Six Years of Teaching Human Bioscience, Pathophysiology and Pharmacology: A Journey of Reflective Practice

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Abstract
Science classes for health science degrees are some of the most challenging any lecturer will undertake. In many institutions they act as the 'gate-keeper' subjects for the degrees they serve and are often deemed the reasons for high attrition and fail rates. This paper focuses on a suite of four biomedical science courses that run over the first two years of various healthcare degrees at Charles Sturt University. The majority of our regional students are enrolled in nursing or paramedic undergraduate degrees and have entered through non-traditional pathways. Students study these courses either internally on campus or via distance education with many moving between modes of delivery. In an attempt to improve student performance we set out to realign the course content and assessments of these key subjects using Bloom's taxonomy.

A review is presented of the teaching teams' experiences and responses to the challenges in teaching human bioscience, pathophysiology and pharmacology. The review considers the data generated over 12 semesters of teaching between 2007 and 2012 inclusive and assesses the impact of the content realignment. It includes the trends in student subject evaluations and historical data relating to student success, attrition and failure. Although student opinion towards these subjects has in general improved, the review highlighted problems associated with analysis of trends over time when centralised raw data is unavailable. Despite this limitation, it has enabled the team to identify where future efforts need to be directed; the student transition from level 1 to level 2.

Introduction

There is a worldwide critical shortage of health care workers (WHO, 2006). Like many other countries, nurses and paramedics make up the majority of the health care workforce in Australia (Duckett & Willcox, 2011). Nurses predominantly spend more time with patients than any other health worker and play a critical role in maintaining a quality of care across multiple health fields. However, nurses commonly report that their high workload has a detrimental effect on the care they can provide to their patients (Aiken, Clarke, Sloane, Sochalski & Silber, 2002; Hong, Barriball, Zhang & While, 2012). Indeed, a recent study has shown a high correlation between nurse workload and health care associated infections (Cimiotti, Aiken, Sloane & Wu, 2012). It is not surprising that there are an estimated 12,000 nurses leaving the profession each year with the average age of preexisting nurses and midwifes steadily increasing (AIHW, 2012). On the other hand, paramedics who are often the first to arrive at a traumatic scene, commonly report high levels of occupational stress and are

reported to have one of the highest turnover rates among health professionals (Grigsby & McKnew, 1988; Beaton & Murphy, 1993; Grevin, 1996).

Increasing the university course numbers of nursing and paramedic students may not only go towards alleviating the current healthcare shortage but could possibly sustain future health care numbers. Often the lack of healthcare workers is keenly felt in rural environments where the ratio of healthcare workers to patients is at a significant lower level compared to metropolitan areas (Dunbabin & Levitt, 2003; Wakerman, Humphreys, Wells, Kuipers, Entwistle & Jones, 2008). Charles Sturt University (CSU) is a significant provider of tertiary education across Australia. Our 2007-2011 graduate destination surveys demonstrate that almost 80% of our students who were originally from a rural environment were employed in regional or remote areas (Clemson, 2012). As such, regional universities like CSU are positioned to play a pivotal role in meeting these health challenges.

The need for foundational biomedical knowledge and sound clinical reasoning in health care is undeniable. North American medical degrees introduced a science-based curriculum early last century which had a profound effect on health care (Flexner, 1910). These science based analytical approaches resulted in almost a doubling of the life span over the 20th century (Frenk, Chen, Bhutta, Cohen, Crisp et al., 2010). However, nursing students have traditionally struggled with bioscience and scientific literacy (Clancy, McVicar & Bird, 2000; Logan & Angel, 2011). Additional reports indicate that paramedic students similarly struggle in their courses (Madigan, 2006; Whyte, Madigan & Drinkwater, 2011). Often students report they do not see the relevance (Thornton, 1997; Logan, 2012) or they find the language too difficult to comprehend (Craft, Hudson, Plenderleith, Wirihana & Gordon, 2012; Logan, 2012).

