e-portfolio tool was helpful for their learning; however, 33.3 % disagreed to a greater or lesser extent that the e-portfolio tool helped their learning. Of all respondents, 46.2 % agreed or strongly agreed that learning to use the e-portfolio tool was a useful experience; however, 32.3 % disagreed or strongly disagreed with this statement. Just over 46 % of all respondents agreed or strongly agreed that the e-portfolio tool will have other applications, however 31.9 % took a neutral stance towards this question, and 18.7 % disagreed or strongly disagreed. No respondents from the COMP unit reported that they strongly agreed with any of these questions. The EDUC and Internship students were generally much more positive.

The next question asked respondents what they thought the priorities for the University should be when choosing an e-portfolio for wider use across campus, using the five point scale. Results are presented in Table 18.7.

Most of the respondents (71.7 %) agreed or strongly agreed that an e-portfolio tool should enable sharing of learning with other students and 70.7 % agreed or strongly agreed that it should support a variety of upload formats. Sharing learning with teachers was also important with 66.3 % agreeing or strongly agreeing with this statement.

Table 18.7 University priorities

The following are considerations for the University in choosing an e-portfolio tool for wider use. Please indicate your agreement about whether it is very important that the tool

Answer options	S/A	A	N	D	S/D	Rating average	Response count
Is simple and user-friendly to use	22.0 % (20)	31.9 % (29)	18.7 % (17)	19.8 % (18)	7.7 % (7)	2.59	91
Works well with the other Uni online learning tools	16.3 % (15)	31.5 % (29)	22.8 % (21)	22.8 % (21)	6.5 % (6)	2.72	92
Can be used after I leave the Uni	12.0 % (11)	28.3 % (26)	29.3 % (27)	21.7 % (20)	8.7 % (8)	2.87	92
Lets me upload a variety of file formats	19.6 % (18)	51.1 % (47)	25.0 % (23)	1.1 % (1)	3.3 % (3)	2.17	92
Enables me to share my learning with my teachers	18.5 % (17)	47.8 % (44)	26.1 % (24)	5.4 % (5)	2.2 % (2)	2.25	92
Enables me to share my learning with other students	20.7 % (19)	51.1 % (47)	20.7 % (19)	5.4 % (5)	2.2 % (2)	2.17	92
Enables me to share my learning with others outside Uni, such as prospective employers	15.2 % (14)	22.8 % (21)	44.6 % (41)	10.9 % (10)	6.5 % (6)	2.71	92
Other (please specify)							6
Answered question							92

The two potential priorities that elicited the highest proportion of neutral responses both referred to the use of the e-portfolio tool outside of the university context. It seems that many students have not made firm opinions as to the utility of the e-portfolio tool outside the context in which they have used it so far (i.e. within university units).

The final question in the survey asked about respondents' overall experience of the unit they had studied, as reported in Table 18.8. Ratings were against the five point scale, with Strongly Agree = 1 and Strongly Disagree = 5.

Table 18.8 suggest that the respondents were satisfied overall with their units. Therefore it seems they distinguished between their experiences with the e-portfolio tool, which were sometimes negative, and level of satisfaction towards the teaching and assessment in the unit.

Table 18.8 Experience of the unit in general

These next questions ask you about your overall experience of the unit. Please indicate your agreement with the following statements

Answer options	S/A	A	N	D	S/D	Rating average	Response count
The unit provided clear aims and objectives	26.1 % (24)	54.3 % (50)	14.1 % (13)	5.4 % (5)	0.0 % (0)	1.99	92
The unit content was structured in ways that assisted my learning	30.4 % (28)	44.6 % (41)	16.3 % (15)	7.6 % (7)	1.1 % (1)	2.04	92
The learning activities were useful for building up my understanding of this unit	24.2 % (22)	48.4 % (44)	16.5 % (15)	8.8 % (8)	2.2 % (2)	2.16	91
Assessment tasks were set at an appropriate level	25.0 % (23)	48.9 % (45)	20.7 % (19)	4.3 % (4)	1.1 % (1)	2.08	92
I received timely feedback that assisted my learning	26.1 % (24)	35.9 % (33)	16.3 % (15)	13.0 % (12)	8.7 % (8)	2.42	92
Innovative teaching approaches were used	25.0 % (23)	35.9 % (33)	23.9 % (22)	10.9 % (10)	4.3 % (4)	2.34	92
Answered question							92

18.3.1 Staff Perspectives

In the initial meeting prior to the pilot, issues which emerged as priorities for the convenors included supporting student collaboration and dialogue, facilitating student presentation of the evidence of their learning, enabling online assignment submission, and streamlining marking. The three convenors of the pilot units were encouraged to reflect on their experiences and participated in a 1 h interview at the end of the semester to gather their perspectives. Staff feedback on the use of the tool also highlighted strengths and weaknesses of the system.

18.3.1.1 Supporting Student Collaboration and Dialogue

Encouraging and supporting student collaboration and dialogue were seen as important to all of the convenors participating in the pilot. The convenor of the Internships unit commented that learners provided reflections and interim products to demonstrate their learning, while student submissions was previously only seen in their complete form by the markers. While in previous years the students had been encouraged to comment on sections of each others' work in the forum, they did not have access to the whole product or any sense of the impact of their feedback to their peers. It was hoped that the e-portfolio environment would enable a more holistic overview of the dialogue and the final products of learning.

The three participating convenors reported that the e-portfolio environment did support students in collaborating and discussing their ideas. The ability to store the documents and reflections in an e-portfolio format did enable students to comment on each other's work from a holistic perspective rather than in separate modular chunks. This was particularly prevalent in the Internship course, where only the Mahara discussion forum was used. In the other two units (EDUC and COMP), the e-portfolio forum was seen as preferable to the Blackboard discussion format, where posts are separated into threads based on the module topic rather than the cumulative learning process. However, convenors reported that students were often confused about whether to post to the Mahara or Blackboard forums.

18.3.1.2 Facilitating Student Presentation of the Evidence of Their Learning for Diverse Uses

Each of the convenors was optimistic at the outset of the pilot about the potential for learning to be shared with a wider audience. In particular, the convenor of the EDUC capstone unit could see obvious benefits for students in preparing their portfolio for use in their transition to teaching. For the covenor of the Internships unit, potential benefits were seen for students in capturing and sharing their workplace experiences. The convenor of the first-year COMP unit had longer-term goals of encouraging students to capture a record of their learning over the whole of their program. This was acknowledged as a challenge at the outset, as it is not currently part of the University's culture.

The e-portfolio did enable students to share the documents with a range of audiences, for example their peers or potential employers, however all convenors reported that students were confused about how to set up different views for these different purposes and which artefacts to include. Even in the units where on-campus training was provided, the convenors reported that students frequently missed steps in setting up the different views and needed help to complete the process.

18.3.1.3 Enabling Online Assignment Submission

In previous studies (McNeill, Diao, & Gosper, 2011), students at the University had identified online assignment submission as a high priority and the participating convenors saw this as a potential benefit of the e-portfolio system. Students in the three units had previously submitted assessments using a variety of programs and the

University's Blackboard platform was configured to exclude files of over 20 Mb. The e-portfolio enabled storage and submission of larger files in a wider range of formats with links between different sections. In their feedback, the convenors reported that the e-portfolio enabled students to store the artefacts of the learning and facilitated the reflective process; however, many students experienced difficulties in submitting assignments. All convenors reported that students needed support to manage the links between these various sections of their portfolio. All three convenors needed to go in and complete the submission process for up to one quarter of their cohort. While this was seen as manageable in a smaller pilot context, it was not scalable to the wider University environment where some units have over 2,000 students in a cohort.

18.3.1.4 Streamlining Online Marking

Opening different file types and programs and loading and saving the separate documents were seen as a time-consuming process by the convenors and they were optimistic that the e-portfolio system would streamline these processes. In their feedback, convenors acknowledged the convenience of having some components such as blog postings displayed directly on-screen; however, they still needed to download some documents as a separate process. The feedback areas were reported as somewhat confusing and convenors needed experimentation to determine the best option for posting feedback for individual students. Marks still needed to be entered into another system such as Blackboard until the e-portfolio is integrated with the University's student management system. This integration is not possible in a pilot, so was acknowledged as one of the limitations that would be addressed in a larger scale implementation. One crucial disadvantage of the e-portfolio marking process was the lack of an auto-receipt to notify students that their assignment had been successfully submitted. Unit convenors needed to respond to students individually to acknowledge that their assignments have been received.

18.4 Discussion

The e-portfolio tool Mahara was trialled to determine its effectiveness in scaffolding students in reflecting on their learning and to gauge its potential to be rolled out more widely across campus. This chapter reported the results of the second phase of the study. The pilot involved a diverse group of cohorts to capture a range of staff and student opinions: first year technology-savvy students, final year capstone students with a need to demonstrate their learning in e-portfolio format, and Internship students in workplace settings. All units were chosen as having intended learning outcomes that were seen as having a strong potential for e-portfolios to support the capture and sharing of assessment—whether the learning journey was beginning as was the case for the first year computing cohort, or blurring boundaries between learning contexts with the interns, or as a transition requirement for the final year Education students. Despite this optimal context for the pilot, the results suggested that the themes relating to Collis and Moonen's (2001) 4 E Model and the Gosper et al. (2007) CICTO framework, usability, technical support, and effectiveness for educational purpose were significant barriers to implementation of an institution-wide e-portfolio system.

Considerable issues were reported with the usability and functionality of the system. While most student respondents (88.8 %) were able to access and use the system very successfully or quite successfully, some still struggled with these essential functions, which required manual intervention or individual support from the convenors. The participating staff members acknowledged strengths of the system, however also reported usability issues. The labour-intensive task of assisting students in uploading and submitting tasks was seen as a barrier, along with the lack of auto-receipt functions and streamlined feedback processes. While these issues were tolerated in a pilot with relatively small cohorts, they would pose considerable barriers to scalability. The students and staff found there was considerable duplication of functions between Mahara and the existing LMS, which caused confusion for example about which forum to use.

As part of the pilot, all cohorts had high levels of support for their use of the e-portfolio system, which in many cases would be unsustainable in the wider university context. Some had on-campus training sessions and some had tutorials dedicated to using the system. The Internship students had the most comprehensive support in the form of both on-campus compulsory workshops and individual support as required, yet still did not agree that the system was easy to use. This suggests that more development is required before such a system can be rolled out university-wide, without incurring substantial training and support expenses.

When compared with the results from semester 1, 2010, there were higher scores in all three sub-questions for the question relating to the educational effectiveness of the tool, indicating the respondents were more positive about the e-portfolios having helped them to collate their work for assessment, reflect on their learning, and make connections between things they have learned. In the case of the Internship unit, students in phase two reported a higher perceived utility of Mahara compared with students in the same unit in phase one. This may reflect the refinements the unit convenor made in the student instructions for using Mahara and the assessment tasks as a result of phase one. Experience from the first trial also informed improvements to the training and support offered to the convenors from the other units, which could have contributed to the more positive student perceptions overall.

The notion of a self-fulfilling prophecy emerged in relation to personal engagement. If the students saw the need to focus their efforts they were more likely to find the tool useful. This theme reiterates the findings of previous studies, where students reported resistance to learning about new technologies if they did not see a clear and pressing need, preferably for use in more than one unit across their program of study (McNeill et al., 2010). The Internship and Education capstone students saw the relevance of the e-portfolio and its potential to capture their developing expertise but the first year Computing students did not. This greatly affected their overall satisfaction and one student reported not being able to submit the required tasks. This is indicative of the significant barriers for large scale use in summative assessment. Macquarie University's culture of a unit-based rather than program-based curriculum was also an issue that emerged as students needed to learn the new system for what they perceived as use in only a single unit.

18.4.1 The University's Policy Decisions

The final phase of the study was to refine the results of the study into a policy for the University about e-portfolios. Feedback from the working party and the pilot participants suggested there was interest in e-portfolios among pockets of staff and students across campus. Drivers such as the need for students to demonstrate development of graduate capabilities along with the potential to capture experiences and reflection from PACE and Internship units have encouraged interest. While the pilot involved small numbers of staff, there have been expressions of interest from other staff members who have volunteered to participate in any future studies. Many see the potential of these tools to enhance student learning and encourage a longer-term approach by students to their learning. It was seen by some of the staff participants in the pilot as a student-designed space to complement the largely staff designed space of the LMS. Along with this interest from across campus is the recognition that faculties and departments are not homogenous and implementing an institutional-wide system is challenging due to the diverse needs and technical skill of the stakeholders and the scale of training and support requirements.

It was decided that the University would adopt a policy of encouraging 'e-portfolio-based learning' (JISC, 2007). The 'e' is included to maintain a focus on the efficiencies of electronic collection, storage, and sharing of data; however, scope is included for either use of a centralised system or a collection of tools which can be determined by students.

18.5 Conclusion

There is considerable interest in e-portfolios from some staff across campus, seeing the potential of these tools to enhance student learning. At this stage, however, the technology does not seem to be robust enough yet to be rolled out across the institution. The Mahara e-portfolio was chosen for exploration in pilots as it was most easily integrated with the current and future LMS and had functions that were desirable for several stakeholders. While some staff and students expressed overall satisfaction with Mahara, many had issues with the key criteria identified from the 4 E Model and the CICTO framework—educational efficacy, ease of use, personal engagement, and fit with institutional context. Although the cohorts in the study were chosen as optimum for its use and had training provided in how to incorporate it into their learning, Mahara's usability and complexity in some cases outweighed the benefits of its use.

The results suggest that, like all successful curriculum innovations, e-portfolios need to be integrated into the learning and teaching process and students need to understand the benefits of using the tools. This will require a shift toward an institutional culture of encouraging students to collect evidence of their learning journey. If greater student ownership of this collection is encouraged, the implementation of one centralised tool may be less significant. Faculty and departmental focus may more successfully be targeted toward encouraging staff to design tasks to scaffold the development of expertise, for example in graduate capabilities. Students can be encouraged, ideally from first year, to design and manage the collection and sharing of this evidence. Staff and student access to cloud computing tools such as the Google suite could be a flexible solution that would enable faculties and departments to design and implement e-portfolio-based learning in their own contexts. Students could store their own work and produce reports for assessment as required.

Another of the issues to be explored is the need for an overt program-wide approach to portfolio-based learning. If a program-wide approach is adopted, this takes some pressure off individual convenors to introduce and manage this change in isolation in their own units and can be spread across several units. Among the changing demands is the need for a culture of encouraging the collection of evidence by students about their learning across their whole program. While the broader institutional policies advocate the integration of learning in capstone units and reflection by students on their development of graduate capabilities, institutional culture can be slow to change. Ideally, the tasks in the units need to be structured to scaffold students in capturing evidence of their developing expertise as they progress through their whole program, in graduate capabilities, and their discipline learning. Plans for future research include exploration of assessment tasks design as an independent issue from technology in order to maximise the introduction of any new system.

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learning and teaching, technology innovation, and changes in the type of typical activities required to achieve the intended learning outcomes expected by course designers (Biggs & Tang, 2007). Chief amongst these changes is the widespread introduction of technologies into the university student learning experience (Bonig, 2011; Johnson, Adams, & Cummins, 2012; Lowendahl, Harris, & Bonig, 2012) and their relationship to the design of curricula (Hopson, Simms, & Knezek, 2002) which is requiring a rethink about what constitutes successful experiences of learning at university. The university student experience of technologies in learning is not uniform (Ellis & Goodyear, 2010) and this variation contributes to the challenge of designing effective curricula. This study considers evidence of the variation of the student experience of technology-mediated learning as a source to inform curricula design.

19.2 Challenge

In terms of curriculum design, decisions to integrate technologies into learning and teaching activities have the potential to disturb the ecology of the student experience (Ellis & Goodyear, 2010). Poor design of a technology-mediated activity can create curriculum misalignment (Biggs & Tang, 2007). In this context, curriculum misalignment would occur when coherence is lacking amongst the outcome expected from the task, the assessment used to judge the task, the activities and tools provided to enable the task, and the objective of the task. Research has shown that different technologies have different educational affordances (Gibson, 1986), and some are more appropriate for particular types of tasks than others (Laurillard, 2002). If there is a poor choice of technology for the activity, then it can impede rather than enable the outcome, increasing the chances of curriculum misalignment.

Misconceptions about the purpose of learning tasks, the technologies used to support them, and/or poor approaches adopted by teachers or students when using technologies in learning tasks can impede successful learning outcomes (Ellis & Goodyear, 2010). Studies have shown that misalignment between student and teacher conceptions of learning within the same course can lead to learning failure. If an experience of learning is shaped by conceptions and approaches which do not fit the intention of learning tasks in curricula design, then the experiances of such tasks do not tend to foreground higher levels of learning outcomes, such as synthesis, analysis, and application in new contexts (Biggs & Tang, 2007; Prosser & Trigwell, 1999; Ramsden, 2002).

A challenge for curriculum design then is to recognize and make allowances for what we do not know. We do not always know how students will respond to the technology-mediated activities and the tools which are being integrated into curriculum design. The *intended* outcomes sought from the activity may not be the *realized* outcomes that the students report and their achievement suggests. Design solutions should consider different student responses to them so that those who may have a tendency to adopt less successful approaches are supported to reconsider how they might engage in the task using tools. If misalignment between intended and realized outcomes is the case, then what are the reasons for the disparity?

And how can curriculum design make use of this knowledge in an approach to design which makes it more effective?

To highlight these issues and embed its implications in an authentic context, this study investigates the student experience of learning in a course in international and global studies, *Transnational Spaces and Networks*. The main learning outcome of the course was to help students better understand how international institutions, both public and nongovernment institutions, define and present their image to their audiences. In this study, a key assessment item, their *portfolio project*¸ is investigated from the perspective of students for the insight it provides to issues of curriculum, learning experience, and outcomes. In the course of their study, the students were expected to engage in lectures, online research, and an online blog as they pursued the completion of their project. The outcomes of this study are designed to crystallize the argument that curriculum designers should draw on the student experience of technology-mediated learning to inform curriculum design.

19.3 A View on Learning and Curricula

The view of learning adopted in this investigation is a relational one, one in which understanding of the student experience of learning is shaped by how different parts of the experience relate to each other, so that a better understanding of the whole can be reached (Biggs, 1987; Biggs & Tang, 2007; Ellis & Goodyear, 2010; Entwistle & Ramsden, 1983; Marton, 1970; Prosser & Trigwell, 1999; Ramsden, 2002).