With the aim of improving student success whilst reducing attrition and fail rates the current teaching team undertook realigning the content and assessments to Bloom's taxonomy. By undertaking a long term review of the quality assurance data the team sought to assess the impact of the realignment and identify any trends in student results and opinions. This report presents the quality assurance data and lecturers' reflections for a suite of science courses operating across five regional campuses that are foundational to nursing, paramedic and other health science undergraduate degree programs at CSU.

Literature review

Less than a third of first year students enter university with realistic expectations of the required workload (Scutter, Palmer, Luzeckyj, Burke, da Silva & Brinkworth, 2011). Australian high school student participation in science subjects nationally at Year 12 (when university entrance exams are attempted), such as biology, chemistry and physics, have been steadily declining over the last 30 years despite student retention rates having increased from 35% in 1982 to 75% in 2009. The drop in the number of high school biology students has been greatest at 29% between 1992 and 2007. International enrolment trends have mirrored those of Australia (Lyons & Quinn, 2010). This explains some of the lack of preparedness for studying tertiary health science; however, university entrance scores have been shown to be less than satisfactory predictors of student success for this group (Dobson & Skoja, 2005). Compounding or perhaps explaining this finding is the high number of students who gain entry through non-traditional pathways. A Victorian demographic study at a regional university found only 56% of students had completed high school (Birks, Al-Motlaq & Mills, 2010). Recent media dialogue indicates the overall lessening of the relevance of university

entry scores when student enrolments numbers are not capped by the government (Battersby & Walker, 2012). Interestingly, the overall numbers of Australian university students studying biological sciences increased by 74% between 1989 and 2007 while those studying physics and chemistry fell (Lyons & Quinn, 2010). This is explained somewhat by the movement of a number of health science programs from the college environment to universities after 1987 when they were merged (Anderson, Johnson & Saha, 2002).

It has been calculated that for each subject a nursing degree student fails the likelihood of degree completion decreases by 36% (Abele, Penrase & Ternes, 2013). Further, attrition rates have been calculated as 30% and over for United States nursing students, resulting in the United States National League for Nursing Accrediting Commission recommending institutions aim for an attrition rate of 20% or less (Abele, Penrase & Ternes, 2013). A recent review found a long list of factors had been identified relating to nursing student academic and clinical performance (Pitt, Powis, Levitt-Jones & Hunter, 2012). These included: age, gender, English as a second language (ESL), paid part-time employment, preadmission high school performance, university entrance scores or exam results, first session grade point averages, university science subject performance, personality, anxiety, support seeking behaviours, class attendance and academic engagement (Pitt, Powis, Levitt-Jones & Hunter, 2012). For some of these there are contradictory findings, for example, age (Ali & Naylor, 2009; Dante, Vallopi, Saiana & Palese, 2011; McCarey, Barr & Rattray, 2006; van Rooyan, Dixon, Dixon & Wells, 2006;), high school biology (Griffiths, Bevil, O'Connor & Wieland, 1995; Ofori, 2000) and paid work (Salamonson & Andrew, 2006; Snelling, Lipscomb, Lockyer, Yates & Young, 2010). Logan (2012) posits the influence of the clinical environment as a factor impacting on a student's motivation to study bioscience. As Prowse and Lyne (2000, p.72) note, "nurses develop a form of 'situated bioscience-based knowledge' in clinical practice" and it can be difficult for them to articulate tacit science knowledge (Titchen & McGinley, 2004) that supports their care of the patient. Although there have been calls for nurses to undertake practice training before theoretical study as context preparation (McVicar, Clancy & Mayes, 2010), there are research reports that indicate previous practice experience can be detrimental to academic results (Whyte, Madigan & Drinkwater, 2011). Clinical site 'busy-ness' was identified by nursing students as a detrimental factor for learning pharmacology administration and management (Manias & Bullock, 2002). A number of authors indicate that the majority of nursing students (up to 81%) feel the undergraduate bioscience curriculum did not prepare them for practice and was in fact insufficient (Davis, 2010; Friedel & Treagust, 2005).

In health courses, where subject content is expanding in volume, there is a risk that the need to cover dense content surpasses that of students' developing the capability of critical evaluation (Ironside, 2004). Aims and objectives styled curricula have been criticised for their behaviourist framework (Kelly, 2004) and the onus it can place on the lecturer to ensure all content is covered (Giddens & Brady, 2007). Torrence and Jordan (1995) used a pharmacology case study to integrate bioscience, pathophysiology and pharmacology theory and practice. Key concepts linking these discrete fields of knowledge were highlighted by the case study. This framework for facilitating learning has been reiterated by other authors. Problem solving, such as using the Problem or Inquiry Based Learning (PBL and IBL) approaches, using incomplete case studies to generate active participation in learning lend themselves to pathophysiology and pharmacology areas. PBL and IBL have been offered as solutions to content dense curricula in nursing (Bebb & Pittam, 2004). However, cases need to be chosen to include key concepts and the links between them. In PBL and IBL group-work solving the case study's dilemma is paramount as a mechanism to facilitate generic

team work skills. Students need to be familiar to some extent with problem solving strategies to avoid surface learning or being left behind in group-work (Bebb & Pittam, 2004). Others have proposed that a curriculum designed around identified key concepts may alleviate content saturation (Giddens & Brady, 2007). It is suggested that such approaches might minimise student anxiety and that a student centered active learning approach better supports memory retention (Bebb & Pittam, 2004). From this viewpoint, student engagement cannot be measured only in terms of lecture attendance and homework completion.

Students who are the first in their family to attend university are less aware of the demands of university study and less able to meet faculty expectations at university entrance (Collier & Morgan, 2008). These students have a steeper adjustment curve to university life as they often enter from non-traditional educational backgrounds. In particular they are noted for being less able to accept the time commitment which is compounded by family and work commitments (Collier & Morgan, 2008). It has also been proposed that the cultural capital possessed by these students is not aligned with university study (Luzeckyj, King, Scutter & Brinkworth, 2011) and studies of these students have indicated they lack the outside resources of the traditional entry students (Collier & Morgan, 2008).

At the present time, CSU has a large number of first in family and non-traditional entry students enrolled in BMS191 (see Logan, Cox & Nielsen, in this issue). Human bioscience courses at our university were recognised as 'gate-keeper' courses for nursing students, that is, success or failure in these early foundational courses had a profound impact on student progression. The fail rate for BMS191 has been as high as 38% for students who have completed all tasks (see Table 3). This was confirmed by Faculty of Science progression and attrition data. Bachelor of Nursing (BN) and paramedic undergraduate degree students have a higher than faculty average attrition rates: 6% and 4% higher respectively (Clemson 2010). In depth demographic studies of our students had not, until recently, been undertaken although the Australian Bureau of Statistics Census data (www.abs.gov.au) and social atlas maps (Haberkorn, 2004) indicated that the populations in regional NSW, where the five main university campuses are located, demonstrated a lower participation rate in higher education.

Aims and method of the review

The present paper describes the development, implementation and reflections on aligning bioscience curricula with Bloom's taxonomy. It is not an empirical paper based on objectively derived data. However, it does present some data to support the progression of ideas and strategies that have been used over six years. Many changes have been undertaken with these subjects as we have tried to better facilitate learning and enable our students to develop academic skills. The aim of the review was to determine if changes made to the subjects based on Bloom's taxonomy had had an impact on student success. The paper uses available retrospective quality assurance data from 2007 through to 2012. The data includes pass, high distinction, fail and attrition rates, and the results for online student evaluations (OES). Student evaluation data held averaged results for 11 core questions that are a component of all course evaluation surveys for students who responded, and not the raw data. This limits the conclusions to be drawn from the statistical testing undertaken with the student evaluation results.

The courses reported here that form a coherent progression in support of health science degrees are: BMS191 Human Bioscience 1; BMS192 Human Bioscience 2; BMS291 Pathophysiology and Pharmacology 1; and BMS292 Pathophysiology and Pharmacology 2.