In a relational view, key aspects of the learning experience include how students report their ways of thinking about learning (concepts of learning), how they go about learning and why (approaches to learning), and how they perceive the learning environment (perceptions) and relevant outcomes of the experience such as academic achievement measured by course marks. Key outcomes from this body of research have identified how qualitative variation in these different aspects are logically, empirically, and structurally related to outcomes. Studies have shown across student experiences of mathematics (Crawford, Gordon, Nicholas, & Prosser, 1994, 1998), engineering (Ellis & Calvo, 2006; Ellis, Goodyear, Calvo, & Prosser, 2008), and physics (Prosser, Hazel, Trigwell, & Lyons, 1996; Prosser, Walker, & Millar, 1995) that they vary considerably. Within this variation, qualitatively better experiences (those shaped by cohesive conceptions, deep approaches, and positive perceptions) tend to be related to relatively higher academic achievement as measured by course and task marks. Similarly, qualitatively poorer experiences, those shaped by conceptions of learning which separate a development of understanding from the experience (fragmented concepts), approaches to learning which are more reproductive than illuminating (surface approaches), and negative perceptions of the learning environment, tend to be related to relatively lower academic achievement. One way of construing misaligned student experiences of curricula and task design is to consider them the students' reactions to the context in which they find themselves learning (Biggs & Tang, 2007).

A relational view is the principle adopted by a constructively aligned curriculum (Biggs & Tang, 2007). In this curriculum model, intended learning outcomes, those outcomes which the course designer/teacher hope the students will achieve once they have completed a task, are used as a point of reference to which the accompanying learning and teaching activities, assessment and evaluation are aligned. For example, if a poor assessment technique is chosen, one that does not assess and promote the intended learning outcomes, then a key aspect of the curriculum is not aligned to the outcome. A simple example of misalignment would be a case of using multiple-choice questions to assess scientific report writing. The skills of answering questions do not help a student to develop their written communication skills. A more complex case might involve a design which demands an alignment between the experience and a task. If we use online research as a second example, an expectation that a student will triangulate different online sources of knowledge for its veracity and quality before drawing on them in an integrated way to form a position on an issue may not necessarily be the strategy that all students adopt. If we find evidence that this is indeed the case, then an effective design may seek to scaffold less strategic approaches more successfully. The exploration of these issues was at the basis of choice of the research site for this study.

This study uses the context of a second year university course on Transnational Spaces and Networks to consider the associations between the intended outcomes of an aligned curriculum, the student experience of the technology-mediated learning activities, and variation in the level of outcomes achieved by the student. The main research question guiding the investigation is;

> What implications for curriculum design does qualitative variation in the student experience of technology in learning have? What reasons might explain this variation and how can curriculum designers respond to these explanations effectively?

19.4 Research Site

In the field of International and global studies, multinational and nongovernment organizations (NGOs) are investing significantly in their online presence and identity. International partnerships, links with stakeholders, funding opportunities, and demonstration of remit and outcomes can be influenced by the success or otherwise of how an organization promotes its identity and presence online.

Using this context, the curriculum of a second year university course was designed to help students to develop the skills and knowledge to analyse the extent to which multinational and NGO institutions had successfully promoted their identify and presence online. The assessment task in the course researched in this study included a *portfolio project.* The aim of the project required students to analyse and evaluate the extent of effectiveness of international institutions' online presence in communicating its purpose and remit to its audience. To complete the project successfully, the students were required to engage with the ideas they attended to in their lectures, the ideas they discussed and debated in the tutorial, and the ideas they researched and reviewed online. The *learning space* of their portfolio task consequently included their class (lecture and tutorial) and online environments.

The assessment schedule of the course was predominately designed around the portfolio project. Students were expected to provide a comprehensive overview of a public or NGO they had chosen by week 5 (15 %), provide an analysis of the online presence of the organization over a 5-week-period using a blog (30 %), and then complete an in-depth comparative analysis of a key issue highlighted by the organizations' policy and communications approach with the approach adopted by another organization (35 %). An additional assessment item was a joint oral presentation based on one of the tutorial readings which provided theoretical and practical backgrounds to the tasks (20 %). The nature of the learning outcomes of the course, the design of the activities, and the goals of the teacher required an embedded approach to integrating technology into the design of the curriculum. The academic achievement variable used in the design of this study was derived from the students' total mark from these assessment items.

19.5 Method

19.5.1 Design

To evaluate the experience of students, two studies were designed over two consecutive iterations of the course. The purpose of the two studies was to capture emerging descriptions and empirical measurements of key aspects of the students' experience that provided some explanation of how the student experience of learning, technologies, curriculum activities, and outcomes are related. Study 1 is meant to be illuminating, providing a rich description of some of the key issues from the students' perspective.

Study 2 provides the main research outcomes of the investigation. It uses ideas from study 1 and instruments from methodologically related previous studies (Ellis & Goodyear, 2010; Prosser & Trigwell, 1999; Ramsden, 1991, 2002) to inform the overall design of the study and the variables chosen to investigate the quality of the student experience.

19.5.2 Participants

For study 1, students were invited at one of the lectures towards the end of the semester to volunteer for interviews. Twenty students volunteered (ten male and ten female), and following their consent, were interviewed in a semi-structured format using the questions below as the structure. Each interview was fully transcribed and used for the purposes of analysis to support the following discussion. The aim of the analysis was to highlight key themes which would inform the subsequent qualitative study which investigated the nature of associations in the student experience. The following extracts are presented to illuminate the student perspective.

For study 2, students were asked in lectures in the last 2 weeks of the semester to volunteer to be part of the study into their experience of learning surrounding the portfolio task. Seventy-seven students took part in the study (43 female and 34 male), each completing the questionnaires sufficiently in order for them to form the population sample. The students were given an explanation at the beginning of the surveying process which helped them to understand the context of the study and questions.

19.5.3 Instruments

The questions for the interview in study 1 were designed to understand and investigate the students' approaches to inquiry using the technologies, their ideas about inquiry, and the nature of the learning environment in which their experiences took place. The questions were:

– How do you approach learning through inquiry for the Portfolio assignment?
– What is learning through inquiry?
– What aspects of the University learning environment helped your learning in this course?

The purpose of the third question was to look for reasons why students, as Biggs suggests, may react to different aspects of the environment.

In study 2, the variables chosen to be measured were informed by prior research (Ellis & Goodyear, 2010; Prosser & Trigwell, 1999; Ramsden, 1991, 2002) and the students' response to the interviews in study 1. It seemed that variation in the students' perceptions of learning space may provide some reason why some more holistically embraced their tasks which involved working both in class and online. By bringing these perspectives to bear on the student experience of the portfolio task, the general hypothesis chosen for investigation sought to look for qualitative variation in the student experience of inquiry that would describe logical and statistically significant relationships amongst approaches to inquiry, approaches to technologies, perceptions of learning space, conceptions of learning, and academic achievement as measured by the course mark. More precisely, the hypotheses used to design the study are:

> Deep approaches to the use of technologies would be related to deep approaches to learning through inquiry, cohesive conceptions of learning, integrated perceptions of learning space and relatively higher academic achievement.
>
> Surface approaches to the use of technologies would be related to surface approaches to learning through inquiry, fragmented conceptions of learning, disintegrated perceptions of learning space and relatively lower academic achievement.

In study 2, a number of variables were used to investigate these hypotheses. The 'approaches to inquiry questionnaire' is divided into two subscales.

Deep approaches subscale identifies the approach as more reflective and independent, taking time to consider many facets of the problem and taking the initiative with a more holistic perspective. The surface approach subscale identifies the approach as more formulaic, simply asking questions and using ideas without much critical evaluation. The 'approaches to learning technologies questionnaire' is similarly designed. The deep approach to technologies subscale reveals an approach which uses technology to develop understanding, interacting with knowledge to better understand the key ideas of the course. The surface approach to technology subscale identifies approaches which are mechanistic in their strategies, limiting use and not relating the approach to issues related to the development of understanding. The questionnaires benefited from the development of similar instruments from prior closely related research (Barrett, Higa, & Ellis, 2012; Biggs & Tang, 2007; Crawford et al., 1998).

The 'Conceptions of learning' questionnaire is divided into cohesive conceptions subscale and the fragmented conceptions subscale. The former subscale identifies a conception of learning which is about clarifying personal understanding of the phenomenon under study, making links with broader issues and topics through understanding its parts and associations in more subtle and complex ways. The latter identifies a conception of learning which is about trying to find the right answer, quick solutions, and remembering information. In addition to this questionnaire, a variable investigating perceptions of learning space was designed to assess positive or negative perceptions on the part of students about the extent of integration between physical and virtual learning space. It assessed the extent to which students perceived the integration between their experience in class and online. These instruments were informed by previous closely related studies (Ellis & Goodyear, 2010; Prosser & Trigwell, 1999; Ramsden, 1991).

Table 19.1 presents the scales of the questionnaires, items which illustrate the meaning of the subscales, and the reliabilities of each subscale.

19.6 Results

19.6.1 Study 1

In Study 1, students reported variation in how they approached the portfolio task, what strategies they adopted, the underlying intent which motivated their activity, and their perceptions of the learning environment.

19.6.1.1 Approaches to the Portfolio Assignment

In answer to the question about their approach to the portfolio task, some students reported evaluative strategies, testing their ideas about the effectiveness of the institution's online identity with their classmates and testing them against the theories they were studying.

Table 19.1 Scales of the questionnaires, reliabilities, their labels, and illustrative items of each subscale

Scales	Illustrative items of the scales
Approaches to inquiry	
Deep (5 items; $\alpha = 0.76$)	I often take the initiative when pursuing a line of questioning in research
Label: *dai*	I spend a long time thinking about just the right question to ask when researching something
Surface (5 items, $\alpha = 0.74$)	When I research something, just asking a question is usually enough
Label: *sai*	Researching something is just like following a formula
Approaches to learning technologies	
Deep (5 items; $\alpha = 0.90$)	I spend time using the learning technologies in this course to develop my knowledge on key topics
Label: *dat*	I try to use the learning technologies in this course to achieve a more complete understanding of key concepts
Surface (4 items; $\alpha = 0.57$)	I use learning technologies in this course mainly to download files
Label: *sat*	I restrict my use of learning technologies in this course to do as little as possible
Conceptions of learning	
Cohesive (8 items, $\alpha = 0.93$)	Learning for this subject allows relating my personal experiences to topics in order to understand them better
Label: *cc*	I think learning for this subject allows me to improve my understanding of the broader topics we study
Fragmented (6 items, $\alpha = 0.84$)	Learning for this subject is just about finding the right answer
Label: *fc*	The purpose of learning for this subject is mostly to help use remember facts for our tasks
Perceptions of learning space	
Integrated perceptions (4 items, $\alpha = 0.70$)	I see the relationship between the tutorial sessions in my course and the online activities
Label: *pls*	All the online activities and resources seem to be well integrated with the course structure

> You raise one issue, and this is your own opinion, and then another one raise another question with regards to that issue. So, you feel, initially you feel(it's) a little bit challenging, and then you have to sort of persuade him (the lecturer) why you think it's correct. And I think that helps you engage in the understanding deeply of these two organizations

> It was looking with a critical eye at everything and thinking about why they (institutional stories) might have been designed that way. Um looking at components such as the layout, what kind of information was presented, the way it was presented the language …how they are presenting the story ..to use theories we've learnt in the lectures um and apply them to how the stories are framed.

The approaches to the portfolio task described in the above extracts appeared to be qualitatively different to other approaches reported by the students in the interviews. Instead of the focusing on the analytical aspects of the task, technology came to the fore in the descriptions reported below.

> I guess the overview was just to get an idea of the organization, for the actual blog. And the blog was to be able to critically analyze web media. Which has been useful but … but there are millions of blogs out there.

> The blog, I didn't learn anything from it.…A blog is something you're passionate about, that you're talking about, like fashion blogs and such. So talking about the UN defeats the purpose of talking in a blog format.

> I did learn about how different organizations used different forms of multimedia and different ways and to different effectiveness standards. So I learnt that the UN probably doesn't use um certain forms of multimedia like Facebook and Twitter particularly well. Um but I meant…but I kind of managed to establish a contrast between that and um my choice of NGO. The NGO's tend to be much better or much more efficient at using multimedia well

These types of responses in the interviews to the first question seemed to have lost sight of the purpose of the task. It was as if the technologically-mediated aspects of the task became the dominant focus of the experience; being overwhelmed by the volume of blogs, being underwhelmed by using blogs for the task; or looking primarily at comparisons of social technologies, rather than institutional identity.

19.6.1.2 Ways of Thinking About Inquiry

The interviews revealed variation in the student concepts of inquiry. Some of the interviews emphasized the importance of independent thinking, emphasizing the importance of making an effort to pursue different avenues of research in order to develop a considered position on an issue.

> I would say yeah maybe it's perhaps kind of using your own um, using kind of the facts or kind of a primary source type thing to draw your own conclusions. So rather than just taking someone else's opinions or perspectives, using those to analyse things, you kind of try and create your own in a way. Um yeah and sort of you know, not taking things at face value but definitely going beyond them and kind of thinking about how um they represent different things and how there's more to it than there might seem.

> This assignment more than any other has sort of forced me to um make up my own mind I think about how people do present things and um like the actual techniques and sort of um like reasons for having you know, put some stuff on the site or left other things out. But um it is very self-directed in a way that maybe reading an article is not.

> I think it goes back to what I was talking about with getting deeper with things and not just taking things at face value. Sort of um looking at what's presented to you but also questioning it and questioning why this way, why not this way. If they're done another way then why would they have done that? Really looking at um the bigger picture of what's presented to you. Because I know in this um portfolio assignment, the first few assignments we weren't supposed to do…well not..well they didn't say we had to do outside research. It was all in the website. So um really just you know, inquiring and not just taking whatever is presented to you because you're only given this one. You're not supposed to look at other critics of the website. You have to be your own critic and make your own analysis and your own inquiries about it.

Other experiences of inquiry suggested by the interview transcripts revealed a more formulaic concept, involving collecting information, asking questions, and producing something.

> I guess researching a lot of information and um correlating that information together to form an opinion from it.

> sort of like learning through being more practical and asking questions.

> Ah so learning by, I guess… through questioning um through interacting I guess with the material which I guess, particularly the blog assignment … the idea of taking in information, processing it and then outputting I guess your own um thoughts, considerations, that kind of idea.

These latter ideas about inquiry did not display much depth in how inquiry is related to critical evaluation, insight from comparative analysis, or synthesis of ideas. They tended to be restricted to concrete aspects of the concept, focusing on the formulaic aspects such as retrieving information and producing something.

19.6.1.3 Perceptions of the University Learning Environment

Through the interview process, the students often described their reactions to the University learning environment in ways that were unanticipated. An interesting theme became apparent about the students' awareness of how the portfolio task required them to engage in their learning both in class and online. Some responses revealed concepts which were holistic in their perception of physical and virtual space, and those which tended to discard or fragment the aspects of virtual learning spaces from their perception of the environment.

Some students reported perceptions which seemed to integrate the contribution of physical and virtual aspects of the environment to their learning.

> The fact that we have areas we can all meet up and do like group presentations when we need to, supports that. It's not like, maybe … where everyone has to meet in the library or something, we have spaces to meet in. Um and through like on the learning management system where you can have the discussion boards because for one of my classes we had a debate yesterday and we all wrote up our points of view in the discussion board and compared them instead of meeting up.

> I just find I really like it (the University) as an environment to work in. It's much easier to concentrate when you're in the library for example than at home. Um yeah and I found the learning management system really good. I thought it was supportive and also I like how there is the option to email tutors and email lecturers and they are very responsive, especially emails. The tutor has been responsive to enquiries and um I know my tutors is always willing to um to discuss things more in depth even if it cuts into his time and um to email me back. Yeah I found that they've been very supportive of us with the blogs.

The aspect of the student perspective emphasized in the above extracts is their perception of the learning environment, which did not separate or perceive a dualism between physical and virtual learning space as they pursued the ideas relevant to their portfolio task.

In contrast, other perceptions revealed in the transcripts seemed to devalue or fragment the contribution of virtual learning space from the experience. Despite experiencing the same activities, resources, and support as the other students, some had negative perceptions about their value for learning and tended not to use them much, or they tended to fragment their experience by substituting their face-to-face obligations with e-learning in a way that was not really intended.

> I find that e-learning can be a bit token sometimes. Like I don't think it's very useful. Um I think it's interesting that I had our blogs up on email. It meant that I visited the site a lot more than I normally would. Um but yeah I mean, apart from that I don't use it all that much.

> Having the learning management system… I know there's discussion boards on the LMS but I never I never use them.

> I think e-learning is um quite good because it does just mean that you keep up to date and um because I only do three subjects, I'm only in Uni nine hours a week, um which means that I don't spend…I don't necessarily come in that much …if they post something up, it does mean that I'm aware of a lot more than I would be without it…so if you miss a lecture you can go listen to it but it doesn't mean you will go and listen to it!

These types of comments by students in the interview seemed to both acknowledge the existence of activities and support what they needed to engage with for their experience, but perceive them as not really necessary to achieve their learning outcomes. These ideas stand in contrast to the previous extracts indicating more holistic perceptions of learning space and to the intent of the design of the course which required students to engage in meaningful interaction with resources, activities, and other students' work online.

If we consider all the interview extracts above together, they illuminate some interesting themes from the student perspective about their approaches to learning using the blog, their ideas about inquiry in technologically mediated learning tasks, and their perceptions of the learning environment. These insights motivated the design of the second study. It is designed to probe more empirically into the relationships amongst their approaches and perceptions of learning, technologies, and the environment. In the next iteration of the course in the following year, the objectives, activities, and structure, assessment, and intended outcomes did not substantially change and consequently provided a useful context in which to tease apart some of the ideas the students raised in their interviews with the intention of considering them in the context of evidence and motivation for redesigning the curriculum.

19.6.2 Study 2

The results of study 2 are presented in two parts; outcomes from correlation and cluster analyses at the level of variables and outcomes at the level of groups of students in the population in the cluster analyses. Together, the results of correlation analyses, principal components factor analyses, and cluster analyses show statistically significant relations between students' approaches to inquiry, approaches to technology, conceptions for learning, and perceptions of learning space and academic achievement.