They are taught in sequence beginning with BMS191 which is a pre-requisite for BMS192 and subsequently, BMS192 a pre-requisite for BMS291. Table 1a and 1b provides extracts from the course curriculum documents.

Statistical tests.

An Analysis of Variance (ANOVA) was conducted using the OES data for all 11 survey questions and from all campus cohorts. This revealed a statistically significant difference ($p<0.05$). In order to determine which group's means were resulting in rejection of the null hypothesis a Fisher Least Significant Difference (LSD) Test was conducted (Williams & Abdi, 2010). The results are presented in Figure 1.

The means and medians for average class results for each subject for each semester were tested for significant difference using the non-parametric Kolmogorov-Smirnov Test after parametric testing revealed non-normal distributions. No significant difference was detected between semesters ($p>0.05$).

Course development.

The suite of four courses were originally designed for the BN and so adherence to the original curriculum document has been a mandatory requirement throughout to maintain accreditation with the state and national nursing bodies. Since 2007 when the suite was first introduced, other degree programs have adopted some or all four as part of their curriculum. Students studying for degrees in paramedicine, oral health, complimentary medicine, clinical science and medical science now access these courses. Students in the BN program, during each session, are required to attend clinical practicum. This requirement, in order to maintain equity across all enrolled groups, has meant that the number of teaching weeks for on campus students for each subject are truncated so that each is delivered in between eight and 10 weeks, despite the sessions being comprised of 16 weeks inclusive of the examination period.

The courses have been taught on five regional New South Wales campuses since 2007 with a cohort of students studying by distance education (DE) each session. As student numbers have increased with increased numbers of degrees accessing the suite, all four courses have become available for study both session one and two (the university now operates three sessions rather than two semesters). Consequently, a large group of lecturers have been responsible for the suite over time – some 23 individuals. For larger cohorts it is common for multiple lecturers to be involved in teaching the one course and for different lecturers to be involved across the four courses. In contrast, for the smaller cohorts the one lecturer may be the sole or primary lecturer for the entire suite of four. A small number of the current lecturers have been team members since the suite of courses were introduced.

The group of lecturers teaching BMS191 and BMS192 began yearly face-to-face meetings in 2009. Initially these meetings were intended to provide opportunities for open discussion of ideas and strategies with the intention of finding ways to improve student success. Other group contact throughout the year was conducted by videoconference or teleconference and email. One lecturer takes the role of course convener undertaking the administrative tasks that are common to all cohorts, then a co-coordinator who delivers the course and co-ordinates marking assessments is designated for each cohort. Teaching team meetings were

extended to include BMS291 and BMS292 in late 2010. The progression of changes over time to the program delivery is presented in Table 2.
Since 2010, the team has undertaken aligning the framework and assessments across all four courses to Bloom's taxonomy published in 1956 (Gopee, 2002). It was believed that through a stepped framework for learning both content and generic skills, as well as learning induced through assessment tasks, the students would benefit (Biggs, 2003). There have been studies that indicate course alignment to Bloom's taxonomy assists students to develop long term understandings of basic concepts, and enables students to apply them (Gopee, 2002; Lord & Baviskar, 2007). It could be expected that this would lead to higher pass rates and reduced attrition. Bloom's taxonomy is structured around three areas of learning - Cognitive, Affective and Pyschomotor domains. The taxonomy is stratified according to degrees of difficulty such that each of these learning domains includes stepped levels for attainment (Lord & Baviskar, 2007). In the cognitive domain there are six levels: knowledge, comprehension, application, analysis, synthesis and evaluation. The affective domain has five levels: receiving, responding, valuing, organising and conceptualising, characterising by value or value concept (Atherton, 2011). Levels for the psychomotor domain have been associated with skill development: imitation, manipulation, precision, articulation and naturalization (Atherton, 2011).

Aligning assessment tasks
BMS191 introduces the student to basic microbiology, chemistry, cells and tissues, and begins exploring the musculoskeletal and nervous systems. In BMS191 the first assessment task is designed to help students develop generic study skills whilst acquiring fundamental concepts. The students are given a question each week that through class participation, laboratory sessions and listening, they should be able to construct an answer for with the support of their textbook and peer group discussions. They are expected to write their own interpretation and understanding of the answer then compile each week's response into an assignment and submit it for review and marking by the lecturer just before midway through semester. This task aligns with the first level of the cognitive domain, knowledge, and the first and second level of the affective domain, receiving and responding. The second assessment item requires the student to complete online an open book multiple choice question test after the middle of semester. The test is limited to approximately two minutes per question and a student can make only one attempt. This encourages them to study the material prior to attempting the test rather than relying on notes and textbooks. This task again aligns with the knowledge and comprehension levels of the cognitive domain, as does the final examination, which is closed book and requires students to demonstrate what they have learnt.

BMS192 covers an introduction to the remainder of the body systems: endocrine, gastrointestinal, respiratory, cardiovascular, genitourinary and reproductive. It had been recognised that students were having difficulty in understanding exactly what an examination or assignment question was asking and this formed the basis of an assessment task where the students wrote and answered their own questions from early session topics. It gave lecturers a chance to help them with comprehension. As the cohorts increased in size this became a mammoth task. Peerwise (http://peerwise.cs.auckland.ac.nz/docs/) was introduced as a means of accomplishing something similar where students construct multiple choice questions and student peers provide answers and critique; an automated mechanism of peer assessment. This task fulfils the cognitive levels knowledge, comprehension and begins the level of application. It fulfils the affective levels of receiving, responding and valuing as well as organising and conceptualising. The second task in BMS192 introduces the students to

scientific process by requiring students to use laboratory class generated data from one topic to construct a report in the format of introduction, aim, method(s), results, discussion - interpretation/limitations, and conclusions. The students are provided with journal articles from which to draw their material for the introduction and discussion in order to introduce them to peer reviewed scientific evidence and how to utilise it. The process is thoroughly discussed in class prior and within the laboratory session. This task incorporates the psychomotor domains of imitation, manipulation, precision and articulation in an introductory form whilst reinforcing those levels of the cognitive and affective domains already experienced. This course has a final closed two-hour examination consisting of both multiple choice and short answer questions.

In the second year of study the students undertake the courses in pharmacology and pathophysiology. These courses utilise the content and concepts learnt in the first year courses. In BMS291 the student completes online mini tests for each topic in the course that are open book but time limited. Their written assessment task requires that they write a short essay on a chosen disease explaining the process of disease development and how a particular pharmacological therapy is utilised in an attempt to return the body to homeostasis or limit pathological damage and/or improve quality of life. This task allows the students to utilise text books and primary sources of information. Once they have received feedback they then construct a peer conference level poster using that information. If they choose they can decide to opt for another disease. The students sit a final closed book examination of two hours duration.

In BMS292 the assessment task is extended in difficulty by requiring students to only use evidence based materials to argue for the drug of choice for treatment of a disease. They can choose their topic from a supplied list. The BMS292 teaching session is the shortest session for the students due to clinical practicum occupying several weeks, and so this is the only assessment task other than the final examination. The cognitive levels of learning reach the level of analysis and synthesis in more substantial ways; the affective and psychomotor domain levels are reinforced. Students then move to their final year professional subjects.

Aligning lecture material

Originally each lecture slide set (which is available to all cohorts and forms the basis of the courses) was preceded with conventionally styled aims and learning objectives. For example, *at the end of this topic you will be able to name and describe the three processes necessary for urine formation.* These objectives were intended to provide a breakdown of component parts for the more general objectives contained in the curriculum documentation (see Table 1). The curriculum objectives were written as statements to be attained, for example, '*demonstrate understanding of the importance of homeostasis*'. The topic slide set would include more precise guides to what a student needed to learn such as the roles of negative and positive feedback for normal body function. Examination questions and other assessment tasks were then composed based on these objectives. Coinciding with the alignment of the assessment tasks for all four courses to Bloom's taxonomy the topic slide sets were re-designed. Beginning with BMS191, concepts presented within the slide sets were formatted to provide a question that was then followed by material forming the basis for answering the question. For example, *How is urine formed? What three processes are involved in the formation of urine?*