Table 19.2 Correlations between elements of the experience of learning

Variables	sai	dat	sat	cc	fc	pls	aa
Deep approaches to inquiry (dai)	–0.30**	0.23*	–0.05	0.17	0.17	0.17	–0.01
Surface approaches to inquiry (sai)		–0.17	0.60**	–0.16	0.56**	–0.10	–0.17
Deep approaches to technology (dat)			–0.24*	0.34**	–0.01	0.46**	–0.09
Surface approaches to technologies (sat)				–0.11	0.48**	–0.00	–0.12
Cohesive conceptions (cc)					–0.17	0.50**	–0.05
Fragmented conceptions (fc)						0.07	–0.31**
Perceptions of learning space (pls)							–0.22
Academic achievement (aa)							

($N=77$), $*p<0.05$; $**p<0.01$ (2-tailed)

19.6.2.1 Correlation Analysis

In order to examine the relationship between variables, a series of Pearson Product Moment correlation analyses were performed. As suggested by Cohen (1977), the magnitude of the association r values of 0.10, 0.30, and 0.50 indicate small, medium, and large effects, respectively. Table 19.2 contains the results of the correlation analyses of the scale and outcome variables. The label for each column is explained in the relevant row.

The deep approaches to inquiry variable positively correlate with the deep approaches to technologies ($r=0.23$, $p<0.05$). The surface approaches to inquiry show a large positive association with the surface approaches to technologies ($r=0.60$, $p<0.01$) and with the fragmented conceptions ($r=0.56$, $p<0.01$). Similarly, the deep approaches to technologies subscale were found to have a positive and moderate correlation with the cohesive conceptions ($r=0.34$, $p<0.01$) and with the perceptions of learning space ($r=0.46$, $p<0.01$). In contrast, the surface approaches to technologies show a positive association with fragmented conceptions ($r=0.48$, $p<0.01$). In terms of the conceptions of learning scales, the results showed that the cohesive conceptions subscale significantly and positively correlated with the perceptions of learning space ($r=0.50$, $p<0.01$); whereas the fragmented conceptions subscale did not show any significant association with the perceptions of learning space ($r=0.07$, $p=0.53$). With regard to the relationship between elements of the experience of learning variables and academic

Table 19.3 Principal components factor analysis of the students' experience of learning

Variables	Factors 1	2
Deep approaches to inquiry (dai)		0.47
Surface approaches to inquiry (sai)	0.80	
Deep approaches to technology (dat)		0.74
Surface approaches to technology (sat)	0.75	
Cohesive conceptions (cc)		0.71
Fragmented conceptions (fc)	0.83	
Perceptions of learning space (pls)		0.83
Academic achievement (aa)	−0.48	
The principal components explained 53.77 % of the variance		
Varimax rotation, loadings less than 0.40 removed		

achievement, only the fragmented conceptions variable was found to be significantly and negatively correlated ($r = -0.31$, $p < 0.01$).

19.6.2.2 Principal Components Factor Analysis

A principal components factor analysis was conducted to look at the structural relationships between the seven variables of the experience of learning through inquiry and one variable on academic achievement. The two-factor result sought following use of the scree-plot data is shown in Table 19.3.

Factor 1 showed substantial loadings on four variables: substantial positive loadings on the surface approaches to inquiry (0.80), the surface approaches to technologies (0.75), and the fragmented conceptions (0.83); and one smaller negative loading on academic achievement (−0.48). Factor 2 exhibited substantial positive loadings on four variables: the deep approaches to inquiry (0.47), the deep approaches to technologies (0.74), the cohesive conceptions (0.71), and the perceptions of learning space (0.83).

19.6.2.3 Cluster Analysis

A cluster analysis was conducted to identify subgroups of students in the population sample who reported similar experiences in the course as measured by their ratings on the questionnaires. The variables representing the constructs of approaches to inquiry (deep and surface), approaches to technologies (deep and surface), conceptions of learning (cohesive and fragmented), and the perceptions of learning space were subjected to a hierarchical cluster analysis using Ward's method (see Seifert, 1995). The analysis resulted in two clusters based on the increasing value of the Squared Euclidean distance between clusters and dendrogram. Students' academic achievement scores were assigned on the basis of cluster membership. An ANOVA to compare means was then used to determine the significance of the between-groups

Table 19.4 Summary statistics of the two-cluster solution for the variables of experience of learning

Variables	Cluster 1 ($N=26$) Mean (Z-score)	Cluster 2 ($N=51$) Mean (Z-score)	p
Deep approaches to inquiry (dai)	–0.06	0.03	0.73
Surface approaches to inquiry (sai)	0.50	–0.26	0.00
Deep approaches to technologies (dat)	–0.89	0.45	0.00
Surface approaches to technologies (sat)	0.55	–0.28	0.00
Cohesive conceptions (cc)	–0.79	0.40	0.00
Fragmented conceptions (fc)	0.64	–0.33	0.00
Perceptions of learning space (pls)	–0.50	0.25	0.00
Academic achievement (aa)	–0.14	0.06	0.44

contrasts. Standardized scores were used for all the variables to reduce the original scores to a mean of 0 and a standard deviation of 1 in order to achieve the comparison. The results are shown in Table 19.4.

The ANOVA analysis identified statistically significant contrasts between the two clusters on almost all variables, except for deep approaches to inquiry and academic achievement, on the basis of the cluster membership. It identified a group of 26 students (cluster 1), with a large positive score on surface approaches to inquiry (0.50, $p<0.00$), a large positive score on surface approaches to technologies (0.55, $p<0.00$), a large positive score on fragmented conceptions (0.64, $p<0.00$), and a large negative score perceptions of learning space. Cluster 2 identified a group of 54 students with a large positive score on deep approaches to technologies (0.50, $p<0.00$), a medium positive score on cohesive conceptions (0.40, $p<0.00$), and a medium positive score on perceptions of learning space. These students also achieved a score on the academic achievement which was in the right direction in comparison to cluster 1, though not statistically significant.

19.7 Discussion

This study is an exploratory one designed to investigate changes in the parts of the university student experience of learning, seeking to understand why some students are more successful than others, and using that knowledge to inform approaches to curriculum design.

Before considering the outcomes, it is prudent to acknowledge the limitations of this study so that the force of the implications can be judged. The design involves 2 population, 20 interviews, and 77 questionnaires. Further studies are required to improve the sample size to assess the reliability of the findings, including attending to the alpha coefficient of the surface approach to technology variable which is low. The results are primarily of a second-order nature, that is they are self-reports by the students of the experience rather than the outcomes of direct observations (Bordieu, 1977).

The design of further studies should also include some observational data as a type of triangulation to assess the strength of the outcomes. These limitations notwithstanding, the study has opened up new research avenues for exploring the implications of changes in the student experience of learning for the design of curricula.

Study 1 provided some interesting descriptions of the student experience of the portfolio task and emphasized aspects of the experience brought about by a use of learning technologies in the task. They used their course website for curriculum information and the tools, they used internet browsers to research the identity of two international organizations, and they used communication tools to discuss issues related to their studies. It is clear from the interview extracts in study 1 that not all students approached the inquiry tasks and use of technologies in ways which were likely to support their learning. Some reported approaches which embraced higher order characteristics of learning such as taking the initiative, reflection, critical evaluation, and looking for ways to develop more holistic understanding through analysis. Others reported approaches which were more formulaic and techno-centric, focusing on a process which produced something, or the tool in which the knowledge was presented.

When considering why students reported such variation, one reason that came up surprisingly from the students was their different perceptions about learning space. The design of the task required the students to integrate ideas from their lectures and tutorials, as well as the online environment. To ignore one in preference for the other would be to ignore half the design of the task. The interviews revealed that some students understood the importance and links between their learning in class and online. They did not delineate strongly between the two, preferring to draw on ideas from any of the places where their learning took place as long as it helped them address the task. Other students in the interviews seemed to separate their online experience from their class experience, not integrating the two in relation to the task which *required* integration. They appeared to react to different aspects of the environment, some avoiding a use of the technology because they did not like it and others limiting the time they spend using it for other reasons.

While the outcomes from study 1 proved valuable as a way of identifying variations in the student experience of inquiry and technology and their perceptions of how the class experience related to the online experience, it did not provide any measurements of the associations or relationships amongst these issues and the students' academic achievement. This was the focus of the second study which looked at associations amongst approaches to inquiry and technology, conceptions of learning and perceptions of learning space and academic achievement. The second study confirmed the existence of qualitative variation in students' perceptions of learning space and that these were related logically and significantly to the other variables in the following ways.

At the level of variables, study 2 found logical and statistically significant associations among deep approaches to inquiry and technologies, cohesive conceptions of learning, positive perceptions of learning space, and relatively higher academic achievement as measured by the course mark. Study 2 also found logical and statistically significant associations amongst surface approaches to inquiry and technology, fragmented conceptions of learning, negative perceptions of learning space, and relatively lower academic achievement as measured by course mark. This was true for both the correlation and factor analyses. At the level of groups of students in the population sample, the associations were confirmed, although deep approaches to inquiry and academic achievement were not statistically significant.

Before discussing related issues and implications of these findings, it is worth dwelling on the significance of looking at student perceptions of learning space in their experience of completing the portfolio project. The outcomes seem to suggest that the students' perceptions of learning space during the task, whether they see both class and online experiences as an integrated whole, are related to the success of their outcomes. This thought is worth dwelling on in some detail.

The learning experience used in this study, the portfolio project, is one in which the analysis of institutional identities online and the use of the blog to publish the students critical thoughts about that analysis both involved a meaningful use of learning technologies in which to pursue their learning as well as publish their outcomes. As a consequence, the structure of the students' experience of learning space involved them pursing ideas backwards and forwards across formal lecture/seminar experiences, informal learning experiences in libraries, at home and virtual space in which they research the identities (the Internet), and published their thoughts and received feedback (their blogs). If a student is engaged in such a task, but does not perceive the online environment as a legitimate place of learning, then it is perhaps unsurprising that their realized outcomes do not align to the intended outcomes of the lecturer. If true, then the implications from this study are worth pursuing in further studies, particularly for what they might indicate in terms of approaches to curricula design.

19.7.1 Issues and Implications Arising

The integration of technologies into task and curricula design threatens to misalign curricula. Intended outcomes of technology-mediated tasks can be thwarted without a strong basis of evidence of the student experience about the surrounding design.

In this study, about a third of the students realized outcomes which were at odds with the intentions of the curriculum design. This outcome can be thought of to frame a design challenge. How could the task design be renewed to limit this type of outcome in ensuing iterations of the course?

Changes to the curriculum design could start at the level of the sequence of tasks throughout a semester. The associations amongst the deep approaches to enquiry and coherent conceptions of learning variables suggest that activities early on *in addition* to the portfolio task could help students to reassess and orientate their ideas about learning through enquiry more meaningfully. The strong associations with approaches to technologies means that such activities may help them to approach their use of technologies more effectively when they engage later on in such activities as the portfolio task.

The evidence also suggests that students may benefit from changes to the structure of the Portfolio task itself. To help students engage more deeply at each stage of the task, a stronger framing of the intended outcomes may help students realign and/or reflect on the approaches they adopt and perceptions they hold. The design of the activity involving the comprehensive overview of an organization could be integrated with tasks which require the students to demonstrate how they went about researching for the task. This type of meta-reflection on process could then inform a class-based task which encouraged the students to debate the effectiveness and benefits of different methods of online research. A similar approach could be used in the task involving the blog, not just requiring students to publish their work and provide feedback to others through the blogs, but to require the students in class to discuss how they were providing and using the feedback as a mechanism of reflection. This type of emphasis in a redesign of the tasks may help students to reconsider the approaches they adopt and the perceptions they hold. This last point offers a point of departure for future studies.

A significant and unexpected outcome of the study is the association of students' perceptions of learning space with the success of their experience. To see if this association is fundamental to the university student experience of learning, future studies are required to understand the structure of those perceptions more precisely, to increase the sample size, and to broaden the disciplinary domains of the findings. With greater depth and scope of the associations in the student experience amongst perceptions of space, approaches to inquiry and technologies, and achievement, the discipline of curriculum design and its intended outcomes may increasingly be realized by the students who benefit from it.

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20.1 Introduction

Curriculum innovation can be broadly defined as finding a new way to solve an existing educational problem or as a way of achieving something that was previously not possible (Salmon, 2005). It might involve a new tool or process, or a different way to apply existing ones. Importantly, innovation needs to be understood in the context in which it occurs (Cox, 2008, p. 204). For university education in the twenty-first century, elearning is a common feature.

A study of 22 cases of elearning innovation that originated within the Australasian higher education sector revealed structural challenges in universities that compromise the prospects for such developments to grow and transform educational practice (Gunn & Herrick, 2012). The study was designed to investigate a problem that has featured in the literature for more than 30 years, i.e., what happens to educationally successful elearning initiatives when start-up grants run out (e.g., Callan & Bowman, 2010; Davis & Fill, 2007; Dede, 2003; Duke, Jordan, & Powell, 2008; Gunn, 2010; Nichols, 2008; Romiszowski, 2004; Southwell, Gannaway, Orrell, Chalmers, & Abraham, 2005; Stansfield et al., 2009; Wiles & Littlejohn, 2003). The broad aims were to identify and attempt to remove common barriers that blight the path from innovation to diffusion and sustainable practice. In this context, sustainable is defined as a learning design or tool that has gone through a proof of concept stage, been adopted, and possibly adapted for use beyond the original development context and where ongoing use and development do not remain dependent on one or a few individuals who created it (Gunn, 2010). A sample of 22 cases from one geographical area is small in global terms. However, the spread of some of the innovations and the literature on sustainability challenges are high-profile internationally, so findings should have broad relevance.

The study identified three main areas where challenges arise, i.e.:

- Organizational structures, processes, and enacted values that present barriers to adoption of innovative tools and practices growing independently of central university systems
- Inconsistent presentation, limited availability, or inappropriate forms of evidence that the innovation has potential for adoption on a wider basis
- The organic and unpredictable nature of innovations and the absence of suitably responsive organizational structures and processes

Little can be done to address the third point, beyond accepting that innovation cannot be managed, at least in the initial stages, and that organizations need to accommodate this degree of uncertainty. However, the first two points can be systematically addressed, either by the innovators themselves or in collaboration with the host organizations that currently espouse, but do not enact, values that should translate into practical support mechanisms. This chapter identifies common challenges that elearning innovations face en route to becoming sustainable tools and practices and proposes practical strategies to allow innovators and institutions to work in partnership to facilitate the transition. Until these issues are addressed, curriculum renewal through elearning will remain largely a matter of chance.

20.2 Problems with Elearning Innovation

One of many problems facing elearning developments in universities is mismatch between the organic and unpredictable nature of innovations in learning technology and the hierarchical and tradition-bound contexts they take place within. In *A Passion for Excellence*, Peters and Austin (1985) note that innovation has always been an uncertain and messy affair. The response from most organizations is to "pursue tidier plans and better-organized teams to beat the sloppiness out of the process," regardless of the fact that this approach has never proved successful in either business or elearning. Instead of futile attempts to control it, they propose designing organizations that take account or even take advantage of the unpredictable nature of the process. However, this implies a degree of flexibility and responsiveness that is uncommon in universities, particularly where large budget items such as central IT services are involved (Gunn, 2010; Stiles & Yorke, 2006).

Innovations struggle to survive without the conducive organizational climate that research identifies as a critical success factor. Wycoff (2004) lists this as a key reason for failure, along with low buy in, limited resources, poor alignment with strategy, inadequate support and training, and no way to capture or manage emergent ideas. After analyzing 14 cases of elearning innovation in the Australian higher education sector, McKenzie, Alexander, Harper, and Anderson (2005) added strong, proactive leadership, effective change management processes, clear understanding of pedagogy, dissemination of ideas within scholarly communities, and networking opportunities to the success factors list. These broad issues influence the willingness of innovators to experiment and take risks and their colleagues' readiness to adopt and adapt ideas or resources developed by others.

Significant challenges to the ongoing success of elearning innovations also arise from the fixed term funding model that has allowed many great ideas to be translated into useful systems and resources. National strategic initiatives for elearning in UK higher education funded a large number and variety of projects over many years. Reviewing the outcomes of these initiatives, White (2006, p. 76) concluded that management support and ongoing investment were important determinants of survival beyond the funded stage. Management support is a vague term that demands further explanation. Ongoing investment may be a more tangible concept; however, the source of such investment is unclear. Many funded projects that have proved their educational value still fail when initial funding runs out (Schoenwald, 2003). Very few institutional or national sources offer second-round or subsequent grants, and operational budgets in universities are often set without consideration of any emergent innovations that the institution may be hosting, unless they are already having impact at enterprise level.

This lack of provision for ongoing support may be the biggest point of conflict between innovators and host institutions. Having sourced start-up funding and gone on to prove an elearning concept, innovators often turn to their institution for ongoing support. In many cases this is not forthcoming. Gunn (2010) and Guthrie, Griffiths, and Marron (2008) contrasted this scenario to a commercial organization where research and development is the domain of staff with one set of skills, and sales and marketing (equivalent to dissemination in the educational sector) is another. It is unthinkable in a commercial context that initially successful innovations would be left to survive on their own, without systematic assessment of future prospects, investment in further development, or support for dissemination where a case for this can be made. Gibbs and Gosper (2006) assert that the wrong people are involved in decisions about which elearning initiatives universities should support. Southwell et al. (2005, p. 2) present an overview of elearning initiatives undertaken within the Australian higher education sector and conclude that current models of dissemination are insufficient to lead to widespread change in an institution or a discipline. The result of these challenging circumstances is low educational impact and poor return on investment in elearning innovations. It is not widely acknowledged that the failure of organizations to fully explore or exploit the potential of creative work undertaken by their staff is a significant part of the problem.

20.3 What Drives Innovation?

> To do things differently we must learn to see things differently. Seeing differently means learning to question the conceptual lenses through which we view and frame the world. (Seely-Brown, 1998, px)

Many factors drive curriculum innovation through the integration of elearning. Broadly, these include institutional policy or strategic plans (top down) and attempts by creative teachers to use the affordances of technology tools to enhance student learning in particular contexts (bottom up). External trends also play a role, but internal factors are the focus of the chapter. The route to sustainable change, the obstacles encountered, and outcomes of such initiatives depend to a large extent on driving forces. Hypothetical examples illustrate the difference between, e.g. a policy initiative that mandates use of a standard online learning management system (LMS) for course information, communication and administration, and a "grassroots" elearning initiative where custom-built online activities or interactions are introduced into a blended learning course to enhance learner engagement with course content. These examples are overly simplistic, but the compliance-driven initiative with specified tools and mandated objectives is likely to produce very different results to the one where an educational challenge is the driver, and the only limitations are tools and skills available to design and implement a pedagogically focused solution. As well as driving forces, the types and levels of support offered by host institutions differ significantly. Top-down initiatives are typically backed by investment, accountability measures, professional development, and central support. Initiatives driven from the bottom up may receive start-up grants and general support from central services. However, there is often no attempt to offer ongoing support, operationalize outcomes, or for the organization to learn from or adapt to accommodate the experience. Many researchers have identified and attempted to address this problem, noting a common factor in its complexity.