In BMS191 and BMS192 the reformatting of the material as questions with answers directed the students to specific knowledge. This means that for these first year courses each has a

long series of questions to be answered but those questions require only the knowledge and comprehension levels of the cognitive domain and the receiving and responding levels of the affective domain. The questions are then used as the basis for the final examination. The students can use the questions to interrogate their notes and textbook to prepare for the final examination and be assured they have studied all the necessary content at the appropriate level. An introduction to the cognitive domains of application and analysis are provided through laboratory and homework exercises.

The objectives are more global and presented as a set of between 10 and 15 statements for the second year courses of BMS291 and BMS292, pathophysiology and pharmacology. The first few deal with knowledge and comprehension, such as definitions and descriptions of disease processes. The next few with application to specific diseases or syndromes and the final one or two, depending on the size of the topic under study, require not only application but also analysis. These last objectives might be based in a case study where a Socratic form of questioning can enable the students to process a scenario and decide a potential diagnostic pathway, appropriate treatment intervention and the related prognosis for the case.

The teaching team holds a variety of scientific and health care backgrounds. This means each lecturer uses the presentation material in a slightly different way. Marking rubrics are designed to be used by all markers regardless of their campus cohort and students have access to these when creating their submission. Quality assurance tasks for assessment marking are undertaken each session across the campuses to ensure that marking rubrics are used fairly and equitably. All marks are compiled into one spreadsheet for review before grades are finalised.

A total of 2,941 students have been enrolled in BMS191 since 2007. The average and median marks for all cohorts since 2007 have been examined (data not included). Statistical testing of this data revealed that there has been no statistical difference in the marks over time. Table 3 and 4 provides the attrition and fail rates by cohort over time as well as indication of the increasing number of students to undertake these courses. The number of high distinction grades awarded is given and shows that for BMS291 and BMS292 the numbers receiving these grades has increased since alignment of the assessments was introduced. Table 4 separates the results for the distance education students. There is no overall indication that they fair any differently to those undertaking their studies internally on campus. Fail rates for the BMS191 and BMS192 cohorts have decreased recently, but there is an indication that moving from BMS192 to BMS291, that is first year to second year courses, is challenging for students as the fail rate substantially and consistently increases again in BMS291, then dropping again in BMS292. Some of the inconsistencies apparent in these figures may be attributed to the decrease in the number of teaching weeks over time. In 2007 there was an extra week in session that was removed when the BN clinical placements were pushed to occupy more of the teaching weeks during semester in 2009. The bioscience subjects were not altered as part of this new BN accreditation documentation. The university later moved to a three-session rather than two semester year, again shortening the number of teaching weeks for on campus students to the current 10 weeks in first year and eight weeks in second year. Due to the accreditation documentation for the BN no accommodating changes were made to the course curriculum documents. On campus students have cited this as a disadvantage compared to distance students who do not undertake the same clinical practicum allocations, however, most are working full time as noted in Table 3.

Table 1a: Extracts from the curriculum documents for BMS191 and BMS192.