Romiszowski (2004) acknowledged multiple layers of complexity, noting that an innovation must become sustainable within a specific socioeconomic context and represent strong instructional design in a particular educational setting. This adds organizational and fiscal issues, politics, and the quirks of human nature and their impact on culture to the challenges of sustainable change. These factors would affect both top-down and bottom-up initiatives, albeit in different ways and in shifting contexts where the conceptual lenses alluded to in the quote at the beginning of this section are being seriously refocused for the roles and skills of both teachers and learners.

One view on the fate of elearning innovations with different drivers is that things are fine the way they are, and the fittest will always survive. This would be more acceptable if the fittest in terms of educational value were the ones supported and driven from the top. Evidence and experience combine to show that this is often not the case (Gunn & Herrick, 2012). An equally valid perspective with strong supporting evidence is that organizations need to reexamine the conceptual lenses through which they view elearning innovations and change their behavior to better reflect espoused intentions.

Some years ago, Goodyear (1999) called for a conceptual reexamination of elearning innovation, because focus on projects rather than environments had obscured key elements of development and made it hard to tease out the complex, coordinated tasks involved in their design and management. He believed this made it harder to share and learn from experience in systematic ways. However, the "ergonomics of learning environments" that he proposed as a means to capture the value of grassroots innovations for the design and management of better learning environments has not thus far been realized. More than a decade later, many worthy initiatives continue to win start-up funding, then struggle or stall when it runs out, unless the innovator has also used exceptional entrepreneurial skills to develop a sustainable business model as well as a successful elearning innovation. Various studies reveal cases where the transition from funded project to sustainable product or system has succeeded, but these only tend to endorse the individually driven and unique nature of the process (Gunn & Herrick, 2012; McKenzie et al., 2005; Southwell et al., 2005). Conditions for successful transition may be identified, but are usually reported in general terms, e.g., investment, management support, or adoption by a critical mass, rather than with specific details or predictive frameworks. It seems that drivers of successful elearning innovation are neither uniform nor guaranteed to produce positive results.

20.4 A Critique of Conditions for Success

The conceptual arguments put forward by scholars such as Goodyear (1999) and Romiszowski (2004) and outlined above are broadly supported by research designed to identify the conditions that support the transformation of teaching and learning practice through elearning. Studies over the past decade or so (e.g., Alexander, 2001; Gunn, 2010; Southwell et al., 2005; White, 2006; Wycoff, 2004) identify the following essential factors:

- Strong leadership and management with a clear vision for elearning
- An institutional culture that supports risk taking and embraces change
- Comprehensive and well-aligned systems for professional development, workload accounting, information sharing, incentives, and rewards
- Appropriate funding schemes and support networks
- Flexible, reliable, and well-supported technology systems

These conditions describe an ideal context for innovation to flourish, though the list is not exhaustive. However, problems arise when published sources note them as being generally absent in national higher education sectors and institutions. This demonstrates the poor alignment of objectives and actions that White (2006) cites as a reason for limited success and endorses the point that institutions rather than innovators need to reconceptualize the problem. The following sections review the list of commonly identified conditions for success, relate the items to research that highlights their absence, then propose productive partnership strategies for innovators and institutions that may led to better alignment of objectives and actions. While evidence does support these proposals, the problem is current and solutions remain emergent, so further testing in institutional settings is required. Like everything related to elearning and educational change, no single solution will work in every situation.

20.4.1 Leadership and Vision

Most universities have a teaching and learning strategy that underwrites various forms of support for elearning as a key element of curriculum renewal. However, the study of 22 cases of innovation featured in this chapter found that such high-level statements rarely draw on the considerable body of knowledge and experience generated by grassroots initiatives or translate into tangible support for them, even where they are internationally acclaimed (Gunn & Herrick, 2012). Duke et al. (2008, p. 2) found "significant shortcomings in the capability of senior management teams… to identify and exploit the full strategic potential of technology." Gibbs and Gosper (2006) endorse the problem, noting that discussions at this level rarely include frontline teaching staff.

O'Grady, Rouse, and Gunn (2010) examined the challenges of elearning strategy implementation in a university through the conceptual lens of organizational models and management control systems. In their case study institution, ineffective and absent flows of information within and across different organizational levels were major causes of failed implementation. The results were a lack of general buy in to the strategic vision and limited knowledge or means to implement it at practice level. On the management side, poor understanding of the resources and supportive structures required, and of reasons why the strategy failed were major limiting factors.

The root of this problem lies in the absence of adequate links between strategic vision, policy, and practice in the context of elearning. This is partly, though not entirely, an issue for management to address. Based on a review of literature and local case studies, de la Harpe and Radloffe (2006) concluded that management responsibility is to create a sense of urgency and imperative to act. There are many avenues through which this can be achieved, including compliance or accountability measures and incentives such as promotion criteria and special funding initiatives. Heads of faculties and schools, and central support services can be brought on board to engage in different areas through existing networks and activities and to provide leadership at practice level. It is therefore important to appoint leaders with knowledge, influence, and authority in the field of operation. It is also recommended that leadership be construed as a collective rather than an individual responsibility. This reflects current thinking in leadership circles (Lefoe, 2010) and brings broader experience to the task. It is, however, at odds with more traditional concepts of individual leadership in universities (Lefoe, Smigiel, & Parrish, 2007) and so may be challenging to achieve.

A further barrier to adoption of a shared vision for elearning innovation arises when the vision does not relate to the reality of those working at grassroots level or reflect emergent practice in the sector. A key area of management responsibility should be to create channels through which the expertise, experience, and aspirations of lead practitioners can flow up to inform the vision and direction of leadership. Corresponding responsibilities of those at practice level are to respond positively, offer experience and expertise to the vision for change, and be willing to share and communicate in terms that others less directly involved can understand. The "flows of information" problem is exacerbated by a lack of existing channels for upward communication. However, it remains to be seen if information will be willingly shared and in suitable form if such channels are made available. Mutual trust and confidence in the prospect of positive reception will be key enabling factors. At present, many success stories are only reported in discipline focused or elearning journals and conferences, outlined in annual reports or individual promotion applications. This limited spread and format of information on learning design features and educational impact is yet another barrier that needs to be addressed (Gunn & Herrick, 2012; O'Grady et al., 2010) by innovators and institutions working as partners to negotiate the process. The implications of this proposal for the status of innovators will be discussed later in the chapter, after the attributes of an institutional culture that supports innovation have been explored.

20.4.2 Culture of Innovation

Many authors describe an ideal context for elearning innovation as one that is flexible, supports experimentation and risk taking, celebrates collegiality, and embraces change (e.g., Breslin et al., 2007; Cox, 2008; de la Harpe & Radloffe, 2006). Conversely, research shows that innovation is less likely to flourish where priorities are clearly focused in an area other than teaching and learning, e.g., research or fiscal constraint, or where workloads are consistently high, leaving little space for experimentation or reflection. Contrary to such observations, however, it is often in contexts where the pressures of scale and diversity on workload are most intense that transformational elearning innovations arise. Necessity is a powerful driver, whether it results from management action to create an imperative for change as de la Harpe and Radloffe (2006) recommend or because good pedagogy and workload management in such contexts demand innovative approaches that only a combination of creative teaching strategies and the affordances of elearning can deliver (Gunn & Harper, 2007; Peat & Franklin, 2002). The conditions for innovation may be less than ideal, but the outcomes can be both transformational and sustainable. A key contributing factor to both of these outcomes is the team teaching approach that is necessarily common in contexts of scale. It helps to spread responsibility, encourage collegiality, and promote sustainability, as developments do not rely on one or a few individuals to drive them forward. Adaptation to different teaching contexts can also occur more readily, thus increasing both the relevance and scope for application of an innovation.

Contexts of scale and diversity are just two examples where a mix of practical and pedagogical factors contributes to a culture of innovation. Less desirable outcomes arise where institutions fail to acknowledge the efforts of innovators, to assist in disseminating their work, to draw on their experience for future strategy, or to lighten the load on others pursuing similar developments. The productive partnerships suggested in the chapter title could have significant impact in this area. Various authors recommend appropriate workload accounting systems as well as recognition and rewards for innovators and early adopters through promotion or awards systems (e.g., Alexander, 2001; Birch & Burnett, 2009), and some positive steps have been taken in recent years. An audit of the time and creative effort invested by innovators could provide a useful basis for such incentive and reward systems. From an institutional perspective, the reality of this is often distorted by the injection of grant funding to employ dedicated project staff and the expectation that no further input will be required to operationalize successful outcomes. Another common obstacle is failure to consider what Whitworth (2011) describes as “invisible” success factors e.g., skillful provision of an easy transition to new ways of working for academics and a more student-centered approach for learners. Many innovators put in expertise, time, and effort that far exceed the normal requirements of their role. A culture that truly supports innovation would be one that recognizes the time and creative effort being expended and gives fair consideration to the value of actions that challenge established norms to promote innovative educational practices. This is how universities with forward-looking teaching and learning strategies should work, but in reality, innovation is a hard road that demands an exceptional level of commitment from the individuals and groups involved.

20.4.3 Funding and Support

Most writers on elearning innovation agree that funding and support are critical success factors. However, the form and function of these provisions demand further investigation. Projections about what can be achieved within specified timeframes and budgets often prove to be unrealistic, and the forms of support on offer have largely failed to meet innovators needs or provide institutions with a good rate of return on investment. A review of research in this area reveals problems with common models for funding and support, suggesting institutional action is required to address them.

One problem is with expectations of what can be achieved within the limits of externally imposed budgets and timeframes. Another is how innovations will be supported when start-up grants run out. The study of 22 cases, most of which have managed to survive well beyond the initial funded phase, revealed common problems in this area.

> Broad consensus is that project funding for two or three years is sufficient to produce a full working prototype, but usually not a finished product that is disseminated widely and is sustainable (Gunn & Herrick, 2012, p. 1).

This quote reflects Stansfield et al.'s (2009) experience, where three phases of funded development were required for a virtual learning environment to achieve sustainability, through what they describe as the "consolidation" phase. Some respondents in Gunn and Herrick's (2012) study suggested that "mature" is a more appropriate term than "sustainable," as most innovations are "works in progress" with improvements continually being made and ongoing funding required for maintenance, further development, dissemination, and user support.

In this context, the common model of project funding is problematic. The end date of the start-up grant is a point at which many initiatives fail, even where educational benefits are evident, and funding bodies have introduced steps to try to ensure ongoing commitment. Davis and Fill (2007) describe a JISC initiative in the UK that required projects to continue for 2 years after grant funding expired, and the Australian Teaching and Learning Council attempted to address the matter through second-round funding for successful projects prior to its own disestablishment in 2011. The outcomes were variable with no conclusive evidence that sustainability prospects were enhanced in all cases. Davis and Fill (2007) concluded that what happened at the end of JISC's mandated 2-year extension period remained to be seen.

From an institutional perspective, the problem is that most elearning innovations do not easily fit within operational budgets, planning cycles, or teaching, learning, and IT support frameworks. Budget planning cycles and priorities for support providers are typically determined with resource management and established enterprise system operations in focus, as indeed they need to be to ensure the smooth running of large complex organizations. However, the devolved leadership model that operates at service center or faculty level in many universities has no scope to accommodate elearning innovations that grow out of grassroots initiatives, and it can be hard for the people driving innovations at this level to connect with or have influence in more senior circles. Thus, the investment–implementation–frustration cycle continues, and some innovators report deliberate subversion of institutional constraints in pursuit of their creative endeavors (Gunn & Herrick, 2012, p. 7).

A productive partnership arrangement in this area would benefit from the multi-directional and multi-level information flows recommended by O'Grady et al. (2010). This would allow management decisions around funding, dissemination, and integration of new systems into support services to be based on more detailed information on elearning trends and local initiatives. It would also provide a practical way to enact the value that the institution places on curriculum innovation and creative teaching. The current situation is less supportive than it might be, particularly in research-focused universities, where innovators reported being penalized for spending time on elearning development instead of research outputs (Gunn, 2010). A collaborative process to review the progress of local innovations and assess the support needs and prospects for wider dissemination would be a useful addition. However, the common management expectation that "one size will fit all" or that innovations have to have potential for enterprise-wide use would need to be managed. Research suggests that a critical element of such a process would be willingness to provide the kind of support that innovators want, rather than simply attempting to fit new ways of working into existing support system structures. It would also require time, incentives, and support for teachers to adopt and possibly adapt innovations to fit their own professional practice contexts. In light of the recent experience of limited growth of the much-anticipated "learning object economy," Gunn, Woodgate, and O'Grady (2005) present a case for adaptable rather than simply reusable resources and note that considerable time and support is required for customization and skill development. This differs from common perceptions of dissemination, so a shift in mindset would also be required.

20.4.4 Flexible, Reliable, and Supported Technology Systems

While universities already make major investment in technology systems to support elearning, evidence shows these systems are both enablers and barriers to curriculum innovation. Problems arising from the convenience-driven notion of a "one size fits all" LMS are well documented in the literature (e.g., Chalke, 2010; Kuriloff, 2001). While an LMS serves essential course management and productivity functions, and some teachers make pedagogically excellent use of them, others find them restrictive and functionally limited as teaching and learning tools (Steel, 2009).

Kuriloff (2001) drew an analogy with one-size clothing, which can be worn by anyone, but tends to fit no one properly. The increased availability and simplicity of software tools is driving a shift away from reliance on a single technology system. This is happening concurrently with extension of the most common LMS (Blackboard and Moodle) to include sophisticated feature sets and functionality. However, the flexible, reliable, and well-supported systems recommended by authors such as Alexander (2001) and McKenzie et al. (2005) exceed the scope of current technology provision in many universities, regardless of the size of investment. The crossover of freely available social networking tools into educational use is increasing flexibility, but challenging security, support, and reliability as institutions lose control over the tools that staff and students choose to use for teaching, communication, and learning. While this is a positive development in terms of learning opportunities and development of new pedagogies and ICT skills, it raises additional challenges around quality standards and security and privacy issues that institutions need to deal with. Evidence suggests that universities are struggling to stay ahead of the field and to provide reliable versions of the elearning tools their staff and students are demanding to be able to use.

Developers of the innovative elearning systems and practices featured as case studies in Gunn and Herrick's (2012, p. 1) report say they undertook the project to address a particular learning or teaching support need, after a survey of existing tools revealed nothing available that met that need. The report noted that the process used to reach this conclusion was unclear, and there was no evidence that the scoping information gained from preliminary investigations was used to inform the specification of what was subsequently developed. While this may not be the best way to gain institutional buy in, raise awareness or foster support, it does suggest that institutionally endorsed elearning systems do not provide the kind of functionality that all users are looking for. The steps taken by some case study project teams to subvert IT services controls demonstrated little confidence in the central systems and services provided to support elearning innovation. Willingness to collaborate to achieve more adaptable technology and support systems was expressed. However, problems were perceived with different work cultures, priorities, and objectives in the departments that would need to be involved, which would be difficult to overcome. The spirit of equal and open collaboration by all parties was not perceived to be present.

For partnerships to operate successfully in this space, different mindsets would be required. IT services would need to concede ground to accommodate experiments and provide safe places for teaching staff to explore and evaluate new elearning tools outside of centrally provided systems. Resource limitations are a commonly cited reason for this not being made available, and it is unreasonable to expect IT staff to be experienced with every tool that teachers might choose to explore. On the other hand, innovators must be prepared to share ideas and ownership of developments, and to consider IT services advice, and alternative ways of achieving the teaching and learning outcomes required. There is also scope to bring more systematic project management and software development processes into the elearning innovation space. The different stages involved in moving from an innovative project to sustainable practice or service require a variety of skills sets. Since it is rare for all these skills to be available where one or a small number of people are involved, the route to transformed practice and sustainable innovation is through collaboration. However, for this to work in the curriculum and elearning innovation space, trust and mutual understanding need to be built up across functional boundaries. All parties have to be willing to cede some of what Becher and Trowler (2001) call their "academic territory," which is perhaps the greatest challenge of all.

20.5 Reflections and Recommendations

Previous sections of this chapter related a review of relevant literature to an analysis of 22 cases of elearning innovation. The case study research was designed to explore the challenges faced by faculty seeking to promote curriculum renewal through the affordances of various technologies. The same sources are now used as the basis for reflection and to recommend ways that partnerships between innovators and other institutional players could enhance prospects for educationally valuable initiatives to lead the transformation of teaching practice and inform relevant university strategies.

The case study data comprised survey data on matters, including funding, project participants, rationale, lifespan, function, dissemination strategies, user base, support provision, evidence of impact, reporting, and institutional response. Collection of the survey data was followed by semi-structured interviews with the people driving the innovation. Most of those interviewed had managed to devise workable solutions to the challenges of sustainability. However, none described this as an easy process or one that they would recommend for others to follow. It was notable that no initiative that started with independently conceived ideas and grant funding ended up working in partnership with, or gaining a realistic level of operational funding or meaningful support from, the host institution. Only ones conceived of and implemented as centrally driven initiatives gained this kind of support, despite the significant positive impact others had on teaching and learning, and the large international user communities that some had developed. The following observations and recommendations are logical conclusions from the data. However, it must be acknowledged that they may still fail to answer some of the more complex questions on how to grow and sustain innovations in tradition friendly, politically charged, and fiscally challenged university settings (Gunn & Herrick, 2012, p. 1). What they surely will do is shed light on the kind of partnerships between innovators and their institutions that would help to move matters forward.

While the case studies represent a small sample of elearning innovations, findings revealed common sustainability challenges that other researchers have identified in different contexts. For example, there was a general lack of clarity on the role of key players such as senior managers and IT services in the innovation support process. It was considered necessary to increase recognition, rewards, and support structures for the work of innovators and to pursue more systematic processes for scoping, planning, and managing the development and dissemination of innovations. Every challenge has a corresponding opportunity, and it is easy to translate these findings into proposals for positive action. Implementing the solutions will be harder to achieve and, in the way of innovations, may produce unexpected outcomes. Three main areas for action are identified: (a) promoting consultation and collaborative partnerships between innovators and their institutions, (b) creating new channels and directional flows for communication, and (c) providing strong but not restrictive support structures around innovations.

20.5.1 Early Consultation

Most projects are started by an individual with a passion to translate an educational concept into practice using the affordances of technology. These individuals tend to consult with colleagues externally rather than within their own institution, so internal discussion does not typically feature early on. If consultation did occur, then broader perspectives could be represented in the subsequent development, and dissemination challenges avoided later on if a sense of shared ownership could be encouraged to develop. Integration with institutional systems and practice could be considered, and mutual awareness promoted. The main challenges would be building mutual trust and having all parties open to negotiation rather than simply avoiding the "sticky issues" that arise from innovators being risk takers and rule breakers that institutions tend to want to "bring back into line" (Uys & Gunn, 2012).

20.5.2 Filling Communication Gaps

To work in effective partnership, both institutions and innovators need to be more cognizant of the effects of teaching and learning enhancement strategies at practice level and of the realities involved in implementation from all perspectives. The multi-directional flows of information that O'Grady et al. (2010) endorse would allow strategic plans and implementation processes to better reflect the realities of workload and resource requirements and the kind of structural and practical challenges involved in moving elearning innovations from the exploratory stage into mainstream practice. Priorities at senior management level are quite different from those of individual faculty, whose career progression often depends on research more than teaching and learning innovation. When limited time is available, these priorities come into conflict. Establishing communications lines to allow this to be acknowledged and suitably addressed would be a useful place to start, with action required from all parties.

Another gap exists because evidence of the value of innovations in terms of impact on teaching and learning seems to be either insufficient or in unsuitable form to influence key institutional players, such as IT departments and those making management-level decisions about funding and support for elearning in universities. Useful actions in this area from innovators include wider discussion of initial ideas, use of transparent and collaborative scoping processes, identifying the forms of support that would help to bring an idea to maturity, and systematic collection and presentation of impact evaluation data to present as a case for ongoing investment. This proposal is deceptively simple however, as experience shows there are no readily available or receptive channels to facilitate this kind of communication. Almost half of the 22 case studies reported difficulties getting products accepted by IT staff at their institution. Some reported deliberate moves to stay "off the radar" or to subvert institutional controls to avoid efforts being stifled. Furthermore, many innovators working at grassroots level do not enjoy the benefits of easy access to senior staff who could acknowledge the value of elearning initiatives and represent their interests at higher levels of the institution (Whitworth, 2011). These issues need to be addressed at institutional level so the culture is more conducive to the innovations that strategy promotes. The current situation where universities fund and often "own" innovations under terms of employment contracts does not translate into meaningful action to support, disseminate, or sustain them.

Where clear strategic priorities and accountability measures are in place to support innovation, the situation may be more favorable. However, it is common to find no such strategy or measures exist or that faculty are unaware of them if they do. It is also common to find senior management with the unhelpful view that investment in an enterprise LMS and training in its use by faculty are all that is required in the elearning space. In this case, innovators may be judged as rule breakers working against the system. Considerable weight of evidence and popular support for innovations have proved insufficient to shift this kind of thinking, so receptiveness is a key to good communication in this context. This works in both directions, as innovators need to accept that some work is too context specific for wider support to be justified. There is considerable scope to raise the level of conversation at all points from conception to implementation and evaluation and to bring more voices to the discussion. Reports on distributive leadership projects describe practical ways this can be achieved (e.g., Lefoe, 2010).

20.5.3 Building Collaborative Partnerships

A commonly cited critical success factor for operationalizing innovations is getting the right team together to back the passion and commitment of the innovator. The kind of collaborative relationships that have been shown to best support the growth of elearning innovations work across functional boundaries in ways that challenge people to think and act beyond the limits of their own role and departmental culture (de la Harpe & Radloffe, 2006; Gunn, Hearne, & Sibthorpe, 2011). This is challenging at both project and institutional levels, particularly where functional lines between teaching departments, centers for elearning development, and IT services are clearly demarcated. Many tensions need to be resolved here, and a common one is where an innovation is not suitable for adoption across an entire institution, yet policy is to provide support only for systems with enterprise-wide potential. This can be a “catch 22” situation, as it cannot be demonstrated at the outset that elearning tools or systems have scope for broad application, yet if investment and support were made available, that would be a likely outcome. The length of planning and budget cycles is also problematic as it is often not flexible enough to accommodate emergent innovations. Where special funds such as teaching and learning enhancement grants are available, these are useful initially, but then tend to perpetuate the problem of what happens when the grant runs out. With large-scale developments designed for broad application, typical grants for 2 or 3 years are sufficient to produce a full working prototype, but not a finished product that is disseminated widely and is sustainable. The expectation that operational funding will be assigned to sufficiently useful innovations has not proved realistic. Building closer relationships between innovators, managers at different levels, and people in various functional roles would make it a more likely scenario as systems and structures could be adjusted to accommodate emergent practice. However, unless clear strategy and accountability measures are put in place to encourage this kind of collaboration, signals from senior management will not be actively supportive either.

Universities would need to operate on a more flexible and collaborative basis than they generally do at present to provide the flexible structures and support systems that innovators need to help their software tools and educational practices to grow and survive. Collegiality in the form of cross-functional collaboration is an emergent phenomenon driven by an imperative to address educational challenges that arise in increasingly common contexts of scale and student diversity. The various forms of expertise required to develop and maintain digital resources and to disseminate new educational practices demand collaboration in flexible, scholarly, and professional teams contributing on an “as needs” basis, then redeploying elsewhere in response to shifting demand. Collegiality may be a well-established norm in academic circles; however, current circumstances demand new types of relationship across functional boundaries where the concept is less familiar.

20.6 Conclusions

Innovators deserve recognition and reward for the valuable contribution they make to teaching and learning development and curriculum renewal. They also need to acknowledge the benefits of sharing ideas and working as far as possible with established project development processes and institutional systems if they wish to gain support. Systematic software development, project management, and robust evaluation processes may be anathema to their creative natures, but they are an important part of the processes for planning, disseminating, and ensuring long-term sustainability of innovative educational practices. Shared ownership of innovations supports greater flexibility and reduces risk, as well as promoting a higher degree of relevance to the professional practice of a larger number of faculty.

The corresponding challenge for university managers is to accept that inflexible structures and tightly managed curriculum innovation processes are not the best way to promote transformational change. New organizational models and ways of working are required to meet changing social and economic circumstances and to reflect the affordances of the current raft of new technologies. The line between supported and stifled innovation is a fine one, which all key players need to acknowledge in order to negotiate shared productive spaces rather than perpetuate the dichotomy between institutional strategy and enterprise systems on one side and educational innovation on the other. Like all systems, universities must respond to their changing environments to maintain equilibrium over time. Synergies between innovators and institutions in the elearning space could do much to facilitate the process if common ground can be negotiated to actively encourage and support the creative work that is driving higher education forward in the technology-rich, socially networked environment of the twenty-first century.

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Chapter 21
Managing the Challenges of Technology to Support Learning: Some Lessons from Experience

Judyth M. Sachs

Abstract In this paper I identify challenges I have faced as an academic leader working to improve and sustain quality learning and teaching in an information-rich environment. If the possibilities provided through ICT are overestimated in the short term and underestimated in the long term, then considerable expenditure may well be spent on resources that have surface appeal of being innovative but do not add much value to the quality of student learning.

Keywords Technology • Management • Organisational change • Learning

21.1 Introduction

At a Hong Kong press conference in the late 1980s, Alan Kay claimed that 'Technology is anything that wasn't around when you were born'. If we take this as our starting point, it becomes clear that there are generational differences in universities between academics and academics and academics and students. This becomes particularly clear when looking at the tools used to support teaching and student learning over the past 10–15 years. Oblinger and Oblinger (2005) maintain that different generations vary in their expectations of the teaching and learning environment held and this has particular implications learning. Late baby boomers, many who are still employed as academics, will have used blackboards and chalk, Xerox machines, overhead projectors, slides, film and video. The X and Y generation among us will have been introduced to ICTs through the use early versions of PowerPoint, Learning Management Systems (LMS) either self-developed or commercially produced tools such as Blackboard or WebCT, web-based lecture

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recordings and interactive whiteboards. The new generation of academics are on the cusp of generation Y being members of the NetGen or millennial, born after 1982. Their experience of technology will be fundamentally different from earlier users. For these digital natives, the use of wikis, blogs, vlogs, podcasting, virtual reality and gaming technologies are the tools they will use, and their students expect, to enhance teaching and learning. Most of our students who are recent school leavers have mobile phones, iPods, MP3 players and access to computers. They expect their learning experiences at university to reflect their technological experience, expertise and understanding (Gabriel, Campbell, Wiebe, MacDonald, & McAuley, 2012; Gosper, Malfroy, McKenzie, & Rankine, 2011).

And those from financially well-resourced schools will be disappointed at the lack of up-to-date resources in some institutions of higher education. Unfortunately, all too often there is a yawning gap between what we are able to offer our students and what they use outside of the classroom. It could be said that there are two distinct cultures: the high-tech culture outside of the university comprising many *millennium gen* students and the lower tech one on the inside of many academics and mature age students!

In response to the changing IT environment, many universities have invested considerable funds to create wireless spaces, both within and outside of classrooms. For many institutions it is a challenge to find resources just to catch up on deferred infrastructure let alone putting in place cutting edge technology.

Arthur C. Clarke made the astute observation: "When it comes to technology, most people over-estimate it in the short term and under-estimate it in the longer term". In this paper I question whether the possibilities provided through ICT as a tool to enhance student learning and the delivery of teaching are overestimated in the short term and underestimated in the long term. If this is the case, then considerable expenditure may well be spent on resources that have surface appeal of being innovative but do not add much value to a student's overall learning experience and learning outcomes. In trying to ascertain what is overestimated and underestimated, I attempt to take into account student, academic and institutional needs and aspirations.

I write this paper from the position of someone who has had management and leadership responsibility for eLearning, among other things, in two large Australian, comprehensive, research intensive universities. In 2005 while at the University of Sydney, I was concerned with the lack of progress regarding online learning at the University and commissioned a review of eLearning across the University. At the same time I established a cross-university governance committee, incorporating academic and infrastructure portfolios to oversee the development and implementation of an eLearning strategy across the University. I am now charged with a similar task at Macquarie University. In both of these instances, my dual challenges were which LMS was the most effective to deliver the university's aspirations regarding quality learning and teaching and what other investments needed to be made to improve pedagogy.

I am not a "techie" but I have had a long-standing interest in flexible learning and pedagogy and how ICT can be used to improve access to learning of various equity groups. My paper is based on lessons learnt and insights gained in what should be seen as a significant period in two universities of organisational transformation, characterised by efforts to enhance student learning and improve the quality of teaching through the use of ICTs.

While labels like "eLearning", "mLearning" or blended learning come and go, the use of ICT in teaching and learning is here to stay. It is now the core business of higher education and needs continuing strategic management and investment (Goodyear, Reimann, & Mahony, 2006). Learning in the twenty-first century will be personalised and be inextricably linked to the use of technology. Web 2.0 will help facilitate this. Doug Brown, an English education consultant, argues that for greatest effectiveness and value add for students and institutions, "the technology should be transparent—and often is—to the learner; but we are not yet to the point where the use of technology is assumed by the teacher—and thus we still have not achieved the ability of our institutional learning to match the personalised learning that happens in the 'real' world" (Brown, 2006:6). But 6 years on from this observation, there are still issues for academics about the integration of technologies into their practice.

Hanson (2009) observes there is an inherent tension between the readiness of academics to take up the potential benefits of ICT to support student learning. For her it is academic identity that stands in the way. She argues:

> The concerns of these mainstream academics about e-learning arise from a strong desire to protect what has become established as a very powerful feature of their academic identity, their close and successful face-to-face relationship with students. (p. 11)

Zealots and politicians alike make claims about the efficiencies gained through technology, how access to education and training can be improved, how the quality of student learning is improved, how costs of education are reduced and how technology can improve the cost-effectiveness of education. And from where I sit that looks and sounds good. But … do we have the evidence to support such claims?

21.2 The Context of Higher Education for Today's Learners

At the level of policy and practice, the social, economic and political context of higher education plays a significant role in the provision of higher education. The Australian government like other western democracies acknowledges the importance and potential of higher education as an economic resource. Higher education is the third highest generator of income behind coal and tourism. In Australia alone $6 billion is generated through education. Two interrelated forces are at play here, that of globalisation and the lifelong learning requirements of professions for their members to be engaged in continuing education for accreditation and registration purposes. New technologies have contributed to what Cunningham, Tapsall, Ryan, Stedman, Bagdon and Flew (1998) call "borderless higher education". Borderlessness includes the removal of the impact of geographic borders as learners and knowledge become mobile. It also refers to borders of time and space, as lifelong learners choose to experience their learning while still employed and therefore need access to information in more flexible modes (Bjarnason, 2006).

In lectures many of our students have their laptops, mobile phones or MP3 players operating in front of them—but what are they doing? Michael Bugeja reflected on the distractions in the wireless classroom. He observed students instant messaging friends, emailing fellow classmates, while others were on MySpace, Facebook or eBay or some other type of social networking tool (Chronicle of Higher Education January 26, 2007). What then does this mean for our own practices? Bugeja went on to indicate that some universities have developed policies to limit technology use in classrooms, where inappropriate use of technology would not be tolerated. So while wireless cannot be shut off, students can be required to comply with a code of practice regarding appropriate use of technology in classrooms.

The current situation brings a number of challenges for administrators. Among others these include:

- Acknowledging and utilising students' experience of technologies
- Providing virtual and physical infrastructure
- Meeting students' expectations about how, when and where they can access courses and resources
- Responding to high prestige international providers like MIT and Harvard, Coursera or the Khan Academy

Many students, especially the NetGen, come to university digitally literate in both computing and network technology, and with expectations that a university campus will be wired, subjects will be online and that resources will be immediately accessible and available. These students are always connected, they are able to multitask, expect immediate feedback, learn experientially and are very social—they like to interact, email or SMS messaging is their preferred form of communication (Berk, 2010; Oblinger & Oblinger, 2005). MP3 players, iPads and iPhones and other handheld devices are now part of a student's academic and social tool kit.

Interestingly, Morgan and Bullen (2011) in their research in a Canadian institution found that there were no meaningful differences between net generation or non-net generation students in terms of their use of technology or in their behavioural characteristics and learning preferences. Paradoxically recent research (Gosper et al., 2011; Jones, Blackey, Fitzgibbon, & Chew, 2010; Madge, Meek, Wellens, & Hooley, 2009) has indicated that while social networking technologies are popular for everyday use, students did not see these tools as particularly useful tools for learning.

Hilton (2006:60) observes that "Today's students want to be able to take content from other people. They want to mix it, in new creative ways—to produce it, publish it, and to distribute it". Quite some challenge for some academics socialised in pre-technological contexts. It is also a challenge to copyright IP and universities regarding plagiarism.

Table 21.1 The shift in learning afforded by technologies

There is a move from	To
Single user/interface/medium	Knowledge communities, connectivity and networking
Students as knowledge consumers	Knowledge producers
Dependent learners	Independent learners
Formal instruction	Informal learning
Accountability shift from lecturer	Student

The above Table 21.1 indicates at the most general level the shift in learning as afforded by ICTs. This is multifaceted and complex and more than a simplistic old versus new.

There is now increasing evidence about the learning styles and interests of these students. Oblinger and Oblinger (2005), for example, claim that research on these students indicates that they are consumers rather than producers of information, are over reliant on Google, they multitask, are apt to begin tasks randomly—perhaps in the middle, are graphics oriented, thrive on change and demand quick or immediate gratification. They have broad but shallow information literacy lacking an understanding of how to find, evaluate, use, and present that information. Consequently they need to be taught information literacy and strong critical thinking skills (Oblinger & Hawkins, 2006).

Goodyear et al. (2006:15) argue that strategies for eLearning—for the effective use of ICT in learning and teaching—need firm roots in the students' experience of the University. They suggest that we should be using ICT (a) to enhance students' participation in the intellectual and cultural life of the University and (b) to help ensure that the precious time they spend on campus is used to good effect. This can mean that a good use of ICT is to allow students to have first contact with new ideas away from campus—that time on campus is used primarily for those things that can only be done face-to-face or that require access to equipment and other resources unavailable elsewhere.

Ellis (2006) identifies four areas where eLearning meets the needs of students: (1) students expect eLearning as part of their tertiary education and they have already experienced the benefits of social and knowledge networks for their personal and educational lives, (2) students expect flexibility in their tertiary education to allow them to combine study with work and family commitments, (3) disciplinary bodies are increasingly providing eLearning resources (data bases, multimedia resources, e-texts) that offer activities difficult to replicate without ICTs, and (4) society has embraced information technology and communication technologies as a way of life and business and employers expect graduates to know how to exploit their affordances across a range of attributes (Business Council of Australia, 2011).

There is now increasing evidence about the learning styles and interests of these students. Reimann (2005) claims that research on these students indicates that they have broad but shallow information literacy and are consumers rather than producers of information, are over reliant on Google, they multitask, are apt to begin tasks randomly—perhaps in the middle, are graphics oriented, thrive on change and demand quick or immediate gratification.

Given how these students learn and their expectations what then should higher education institutions do to be receptive of their needs and skills? Reimann (2005) suggests the following: (1) maintain our core business of knowledge creation, human capital building and social capability building while developing relevance for this new generation, (2) align student's personal IT with that of the University (this will have significant implications in terms of infrastructure investment, especially bandwidth, security and intellectual property), and (3) provide multiple options and types of learning spaces—both formal and informal.

Having given some contextual information, I now return to Arthur C. Clark and elaborate what has been overestimated about technology in the short term and underestimated in the long term. I present what I believe are a common set of issues around technology.

21.3 What Is Overestimated in the Short Term?

21.3.1 Student Readiness and Access

There is the assumption that all our students are of the NetGen, however, in many universities, school leavers are a minority. Many students are postgraduate or retraining in another field. Organising programmes and modes of delivery to suit a diversity of student expectations, needs and abilities is important. Flexibility then is critical as is the recognition that there are differing levels of ICT literacy and capability.