	BMS191	BMS192
Abstract	This subject begins the study of human bioscience. Relevant chemistry, physics and microbiology are introduced before beginning the study of normal structure and function of the human body. This subject focuses on the structure and function of the integumentary, musculoskeletal, and nervous systems.	This subject continues the study of normal structure and function of the human body which was commenced in BMS191 Human Bioscience 1. This subject focuses on the structure and function of the endocrine, cardiovascular, lymphatic, respiratory, urinary, digestive and reproductive systems.
Syllabus	*The subject will cover the following topics* PHYSICAL SCIENCES * Elements and atoms * Molecules and compounds * Electrolytes * Acids and bases * Buffers * Carbohydrates, lipids, proteins and nucleic acids * Mechanical forces * Heat * Fluids * Electricity * Radiation MICROBIOLOGY * Major classes of microorganisms * Control of microbial growth * Control of the spread of infections HUMAN BODY * Anatomical terminology * Cell structure and function * Plasma membrane and transmembane transport * Function of cell organelles * Genetic material (DNA & RNA) and cell division * Homeostasis and associated processes * Body tissues * Body cavities and associated membranes INTEGUMENTARY SYSTEM * Structure and function of the skin and accessory structures SKELETAL SYSTEM * Structure and function of the skeleton * Bone growth MUSCULAR SYSTEM * Structure and function of the muscular system * Major muscle types * Major skeletal muscles of the body * Muscle contraction NERVOUS SYSTEM * Structure and function of the nervous system (central, peripheral, autonomic, special senses) * Neurotransmission & neurointegration	*The subject will cover the following topics* ENDOCRINE SYSTEM * Structure and function of the endocrine system * Hormones * Integration of nervous and endocrine systems in the maintenance of homeostasis CARDIOVASCULAR SYSTEM * Constituents of blood * Control of blood fluidity * Structure of the heart * Characteristics of cardiac muscle * Cardiac cycle * Structure of blood vessels * Circulation * Blood pressure and its control LYMPHATIC SYSTEM * Structure of lymphatic vessels, nodes and nodules * Functions of the lymphatic system RESPIRATORY SYSTEM * Structure of the respiratory system * Mechanics of breathing * Control of breathing * Alveolar gaseous exchange * Blood gas transport * Cellular gas exchange DIGESTIVE SYSTEM * Structure of the gastrointestinal tract * Structure of the liver, gallbladder and pancreas * Nutritional roles of the major nutrients * Digestion * Absorption * Metabolism * Elimination URINARY SYSTEM * Structure of the urinary system * Urine production * Characteristics of urine * Micturition * Regulation of fluid, electrolyte and acid-base balance by the kidneys REPRODUCTIVE SYSTEM * Structure of the male and female reproductive systems * Gametogenesis & meiosis * Fertilisation * Foetal development * Pregnancy * Parturition * Lactation * Inheritance

Objectives	*Upon successful completion of this subject, students should* be able to describe the nature and properties of matter *recognise simple chemical formulae and equations *recognise some important classes of chemical functional groups *describe the structure of carbohydrates, lipids, proteins and nucleic acids *describe common applications of mechanical force, heat, electricity, fluids and radiation to health care *demonstrate understanding of the basic principles of microbiology *describe the human body using appropriate anatomical terminology *define homeostasis *describe processes that maintain homeostasis *describe the structure of the cell *describe the function of major cellular constituents *differentiate between the four tissue types (epithelial, connective, muscular and nervous) on the basis of structure, function and location *describe the body cavities and associated membranes *describe the structure and function of the integumentary system *demonstrate understanding of the role the integument plays in protection, sensation, fluid balance, temperature regulation, vitamin production and immunity *describe the structure and function of the skeletal system * demonstrate understanding of the process of bone growth *describe the structure and function of the muscular system *differentiate between the three major muscle types (skeletal, smooth, cardiac) *identify major skeletal muscles *demonstrate understanding of muscle contraction *describe the structure and function of the nervous system (central, peripheral, autonomic, special senses) *demonstrate understanding of neurotransmission and neurointegration	*Upon successful completion of this subject, students should* be able to: *describe the structure and function of the endocrine system *demonstrate understanding of homeostasis and the role of the endocrine system *describe the structure and function of the cardiovascular system *describe the function of the major constituents of blood *demonstrate understanding of key events in the control of blood fluidity *demonstrate understanding of the cardiac cycle *demonstrate understanding of circulation *demonstrate understanding of foetal circulation and the changes that occur at birth *demonstrate understanding of blood pressure and its control *describe the structure and function of the lymphatic system *describe the structure and function of the respiratory system *demonstrate understanding of the mechanics and control of breathing *demonstrate understanding of alveolar gas exchange, blood gas transport, and cellular gas exchange *describe the structure and function of the gastrointestinal tract, liver, gallbladder and pancreas *demonstrate understanding of the nutritional roles of major nutrients (carbohydrates, lipids, proteins, vitamins and minerals) *demonstrate understanding of the chemical and mechanical events that occur during digestion, absorption, metabolism and elimination *describe the structure and function of the urinary system *demonstrate understanding of processes that maintain fluid, electrolyte and acid-base balance *describe the structure and function of the male and female reproductive systems *demonstrate understanding of processes associated with reproduction including fertilisation, foetal development, pregnancy, parturition and lactation *demonstrate understanding of the major types of inheritance (dominant-recessive, incomplete dominance, multiple-allele inheritance, sex-linked and polygene inheritance)