Students' lives are complex, no longer are they just studying full time; for many of them they are having to balance outside employment (sometimes nearing 30 hours a week just to survive) with study, family commitments and at the same time have a social life (Anderson, 2006). They want to have access to libraries, learning commons, help desks, learning resources and terminals outside of usual office hours. There is certainly considerable pressure for university resources to be available 24/7. The provision of wide coverage wireless has significant resource implications. Like most universities, Macquarie has spent considerable resources improving the student experience of ICT, and with limited resources this has meant a redistribution of funds away from other areas. In response to student input, the University has improved wireless coverage and provided charging points for students to charge their computers.

While NetGen students may have a strong affinity with technology, as administrators we need to be careful about the assumptions we make in relation to their preference for online and face-to-face experiences. For NetGen students technology is a ubiquitous tool, however, they come to university to interact with academics and peers. Research by Kennedy, Judd, Churchward, Gray and Krause (2008) on a cohort of 2,000 Australian university students showed that while many first year students are highly tech-savvy, the patterns of access and use of technologies beyond the entrenched technologies and tools (e.g. computers, mobile phones, email) show considerable variation. For educators and university administrators the challenge is how to cater for the broad range in students' levels of access and experience. More mature students are much more likely to be satisfied with fully web-based courses than are traditional-age students, because they are less interested in the social aspects of learning; convenience and flexibility are much more important (Oblinger & Oblinger, 2005).

Lesson: While recognising that it is unlikely that any ICT initiative will meet the expectations and requirements of all students, in planning and prioritising the allocation resources the rule of thumb should be to serve the interests of the majority of students.

21.3.2 Ability of Institutions to Cope with Cultural Change

ICTs by their very nature provoke change in organisations and individual's behaviour. Historically, universities have been characterised by silos of activity and influence; this has been seen in the divide between the academic and infrastructure side of the organisation. How many times have we seen decisions made about the use of ICTs without input from academic users? More often than not decisions about academic priorities and infrastructure development run parallel to each other.

Clearly both sides need to talk to each other, and opportunities for cross-functional teams to work together will help to bridge the infrastructure and academic divide. At the University of Sydney and now at Macquarie, solving the issue of governance, through the establishment of a high-level committee with senior representatives from the academic portfolio and infrastructure, helped significantly to improve communication and establish a shared vision. As a result, there were robust debates around priorities and resource allocation; the outcomes were improved and strategically aligned investment.

Cultural change also needs to occur at the faculty and departmental level. The implementation of new policies and practices require buy in at these levels to ensure organisational alignment with the institutional strategic goals and existing policies. Workload, reward practices, recruitment and so on are challenged by the implementation of ICTs in the workplace. Accordingly identifying and resolving the impact of these areas on productivity and academic engagement should be a priority.

While regulatory requirements of ICTs in the areas of IP and copyright have been addressed, other areas such as assessment, privacy, equity and access policy and practice cannot be neglected. In many cases the impact of ICTs on these practices is often left silent, and from the position of a senior administrator become an area of risk to the institution's reputation with respect to their policies and practices regarding equity and access.

Lesson: Universities are complex and diverse organisations, and sometimes a one-size-fits-all imperative for policies and procedures may need to be modified in order to meet the diversity of needs and expectations of various stakeholders.

21.3.3 Capacity of the Technologies Themselves

For many of us experience would have it that when it comes to technology, Murphy's law comes in to play—"if something is going to go wrong it will happen in my lecture"—the technology won't work, access to the web won't be available, wireless connections will suddenly dissipate and so on. We need to ask how flexible and robust is the hardware and software and, more importantly, how flexible is the pedagogy that supports learning.

I foreshadowed earlier some of the new technologies that are on the horizon. Technological forecasters (e.g. NMC Horizon Reports http://www.nmc.org/horizon-project/horizon-reports) are making claims about what is on the horizon. The use of simulations, virtual worlds and gaming technologies certainly do look exciting. However, these technologies have not been well tested in the academic context and will need to be adapted to ensure suitable use in classrooms. Their appropriateness and robustness is still untried. It could be said that "they are nearly there but not there yet". The use of blogs is a good example. These are good for logging a personal journey, developing social networking capabilities and so on, but there are some significant limitations if you try to use them for other learning activities. Issues of privacy and gaining permission for making these blogs public emerge when they become items for assessment.

Lesson: Not all technologies will meet the full expectations of users; they will promise a great deal but perhaps not deliver as hoped.

21.3.4 The Quality of Learning Resources and Activities

If improved learning outcomes are to be achieved, then it is imperative that students have access to high-quality learning materials. All too often the use of ICT in classrooms can be described as a technological book where print material has been transcribed into the LMS, or worse still students are lulled into a near catatonic state through presentations that can be described as "powerpointlessness". In such situations teaching itself becomes a performance piece, where students are entertained by being taken through a PowerPoint presentation with all of its bells and whistles (if the academic has those skills in the first place) or bored by simple duplication of PowerPoint into LMSs. Moreover, at its worst, the activities that students are asked to engage in are not challenging and do not extend the learning experiences nor the intellectual capacity of students. Teaching here is about transmission of information, not about developing skills of critical thinking or analysis.

Lesson: For ICTs to have the greatest benefit to the greatest number of students the quality of learning objects and materials in terms of content and purpose is of fundamental importance.

21.3.5 Academic Ability to Integrate Technology into Teaching

Academic capability is fundamental to ensure that the pedagogical possibilities and opportunities of ICT are achieved. At its most basic this requires that teachers resocialise themselves as learners and learn how best to use the technology and to engage in some critical reflection about what kind of content can best be delivered through technology, what value does the use of technology add to a learning experience and, finally, what the role of the lecture or tutorial in an information-rich environment is. The issue here is as Ellis and Goodyear (2010:104) claim is:

> When teachers do not focus on the development of student understanding and have poor conceptions of learning technologies, they tend to use e-learning as a way of delivering information bolting it on to course design in an unreflective way.
>
> Teachers, who focus on the development of student understanding and have richer conceptions of learning technologies, not only integrate e-learning into their approach to teaching, but also stress the importance of the integration of learning across physical and virtual spaces.

Most significantly it demands that teachers are able to be flexible in how they work and in their ability to change their practices and to fundamentally rethink how they design the content of the curriculum, how it is assessed and how it is evaluated. Put quite simply it requires that teachers make judgments based on their experience and expertise about how students learn and how technology can be used to facilitate that learning. And while this sounds "easy" getting some teachers to fundamentally rethink what and how they teach can be challenging. Importantly in terms of strategy, ICTs can be used to change institutional teaching cultures and the power relationships inherent in these cultures to the extent that the focus moves away from the teacher to a focus on learners and student engagement.

In practice it becomes evident when technology is used as a solution to the delivery of large first year classes by adopting flipped classroom strategies. For example, a lecturer records the lecture as a podcast which students listen to before the lecture time. Time is then freed up for face-to-face work with groups of students on areas of difficulty or interest (Prober, 2012).

Lesson: Ensure that there is alignment between the technology and the skills (both technical and pedagogical) staff have to use that technology.

21.4 What Is Underestimated in the Long Term?

Having indicated the areas where technology is overestimated in the short term, I now indicate several areas where it has been underestimated in the long term.

21.4.1 Workload

As ICT becomes ubiquitous in everyday life and academic life pressure is being felt by academics and students learning in an information-rich environment. For academics putting learning materials and activities online, promoting learning through electronic discussion groups or blogs creates expectations that academic will always be available, accessible and responsive to students at anytime. There is certainly a body of anecdotal evidence emerging of students becoming abusive when academics are not responding immediately to student questions or providing instant feedback to student work.

Lesson: The use of ICTs may not necessarily reduce the workload of teachers, and in many cases it intensifies it. Accordingly, workload policies and practices need to recognise the difference between face-to-face and online teaching.

21.4.2 Sustainability

Implementing change and new initiatives is relatively straight forward, sustaining them and keeping the momentum going is much more difficult. Sustaining the effort and interest of staff, when there are competing demands, especially in a research intensive environment effort needs to be considered at the individual and corporate level. Goodyear et al. (2006:16) capture the essence of the broader strategic challenge. It is worth quoting them in detail:

"To mainstream eLearning in the organisation, it must be profitable for the individual academic to engage in related activities. For this to happen, at least the following requirements need to be met:

- Clear workload policies in place, acknowledging the efforts invested for developing materials as well as running the single unit of study, stream of units of study or the course.
- Sufficient support. This comprises human resources (technical and instructional/web design support), a set of tools, and opportunities for training and knowledge exchange.
- Long-term perspective and strategic alignment with organisational objectives: technology and support must not disappear suddenly (or be perceived that it might), thus rendering previous investments meaningless. Staff will not invest effort into an area with uncertain institutional commitment.

In addition to these minimal requirements, we think that academics will be more motivated to "get their feet wet" and maintain a high level of effort when they see these additional benefits occurring:

- Teaching accomplished more efficiently; in particular, when time-consuming and repetitive activities such as receiving, marking and giving feedback on assignments can be performed with the use of ICT.

- Significant returns in personal productivity and in quality of the learning experience for upfront investment in ICT supported learning strategies that make use of the unique qualities of the medium.
- More flexible allocation of time for teaching; an academic's work is not the same each week; research requirements, conferences, presentations, visitors and administrative demands frequently punctuate the "regular" schedule. Being able to arrange time invested in teaching more flexibly is a strong incentive for busy academics.
- Synergies with research and technology transfer.
- Higher levels of competence developed in students, along with increased student satisfaction."

For Jenkins, Browne, Walker and Hewitt (2011) upgrading staff skills was the greatest challenge that the integration of ICTs into teachers' practice created, while staff development and supportive strategies were seen as the primary remedies. Importantly though, was the perception of "lack of time" was identified as the main barrier that needed to be surmounted by teachers for them to feel confident in their classroom practice.

Lesson: All too often when developing online solutions to improve teaching, there is an expectation that the move from conception to execution or implementation is linear and straightforward. Projects can be derailed if a transitional element in not included in the planning process to ensure that the expectations and needs of all stakeholders are met.

21.4.3 Leadership

At the corporate level "the introduction of ICT into the core activities of an enterprise involves disruption, a questioning of assumptions about existing and future ways of working and the creation of opportunities for synergy between what were previously seen as separate areas of activity. Effective use of ICT in academic work must involve strategic thinking and management at high levels" (Goodyear et al., 2006:26). This stewardship of an agenda that must integrate both academic and infrastructure pressures and priorities must come from a senior level if it is to have any effectiveness. As Goodyear et al. (2006:12) observe "the cost, if this does not happen will be further fragmentation of the academic role, an intensification of the competition between teaching and research, missed opportunities for strengthening research-led teaching and the development of parallel but disconnected infrastructures for research ICT and teaching/learning ICT".

Lesson: The development of an integrated learning strategy is required to ensure that there is no fragmentation between the academic and infrastructure portfolios. Furthermore, there needs to be a seamlessness between the physical and virtual learning environments to ensure both cost-effectiveness, strategic benefit and sustainability of interest, effort and resources.

21.4.4 Harmonisation of Technology and Cost

The need for *harmonisation of technology* is more often than not underestimated. It has often been the case that early adopters use a customised LMS or technology platform to meet their specific needs. It is not possible from a technical or financial perspective for a university to be able to support a multiplicity of platforms or technologies.

Many of us have been caught out in overspends and cost spirals despite our best efforts. Moreover, many of us have spent money on what we don't need. Rather than spend money on keeping up with a mythical student expectations, perhaps we first need to collect evidence about what students do expect. Kuh (2003), in his research on student engagement, cautions against universities making judgments about policies and practices in the absence of student engagement data or comparable sources of information. Also when developing business cases, we need to ask which technologies will deliver most to student learning and improved student expectations. We should not be seduced by the new technical flavour of the month. In making our decisions on where we distribute resources and how much we spend on them, we need to develop a strategy that is both rigorous and builds capacity in terms infrastructure efficiencies as well as academic quality. Thus, user research can provide the basis upon which to make decisions about what technology to invest in and where it is best used in a beginning point. Some universities, for example, may not have invested in lecture recording and podcasting technologies if they had foreseen the consequences of their use on lecture attendance and the campus experience. Information that students did not find that this enhanced or improved their learning or campus experience may have provided the basis for effective decision making.

Lesson: There will always be more requests for the IT spend than there are resources available in the budget.

21.4.5 The Complexity of Learning and the Crudeness of the Technologies

Learning in universities is a sophisticated and complex process that is influenced by philosophical and epistemological perspectives. For example, learning based on a critical theory paradigm is far different from one that is centred on a competency-based framework.

The technologies that have been available to us in the past (LMSs like WebCT and Blackboard) have largely been of the one-size-fits-all variety. When compared to the sophistication of the learning process, they fall short of being able to facilitate the cognitive processing underpinning learning in different contexts.

Gibbs and Gosper (2006:48) claim that a key enabling feature of these technologies is the tools they provide for developing, organising and managing access to online content, but this strength tends to promote narrow pedagogies—the delivery of content-centric instruction via a transmission model of learning is a common practice. They do not readily allow for the creation of learning environments and sequences that provide opportunities for multi-user collaborative activities or the co-construction of knowledge—both representative of current learning theory.

Experienced and creative teachers can manipulate these technologies to suit the needs of their students and the discipline; however, for many, they are still a crude tool when compared with the spontaneity, interactivity and dynamism that can be created in the classroom.

The emergence of Web 2.0 technologies has added new dimensions to the potential of technologies to facilitate learning. Pre-Web 2.0 technologies were about content delivery, access and management of information, interaction with content and communication between participants. Web 2.0 technologies have given students a real voice and enabled their participation in the creation and dissemination of knowledge and information. This is a good start. More needs to be done to bring educators and software developers together in order to develop specialised tools for learning that go beyond the delivery of content and the provision of basic forms of communication. The conversation between educators and software developers has to begin in earnest.

Lesson: Educators need to clearly articulate the processes involved in teaching and learning in their own discipline; software developers need to capture these processes into the design of new and better technologies for learning.

21.5 Conclusion

This paper is being written at a time when a major shift in the delivery of online learning and teaching is taking place. Rather than student target groups being local or national the focus will now become global. The arrival on the education landscape of MOOCs through the collaboration between MIT and Harvard (Martin, 2012) to deliver EdX and Coursera with its 33 and growing participating universities offering online courses for anyone to take for free is a significant disruptive moment and will be a major game changer. Courses will be available online from these elite institutions. While students will not be awarded a Harvard or MIT qualification and gain the associated prestige these qualifications bring, the content of courses will be available. There are some commentators who are already suggesting that in the next few years, a limited number of institutions will be designing and delivering the content of courses and these will be franchised or outsourced. The role of on-campus learning, student support, student experience among others will need to be rethought. Whether or not this transpires the EdX innovation will at least provoke critical conversations within universities about the nature of learning in an information-rich society. From where I sit, I will be looking at which units could best be delivered online but with the necessary learning support. Some first year statistics or accounting courses could be the first units to be outsourced. This could well be a perfect scenario for Clarke's over- and underestimations of the possibilities and challenges facing educators and administrators alike. But in this instance it challenges the fundamental assumptions about what to teach, when to teach, delivery modes and last but not least financial models for higher education.

In this paper I have reflected on the challenges facing me as an academic manager with responsibilities for delivering quality learning and teaching in an information-rich environment. On the basis of my experience, my position demands the strategic allocation of resources through investment in people, hardware and software. Bjarnason (2006:389) captures the major challenge for universities; he observes that "without adequate investment in helping academics to learn capability of technologies, and then investing further in creating the opportunity for them to experiment and begin to embed technologies in their day to day teaching—little will change in the short to medium term". Clearly the message here is if we invest in technology, we must also invest in supporting staff to ensure its optimal use.

Upon reflection, what then have I learnt during my time as an academic manager with responsibility for the delivery on ICT to support student learning. First and foremost, much of the activity I have been responsible for has been about managing change; this change is not only about implementation of technology but also how best to ensure the mediation of student needs with the capability of technology. Second, in order for change to be enacted with the least disruption and the greatest benefit, projects need champions at the highest level to ensure alignment between strategy and activity and priorities. If asymmetries emerge then the role of the champion as sponsor is to be persuasive and redirect activities back on track. Finally, change is about bringing people along, sharing the vision, understanding the issues and creating a common set of expectations about the outcomes.

Learning technologies hold great potential for student learning, both in terms of access and learning styles. It holds great opportunities to be innovative in terms of how information is presented to students. However, one must not overestimate what technology can do—it is essentially a tool to enhance student learning! We must not be held captive to the imaginings of what might be over the horizon and be tyrannised by what may often be seen as a magic bullet by academic managers like myself. In moving ahead and taking everyone with us, Seymour Papert's idea of "hard fun" seems like an appropriate analogy to describe the challenges ahead!

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These processes embed theoretical perspectives and address challenges that academics face in achieving goals of design and development of technology-rich curricula that develop graduate capabilities.

Keywords Course design intensives • Curriculum renewal • Sustainable flexible learning • Learning designs

22.1 Introduction

The changing demands on higher education institutions globally include challenges faced by widening participation and access: of being more responsive to learner's needs and for capturing the growing new markets and new learners by increasing intake from a nontraditional student base in response to university priorities and government policies (Bradley, Noonan, Nugent, & Scales, 2008; Marginson & Wende van der, 2007). These demands suggest an increased importance in ensuring that learning technologies are integrated in the curriculum and are flexible and responsive to meet these demands, and technologies used create a better learning environment for all learners, whatever and however they study (JISC Executive, 2009).

There have been many efforts to reform traditional models of teaching and learning to embed creative, flexible teaching and learning modes involving learning technologies in higher education (JISC Executive, 2009). These reforms have led to large expenditure of time and money to provide cost-effective, flexible online learning to enhance student learning experiences and outcomes. Substantial effort and resources have been deployed to develop and disseminate research-based pedagogy and curriculum; however, there is limited evidence that full potential of learning technologies have been realised in the complex activity of designing curriculum, learning and teaching in the dynamic higher education environment (Conole, Basher, Cross, Weller, Clark, & Culver, 2008; JISC Executive, 2009; Sharpe, Benfield, Roberts, & Francis, 2006).

Application of learning technologies within the curricula often takes place at the point at which *activities* for teaching and learning are considered, that is, at a later stage in the process of constructive alignment and curriculum renewal of courses (programmes) in higher education. A lack of uptake of designated learning technologies in teaching practices is an outcome that arises from a lack of integration between interrelated pedagogical, technical and institutional factors (Conole & Oliver, 2007). Understanding the design process is complex and multifaceted, and according to Conole et al. (2008), there is a gap between how technologies are utilised in reality and the potential of learning technologies to support learning that occurs "due to a lack of understanding about how technologies can be used to afford specific learning advantages and to a lack of appropriate guidance at the design stage" (p. 117). Considering learning technology at this teaching and learning activity phase of curriculum design tends to focus on technologies as the delivery mechanisms of the instruction through the selection of corporate/institutional supported technologies.

Consequently, this approach can unfold as technology guiding the intended learning rather than pedagogy guiding the use of technology that will best facilitate student learning experiences and outcomes. This "bolt-on" approach to learning technologies is adopted at the expense of the embedded, "built-in" design of learning activities that is based on educational theories and teaching and learning models (Milton & Lyons, 2003).

The increasing complexity brought by wider participation and institutional demands for flexible learning in universities requires a curriculum design process that is adaptive to institutional and technological conditions and responsive to teaching and learning *practices*. In this chapter we propose a systematic, university-wide process to design and develop educational innovations in a collaborative, sustainable way. This integrative approach to curriculum renewal links design with technologies and aims to:

1. Facilitate quality learning experiences that are engaging and relevant to students and achieves desired learning outcomes
2. Meet the needs and expectations of students and staff of the institution and other key stakeholders such as professional accreditation bodies and employers
3. Reflect research-based theories of curriculum, learning and teaching
4. Be sustainable within the context of institutional constraints

This chapter describes two interrelated processes for development and integrating learning technologies into curriculum design and renewal: one, an academic development process and, the other, an institutional supporting framework. First, the course design intensive (CDI) model facilitates an intensive process for learning design that aims to integrate technologies into curricula and build capacity for sustainable teaching and learning practices. Second, the intensive process of the CDIs is resourced and supported by a call for institution-wide projects referred to as flexible online learning development (FOLD) projects. Factors that are critical to the success of the CDI model are a collaborative decision-making process, ownership of the design by faculty academics and peer review by cross-disciplinary "critical friends". Finally, this chapter presents examples of the CDI process and a theoretical reflection on the renewal or design and development of technology-enhanced curricula for programme and institutional goals.

22.1.1 Curriculum Design as a Shared Practice

Curriculum design and development involving learning technologies has proved to be complex and troublesome. One characterisation of engagement in the ever-changing forms of educational technologies uses Rogers's (2003) model of diffusion to describe a gap between "early adopters" of innovative technologies and the "late majority" and "laggards". However, to attribute a troublesome rate of adoption to purported characteristics of individuals would miss the role of the organisation in framing processes for change. For example, Uys (2010) reported a gap between early adopters and "academic middle management" (p. 993) during an organisational change process involving learning technologies.

Despite the critical role of learning technology systems in universities, their potential for innovative pedagogy is yet to be realised in institutional practice (Benfield, 2008; Hedberg, 2006; McLoughlin & Lee, 2010). Selwyn (2010) typified this commentary in observing that educational technology reflects "a long history of eagerly anticipated but largely unrealized technological transformation" (p. 66) and noted that while there is evidence of their potential, the institutional arrangements and "barriers" are discussed less often.

The significance of institutional processes on the pedagogies of learning technologies has recently emerged as part of the discussion on universities as particular types of organisations. Examples of research on embedding learning technologies in organisations include competing goals and incongruent processes (Conole, White, & Oliver, 2007; Hannon, 2013), the trade-offs and negotiations during the implementation of institutional learning technologies (Marshall, 2010; Uys, 2010) and the gap between practices of teaching and learning and institutional strategies for change (Gunn, 2010; Russell, 2009; Stepanyan, Littlejohn, & Margaryan, 2010). These and other examples of research confirm the limitations of "top-down", planned approaches to organisational change with learning technologies and the lack of success with technology-led implementations (Bennett & Oliver, 2011). On the other hand, individual or "lone ranger" innovations can inform curriculum change; however, if they are unsupported by other parts of the university, they tend not to persist and are rendered unsustainable (Gunn, 2010; Marshall, 2010; Uys, 2010).

A series of tensions can be identified in this literature: between supported learning technologies and emerging forms of social media and Web 2.0, between innovative and sustainable practices and between organisational layers—top versus bottom, or the extent to which macro- and meso-levels of the organisation constrain or facilitate micro-level teaching and learning practices. A perspective that offers a framework to address these dichotomies is that of a *learning ecology* as a means to integrate the organisational, technological and pedagogical practices, "by viewing the university as a living adaptive system" (Russell, 2009, p. 4). The understanding of learning as ecological has been used as a basis for fostering communities of practice (Wenger, 1998) and to manage emergent learning that is self-organising and "open and is created and distributed largely *by the learners themselves*" (Williams, Karousou, & Mackness, 2011, p. 52). Ellis and Goodyear (2010) propose the ecological perspective to foreground "the complexity and interdependence of the many components and activities that make for success in a learning environment" (p. 19). In contrast to pragmatic curriculum design approaches (Reeves, Herrington, & Oliver, 2005), an orientation to ecology of learning addresses uncertainty and change with adaptable and sustainable design (Stepanyan et al., 2010).

The challenge, therefore, in embedding learning technologies in an organisation in a sustainable and enduring manner is this gap between two types of practices: academic practices of teaching and learning with technologies and those that arise from organisational processes. The risk is that in focusing narrowly on local contexts of e-learning, the organisational factors shaping the experience of learning are missed.

In attempts to move beyond a technology-centred approach, Benfield (2008) noted that a consequence of "mainstreaming e-learning" in universities has led to concerns with course development and redesign. He noted that CDIs do not address mainstreaming e-learning, rather:

> The Oxford Brookes University CDIs are an example of a meso-level intervention that aims to disrupt the "norms" of privacy and tacitness associated with curriculum design, making the process more public, explicit, and team-based.

The CDI model engages with the organisation at the meso-level, so that teaching academics abandon a higher education tradition of solitary course development and work alongside faculty leaders, curriculum and course designers, educational technologists, managers and administrative staff in a facilitated process ensuring shared learning for all participants in the curriculum project. CDIs are centred on actual, existing practices in the university and their alignment to the organisation: practices of teaching staff and students with learning technologies and institutional practices in a complex organisation.

The following sections describe how the CDI model is put into operation within an institutional strategy, exemplified by the FOLD approach.

22.2 Practical Application of the FOLD Process

22.2.1 The Flexible and Online Learning Development Approach to Embedding Learning Technologies into Curriculum

The La Trobe University flexible and online learning development (FOLD) approach to curriculum development is a complex but sustainable approach to embed learning technologies into curriculum that ensures the institution priorities are met and that sustainable models of course design and delivery are employed to enhance student engagement, learning experiences and outcomes. FOLD is an initiative that meets the challenges of the changing landscape and the flexible learning imperative arising from multicampus teaching.

The starting point for the FOLD approach is the local setting for curriculum renewal. A FOLD project offers course and subject teams an opportunity to collaborate in developing or renewing their curriculum to align with course and faculty goals and organise resources to support the development of learning designs, the execution of the curriculum project, the preparation of staff and students and implementation of the new curriculum. The course and subject teams are supported through this process by facilitation of CDI sessions and workshops and support for project development. Participants can include course and subject teams, educational designers, academic developers and library, central and faculty support staff.

FOLD also draws on the meso-level of the organisation and takes into consideration existing institutional practices in order to shape coherent processes that are more cost-effective and less resource intensive, ensuring that quality courses and subjects (programmes and courses in some institutions) are designed and delivered to facilitate student learning experiences and outcomes. The FOLD approach builds sustainable curriculum through professional development and CDIs that enable academic staff to design and develop e-learning practices and resources that are fit for purpose, rather than deploying externally produced resources. The FOLD approach incorporates both CDIs which focus on pedagogy to design with technology and Course Delivery Innovations which focus on the development and delivery of the instruction through e-teaching and e-learning innovations and resources. Using the same acronym CDI for both design and delivery of curriculum innovation can be confusing; however, it is deliberately used here to show the integrated and complex nature of curriculum design and development process involving the use of appropriate learning technologies. The CDIs as course design intensives have been successful in producing cohesive, constructively aligned curriculum (Benfield, 2008). The FOLD approach can be applied regardless of whether learning design is considering course design and development or course innovation for delivery of instruction in flexible mode.

FOLD is a strategic approach that aims to connect learning design for local disciplinary practices and institutional processes and technologies (Fig. 22.1). As part of this strategy, it aims to be:

1. *Strategically aligned*: guided by university and faculty strategies and priorities and makes flexible and online learning a valued means of to enhance the institutions vision for responsiveness in the marketplace (Rosenberg, 2001). It ensures that management champions the flexible and online learning initiative in creating a culture for e-learning. It also encourages management to invest resources in developing a robust infrastructure to deliver instruction.
2. *Collaborative*: team-based curriculum development projects, with multiple academics engaged in collective decision-making. This creates a culture for e-learning and a shared community of practice by facilitating a readiness and an openness to share information, ideas and resources in a comprehensive manner. A collaborative design builds capacity in the programme team, enhancing quality and ensuring sustainable delivery and teaching in the course by getting the team members on board ensuring continuity in readiness of team members to improve quality and continued engagement in the initiative as peer reviewers and critical friends.
3. *Curriculum-focused*: design of subject assessments and learning activities are based on a course-intended learning outcomes focus. This ensures pedagogical learning designs are learner-centred, keeping the learners' needs and the learning situation as the key focus. The learning experience is constructively aligned to present a cohesive learning experience and to achieve success in learning.
4. *Sustainable*: learning designs can be adapted to other contexts and extended in scale-mounting focused efforts towards sustainability. The corporate intelligence and knowledge and skills gained in one project can be transferred to other curriculum projects.
5. *Achievable*: the scope of the projects has defined goals that can be achieved over a predetermined time frame and can be evaluated for continuous improvements during the design, implementation and delivery of the curriculum project.

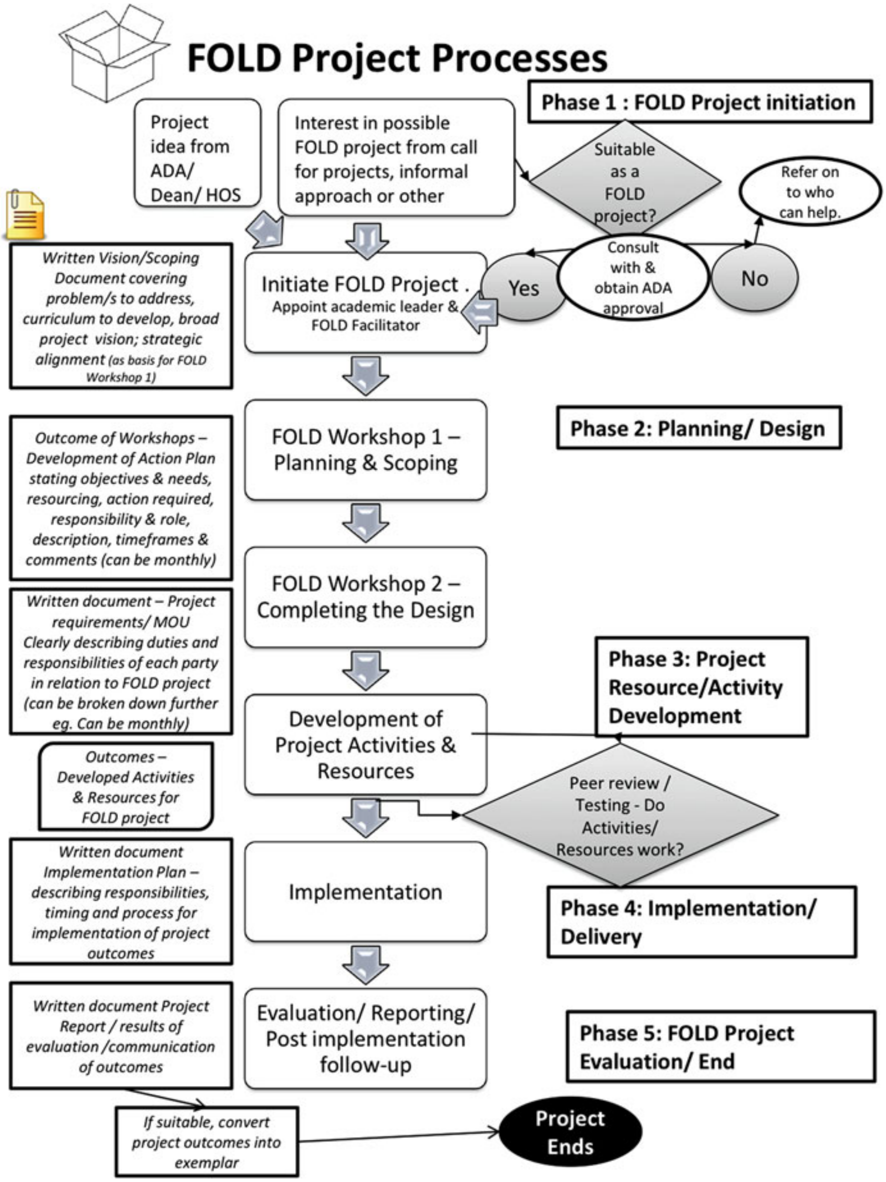

Fig. 22.1 Commencing FOLD projects

The FOLD process of embedding learning technologies into curricula can be based on any suitable educational research methodologies, for example, critical action research (Carr & Kemmis, 1986), the appreciative inquiry approach proposed by Cooperrider and Whitney (2005) or the participation process for the emergence of a sustainable community of practice (Lave & Wenger, 1991).

Action research is inquiry into practice with the view of improving practice. Critical action research is underpinned by the tenets of critical theory, including critical reflection in action and on actions (Carr & Kemmis, 1986). It is a practical way of addressing an issue to find solutions and as a process is described as a cyclical process with the four interrelated stages: *plan, act, observe* and *reflect* (Carr & Kemmis, 1986). Using action research methodology in the FOLD processes commences with phase 1 of the process where a question, need, problem or an educational issue needs to be resolved. Phase 2 of the FOLD process includes planning and scoping of the learning design. Phase 3 involves acting to develop the learning resource. Phase 4 involves implementing and teaching with learning resources, and finally phase 5 evaluates and informs the redesign process. The action research cycle embeds continuous evaluation of a curriculum development project.

Appreciative inquiry is also a staged process that engages individuals in renewal and change and fosters positive engagement. This approach sits well with strategic change and institutional uptake of e-learning. The characteristic are to be appreciative, applicable, provocative and collaborative. The process includes discovery phase to identify what works well and appreciate the best of what exists; dream to imagine the results as what it might be in the future; design what should be the ideal to co-construct the future to have better outcomes; and, finally, the destiny phase to create and implement the final product taking into account how to empower, learn, and adjust to sustain the change (Coghlan, Preskill, & Catsambas, 2003; Cooperrider & Whitney, 2005).

Using appreciative inquiry approach within the FOLD process starts with discovery in phase 1 to appreciate what is good and needs to be carried forward. FOLD phase 2 involves blue skies thinking to plan the best outcomes possible in planning technology-based learning. The FOLD phase 3 incorporates the design and development of the e-learning resources. FOLD phase 5 represents the destiny phase in implementing the e-learning, and finally evaluation phase 5 of FOLD process reenters the starting point of appreciative inquiry of the positive aspects and strengths of the e-learning resources which will also highlight the weaknesses that need improving.

Utilising these approaches provide a way of engaging with the task of designing and delivery technology-based learning. The FOLD approach is able to accommodate either of these processes depending on the starting point or the issue we are addressing.

22.2.2 Phase 1: Initiating FOLD Process

This phase ensures that the aims of FOLD can be met with the proposed curriculum innovation project. Key principles of FOLD are as follows: projects are proposed by academics; approved by faculty and university with help from e-learning experts to ensure that it is strategically aligned, appropriately scoped and achievable; and scalable to ensure it is sustainable. The processes for proposal and expression of interest to conduct such a curriculum project are streamlined so that appropriate resources can be allocated to such projects.

The appropriateness of the innovation is a major consideration in the development and embedding of e-learning into curriculum. Analysing the appropriateness of the e-learning approach at the initial phases ensures that the learning design and the learning object meets the learners' needs and is the best learning environment to achieve student learning outcomes. The learning object refers to technology-enhanced learning that is self-contained stand-alone component that can be reused in different learning contexts.

The appropriateness also considers the value of the e-learning that is being created or designed. Value considerations are in terms of *quality* and *reusability* of the object or the processes for creating the object to scale it into different contexts. Value considerations also account for sustainability discussed later. Appropriateness also considers how well the e-learning innovation addresses the educational issues: does it reduce practical demonstration times, prepare students more effectively to undertake another learning experience or use time spent on learning more effectively? The e-learning innovation has the potential to address specific issues like multidisciplinary, cross-disciplinary engagement or multicampus teaching and learning.

The final consideration of appropriateness of e-learning designs is academic time and workload and the extent to which there is a return on investment of time and resources.

22.2.3 Phase 2: Planning and Design, Initiating CDIs in the FOLD Approach to Course Design

In this phase, the aims and outcomes of the educational innovation are determined, including the nature and scope of the innovation, budget and feasibility, timelines and details of the project. A learning design document specifies the learning experiences to be created by the learning activities. The dialogue with academics formulates and refines pedagogical ideas so that learning resources and learning activities achieve their educational aims and objectives. An analysis of requirements conducted at this phase ascertains the feasibility and viability of the learning design.

The design principles underpinning CDIs include three key principles underpinning the process of design to incorporate learning technologies into the curriculum. These are:

1. Sustainable and scalable design
2. Led by institutional strategies
3. Collaborative design approaches

1. Sustainable and Scalable Design
   From an institutional perspective, the most important principle is a sustainable and scalable approach to design. The meaning of "sustainability" is open to interpretation. For example, Nichols (2008) used the term "sustainable

embedding" to describe a process where e-learning is characterised as 'proactive, scalable and self-perpetuating' process (p. 603). Robertson (2008) explained sustainability in terms of "organisational sustainability" meaning "the capacity of the organisation to meet present and future demands in respect to political, legal and social obligations" (p. 821). Gunn's definition of sustainability for e-learning requires three elements:

(a) An overall teaching and learning strategy that includes a vision for e-learning with accountability measures at both management and practitioner levels
(b) Flexible but measurable goals for e-learning that are reviewed on a regular basis with well-defined means of assessing performance against these goals
(c) A vision for e-learning that is relevant, coherent and shared (Gunn, 2010, p. 93)

In essence, sustainability embraces the concept that effective e-learning practices are expanded beyond the development context (Gunn, 2010, p. 90) learning designs can be adapted to other contexts and extended in scale.

The "lone ranger" model in which an instructor learns how to design and teach an online course by himself or herself is not scalable and does not lend itself to the diffusion of innovative practice in an organisation and unsustainable (Chao, Saj, & Hamilton, 2010, p. 108).

Various factors can contribute to sustainable design outcomes, including:

(a) Prioritising and allocating resources to designs aligned with faculty and university-strategic initiatives
(b) Responding to local, community or organisational needs rather than using a generic approach (Stacey & Gerbic, 2008)
(c) Introducing design approaches as a scholarly and transformative redesign process within the institution that rebuilds the course rather than simply adding on technology (Stacey & Gerbic, 2008)
(d) Embedding effective change management processes in design processes
(e) An institutional practice of carrying out regular evaluations and publishing the results (Stacey & Gerbic, 2008)

2. Led by Institutional Strategies

As the second principle of design, curriculum renewal through CDIs must be guided by university-led strategies and policies. This requires institutional leadership and informed management of resources, with access to technological provision and support (Inglis, Ling, & Joosten, 2002). There should be a clear vision in place at the most senior level(s) so that staff can gain understanding of why change is important and necessary (Goolnik, 2006, p. 10).

To ensure sustainable and scalable approaches, an institution should have an overall vision and strategy for e-learning, existing beyond the realm of enthusiasts who are prepared to work with low priority status and without institutional endorsement (Gunn, 2010, p. 93). There should be institutional building blocks in place, including organisational readiness, sufficient technical resources, motivated faculty and good communication and feedback channels with students (Stacey & Gerbic, 2008).

3. Collaborative Design Approaches
   A third principle of design for CDIs is that the process is entirely collaborative and team-based, with multiple academics engaged in collective decision-making. Collaborative design creates a culture for e-learning and a community of practice by facilitating a readiness and an openness to share information, ideas and resources in a comprehensive manner.

   A collective approach can streamline institutional response times and policy development processes (Gunn, 2010, p. 101) and builds intellectual capital enhancing quality and ensuring sustainable delivery and teaching in the course by getting the team members engaged. The collaborative approach to design also recognises that a high-quality online course requires various sources of expertise not usually possessed by one person (Chao et al., 2010, p. 107).

   It should be recognised, however, that collaborative design approaches present a challenge to institutions. The CDI process is necessarily one of change, with the potential to disrupt patterns and create uncertainty, as well as resulting in confusion, anxiety, feelings of incompetence and withdrawal (Andrade, 2011, p. 4). The collaborative nature of CDIs gives the opportunity to resolve conflict and differences through negotiation and compromise, an effective change management strategy (Andrade, 2011, p. 4). As Goolnik indicated resistance to change is therefore likely to be overcome if "academic staff is fully involved/have full ownership in the design, development and carrying out of these changes; they have to be an understanding of their new roles …" (Goolnik, 2006, p. 11).

22.2.4 Phase 3: Course Delivery Innovations, Activity and Resources Development

The Course Delivery Innovation is the subset of the overarching process where the learning activities designed are developed. The key purpose is to create a functioning product and or sequence of educational experiences as specified in the learning design process. This is the collaborative process that aims to develop the academic capabilities so that the learning object developed is contemporary and relevant to learners need and can be easily modified by the academics.

The collaborative decision-making ensures inclusiveness and that all possibilities are considered and therefore would be used by as many academics as possible without having to constantly make modifications to the design and development of the learning experience. It also includes all stakeholders, e.g. academics, educational designers, librarians, topic experts like assessment experts, flexible learning design and development experts to name a few.

The learning activity design and development incorporates the intended learning outcomes and aligns itself to the assessment task. The learning activity and experience support the individual learning styles of the learner and that it is pedagogically sound. It also considers cognitive ergonomics, i.e. how the information is presented and how the students interact or engage with the e-learning activity.

The design and development work is conducted through the course design and course delivery intensive workshops see Fig. 22.2.

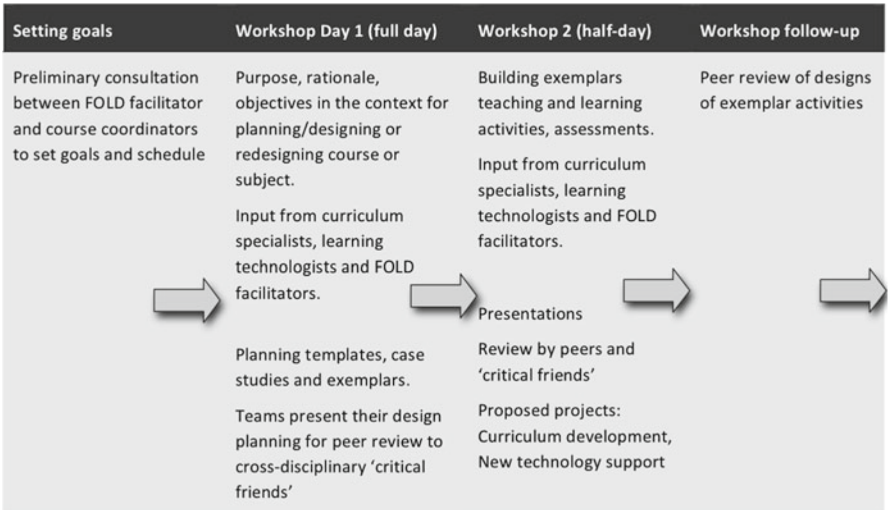

Fig. 22.2 CIDs in the FOLD process (Adapted from OCSLD, 2009)

22.2.5 Phase 4: Implementation and Delivery of Educational Innovation

Implementation and delivery of the finished product is deployed and supported by the institution to ensure that the users have the knowledge and resources to use and experience the learning sequence, product or learning technology in the desired manner. There is support for both the staff and the students who engage in learning with technology which include systems administration support, training support, documentation and technical support. The delivery is usually through the student learning management system (LMS) of the institution; however, they can be stand-alone initiatives.

22.2.6 Phase 5: Evaluation of Learning Design, Experiences and Outcomes

Trialling and testing the learning design and the learning experience sequences with all key stakeholders to validate the finished product against the initial requirements are keys to successful outcome. Evaluation starts from the design phase capturing the formative evaluation as in action research cycle noted earlier. Formative evaluation and feedback to make adjustments and minor modifications that verify and improve the product can be through self-reflection, peer review, student trials, paper trials, rapid prototype trials and wireframe trials depending on the nature of the innovation.

Summative (final) evaluation of the learning experiences and outcomes through student feedback and self-reflection follows the implantation and delivery of the instruction phase to continuously improve the student learning experiences and outcomes and to keep the learning design working in the prescribed manner.

22.3 Embedding Pedagogies into Design

The widespread presence of LMS as a standard e-learning environment in universities brings a particular pattern of use in teaching with technologies, in which uncritical or "default" approaches are adopted that arise from the functions of such system technologies and comprise mainly transmissive rather than participatory pedagogies (Blin & Munro, 2008; Marshall, 2010; Mott, 2010). A key challenge in the CID workshops was to disrupt this default use of learning technologies and to make explicit the pedagogical decisions that link particular technology uses to learning outcomes and graduate capabilities. As a guide during the FOLD process, we adapted four "online pedagogies" that were elaborated by Bower, Hedberg and Kuswara (2009, p. 1156), to produce a resource for the intensive workshops. The resource aimed to distinguish four pedagogies that could be matched to learning outcomes, subject or programme graduate capabilities and to which uses in the LMS could also be assigned (see Fig. 22.3).

The "online pedagogies" were distinguished with the following brief descriptors:

1. A pedagogy of *transmission* can introduce understanding on a topic through an instructional approach, directly imparting knowledge and processes.
2. Pedagogy of *dialogue* enables students to extend the achievements of individual learning to learn in their zone of proximal development (Vygotsky, 1978) through dialogue and conversation. This pedagogy follows Laurillard's (2002) dialogic model of a goal-action-feedback cycle.
3. In a pedagogy of *construction* (Papert, 1986), students learn through construction of a product rather than through transmission of knowledge and information. They engage in activities over which they have a large degree of control and find personally meaningful.
4. Pedagogy of *collaboration* makes groups of learners responsible for the co-construction of a product or artefact, drawing on the peer processes of the dialogic pedagogy and productive activities of the constructionist pedagogy.

This resource was used during FOLD intensive workshops and applied to the particular arrangements for settings of teaching and learning. It was used as a method for reviewing the traditional lecture-tutorial structure of delivery, particularly where a unit was taught concurrently across two or more campuses.

Subject information	Online pedagogies	Example graduate capabilities	Designing assessment & learning activities in the LMS
A subject in the LMS will contain: • Subject Description • Intended Learning Outcomes • Learning Activty Summary • Assessment and Feedback Summary	**Transmission:** learning occurs through a focus on knowledge and information delivery	Writing Speaking Inquiry/research Critical thinking Creative problem-solving Teamwork Faculty graduate capabilities	**Knowledge presentation** Lecture presentation (Lectopia, podcasting), library resources, quizzes, self-assessment
	Dialogue: participants learn through interaction and dialogue	Critical thinking Inquiry/research	**Discussion and feedback** Discussion forums, chat, shared jouenals, peer review blogs, debates & role plays
	Construction: learning occurs by developing a product	Writing Creative problem-solving	**Knowledge building** Project work in individual wikis, reflective writing, image creation, case study activities, video, desktop recording, mindmapping
	Collaboration: groups of learners complete a series of goal-related tasks to produce an joint artefact	Teamwork Creative problem-solving Inquiry/research	**Collaborative production** Shared presentation via wiki collaboration, problem-solving, shared document creation, image sharing, group blogs & wikis, community journals

Fig. 22.3 Matching online pedagogies to curriculum design

22.4 FOLD Examples

The following examples demonstrate the FOLD process that can be applied to curriculum renewal and innovation: (1) course or programme example at departmental and course levels and (2) development of non-award educational resources and programmes.

22.4.1 Course or Programme Example of FOLD and CDI

In the past 5 years, La Trobe University has undertaken massive course renewal and redesign through their "Design for Learning" project to embed graduate capabilities into curricular. Part of the early discussions during the curriculum renewal process has been on integration of learning technologies into teaching and learning activities.

Phase 1—the need for curriculum renewal was identified and how best to employ technology to enhance learning.

Phase 2—two groups of similar, large cohort multicampus course staff engaged in phase 2 CDI workshops for two different types of curriculum projects. One CDI workshop was with 30 nursing and midwifery staff members who used appreciative inquiry to identify the strengths and weaknesses of the current curriculum. The focus was on strengths and what needed to be retained and how best it could be delivered to five different campuses simultaneously. This planning phase CDI was also conducted in another campus with 20 regional staff. Working in the subject teams, the academic staff identified issues they planned to address by using learning technologies, what learning technologies were best able to address their student's learning needs and what types of learning activities and experiences will be addressed within each subjects of the whole course. The second group was 12 Science, Engineering and Technology staff redesigning a subject that had to be delivered via technology to three different campuses simultaneously.

The academic staff had resources and expertise including library staff, educational designers, technology development and production expertise available to them and all decisions, timelines and action plans were documented. At the end of the workshop, the teams presented their work and action plans to all participants to get feedback and address questions that may arise from experienced experts. In this way collaboration, evaluation and peer review are built in at the commencement of the process. The staff left to devise the conceptual framework of the learning experience and to start the resource development. The conceptual framework included blue skies thinking of the core attributes that needed to be developed and the core knowledge and skills that will assist students to achieve these graduate capabilities.

For phase 3, a second smaller workshop was conducted several weeks following the first CDI workshop for both projects. During the interim period between the workshops academic staff refine their planning and scoping decisions and documentation taking into account the feedback received from their presentations. At the second workshop they present their collective decisions and refinements to all course team members and support staff and receive further feedback before commencing the development phase of the project. These two capability-building workshops were important for personal and professional development of staff as staff learn from their colleagues about good practices in flexible learning. The continuous evaluations and reflections ensured the academic staff had consensus and owned the decisions made, worked more effectively as a team and produced the required work.

In the next phase academic staff developed specific teaching and learning activities, learning experiences and resources with the in consultation with and help from the support staff as required. A range of e-learning and m-learning technologies like LMS, Web 2 applications, Echo 360, Lectopia, Collaborate, Pebblepad, wikis and blogs are available to staff. Throughout the development phase the resources created are tested and peer reviewed at each milestone ensuring the quality of the product. Two peer review sessions were held during the development of the subjects.

Phase 4—the learning design and activities created were implemented through the semester by subject teams. This phase in appreciative inquiry is the destiny phase and the final phase leads us back to evaluation including formal evaluation by students and staff at the end of the semester to add to the continual improvement of the curriculum resources.

22.4.2 Professional Development Unit for Nursing Clinical Educators

In recent years, the Faculty of Health Sciences at La Trobe University has overseen the emergence of postgraduate programmes for advanced nursing practice in a mode of distributed learning, in which practitioner-students conduct coursework from their hospital-based workplace without on-campus attendance. The arrangements for distributed learning were facilitated through a FOLD project that involved lecturers on two campuses and clinical educators in several hospitals who were undertaking the roles of supervising and assessing hands-on clinical practice. The risk that arose from the distributed learning settings was that disparate learning setting fostered fragmented and inconsistent teaching and assessment practices in the postgraduate programme.

To establish quality assurance across teaching and learning contexts and provide a consistent set of resources and guides for communication between clinical educators and coordinating lecturers, a professional development unit was developed as a FOLD project. This took the form of a Moodle-based unit for clinical educators that could be accessed from their workplaces.

The FOLD process involved team collaboration between 2 nursing academics, 2 curriculum developers and 6 clinical educators, comprising three FOLD workshops over one semester. A priority for FOLD facilitators was to achieve early accomplishments in order to maintain the engagement of participants, following a change approach that included "short-term wins" (Uys, 2010, p. 986); hence, the goal of the first workshop was to develop and produce some elements of the proposed unit in Moodle. During the initial session goals and outcomes were agreed, topics selected and allocated to participant pairs for immediate development in structural form in the Moodle LMS. Topics that emerged during FOLD workshops were *Role of Nurse as Educator*, *Theories of Learning for Clinical Education*, *The Clinical Practice Setting as a Learning Environment*, *Assessment and Feedback* and *Managing Challenging Situations*. These were developed into a consistent and accessible format and finally presented during the third and final FOLD workshop to peers and other invited guests. Having successfully achieved a participant designed unit and resource for professional development, the teaching team plans further development as a unit for postgrad qualifications in nursing practice.

22.5 Assembling Flexible Learning Through FOLD and Conclusion

The CDI model embedded within the FOLD approach both involves multi-professional teams in course development which brings a disruption to traditional, individually oriented, procedural modes of curriculum design and rather involves collaboration for a curriculum design that is fit for purpose. FOLD also has a goal of sustainable education, with a purpose of capacity building among a discipline team, resulting in a curriculum design that is faculty oriented, located with discipline participants rather than one individual. Both approaches involve principles that can be applied through suitable approaches on team collaboration to accomplish action and embed learning. Examples approaches are action research (Carr & Kemmis, 1986), which builds capacity in participants through cycles of action, reflection and evaluation; appreciative inquiry (Cooperrider & Whitney, 2005), directs inquiry towards positive accomplishments and organisational strengths; and the community of practice approach (Lave & Wenger, 1991) involving peripheral participation of practitioners to establish a practice community. These theory-informed approaches support the development of sustainable e-learning environments as learning ecologies, in which practice settings are the locus for integrating technologies and organisational contexts.

The FOLD approach brings implications for curriculum design work. The engagement of institutional learning technologies means an inevitable entanglement between learning development and institutional processes and practices. A common solution is the use of standardised, institution-wide applications of technologies to teaching and curriculum, through LMS and planned approaches to e-learning curriculum development. There have been cautions, however, that design approaches to learning technologies that bring too narrow or instrumental a focus on application can implicitly separate technology from practice and limit the sharing and advance of knowledge and practice (Bennett & Oliver, 2011; Gunn & Steel, 2012; Oliver, 2011). One consequence is that instrumental or "tool"-based approaches to learning technologies are unable to engage with the fluid, rapid and dynamic uses of Web 2.0 pedagogies. The FOLD process does not construct and bring a premade design to a setting for learning but gathers participants to consider all factors for review (by engaging with early-stage "blue-sky thinking"). Participants then *assemble* a curriculum that is negotiated between all the entities in play that constitute ecology of learning: teaching staff, faculty strategies, ready to hand learning technologies, costs, support, and specific times and locations of learning. The actual designs are still critical, but designs are one of many activities in an adaptive process of assembly. Rather than adoption of curriculum plans or designs, this in situ approach of assembly attends to the messy realities of the existing state of affairs, with the tensions, conflicts, trade-offs, in which designing a curriculum extends to both discipline goals and institutional actors.

A further ramification of FOLD is a working with multiplicity: recognition that curriculum work involves a diversity of professional standpoints that produce multiple institutional practices (Orlikowski, 2010). Where traditional notions of the organisation as unified and coherent, from which strategies are operationalised as single implementations, learning technologies tend to be approached as top-down, planned strategies or bottom-up innovations by individual enthusiasts. The FOLD approach engages with organisational processes of the university as meso-level practices that are enacted in multiple ways according to situational arrangements. To acknowledge multiplicity anchors curriculum design and learning technologies as a practice-oriented project that is contingent on everyday realities: resources, places and times for learning, and the task of assembling a technology-enhanced curriculum becomes a task of alignment with existing practices, technologies, people, resources and processes.

This chapter has proposed an approach to curriculum design that is oriented to sharing collegial practices by embedding learning technologies into the early design and development phases of curriculum renewal, in contrast to individual approaches that add on technologies at the later delivery phase of teaching and learning.

The CDIs in the FOLD approach provided a framework for successful analysis, design, development and implementation of e-learning that entailed capacity building processes that are sustainable and that can be shared, used and reused through a community of practice. Similarly, teaching, assessment and administration of e-learning can be strengthened though a process of capacity building that is able to release the full potential of embedded learning technologies. The collaborative process of academics working closely together promoted understanding of how technologies can be used to afford specific learning advantages and provided appropriate guidance at the design stage.

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