Table 1b: Extracts from curriculum documents for BMS291and BMS292.

	BMS291	BMS292
Abstract	This subject explores pathophysiological processes contributing to disease. This subject focuses on pathophysiological processes associated with musculoskeletal, cardiovascular and respiratory dysfunction. Relevant pharmacology is integrated throughout.	This subject continues the study of pathophysiological processes contributing to disease. This subject focuses on pathophysiological processes associated with dysfunction of the nervous, endocrine, digestive, urinary and reproductive systems. Immune responses and wound healing are also covered in this subject. Relevant pharmacology is integrated throughout.
Syllabus	*The subject will cover the following topics* PATHOPHYSIOGICAL AND PHARMACOLOGICAL FOUNDATIONS * Cell injury, adaptation and death * Pharmacokinetics and pharmacodynamics GENERAL PATHOPHYSIOLOGY AND ASSOCIATED PHARMACOLOGY * Fluid, electrolyte and acid-base imbalances * Pain and analgesic agents * Inflammation and anti-inflammatory agents * Infectious disease and antimicrobial agents * Neoplastic disorders and antineoplastic agents SYSTEMATIC PATHOPHYSIOLOGY AND ASSOCIATED PHARMACOLOGY * Cardiovascular dysfunction (coagulopathy, hypertension, atherosclerosis, dysrhythmias, pump failure) and associated pharmacology * Respiratory dysfunction (asthma, chronic airways limitation, hypoventilation, pulmonary hypertension) and associated pharmacology * Musculoskeletal dysfunction (arthritis, osteoporosis, metabolic disorders, muscular dystrophy) and associated pharmacology	*The subject will cover the following topics* SYSTEMATIC PATHOPHYSIOLOGY AND ASSOCIATED PHARMACOLOGY * Nervous dysfunction (coma, epilepsy, cerebrovascular accident, dementia, multiple sclerosis, glaucoma) and associated pharmacology * Endocrine dysfunction (hyperthyroidism, hypothyroidism, diabetes mellitus) and associated pharmacology * Digestive dysfunction (gastrointestinal ulceration, hepatitis, liver failure, cholelithiasis, cholecystitis, pancreatitis) and associated pharmacology * Urinary dysfunction (renal lithiasis, glomerular disorders, renal failure) and associated pharmacology * Integumentary dysfunction (wounds) and associated pharmacology * Reproductive dysfunction (infertility) and associated pharmacology * Immune function (natural and acquired immunity, primary and secondary immune responses, humoral immune response, cell-mediated immune response), dysfunction (hypersensitivity, allergy, immunodeficiency (congenital and acquired), autoimmunity, alloimmunity) and associated pharmacology

Objectives	*Upon successful completion of this subject, students should* be able to: *define common pathophysiological and pharmacological terms; *describe characteristics and origin of different types of cellular injury; *demonstrate an understanding of cellular adaptation to injury; *identify the interaction and relative contribution genetic and environmental factors have on health breakdown; *describe the characteristics of cancerous cells; *describe the four pharmacokinetic processes (absorption, distribution, metabolism and elimination); *outline key pharmacodynamic principles (e.g. agonist and antagonists, receptor-drug interactions); *describe the involvement of microorganisms in disease; *name and describe the actions of the major classes of antimicrobial drugs; *describe the consequences of alterations in fluids, electrolytes and acid-base balance; *outline the major haematological pathologies and malignancies; *describe the pathogenesis of major cardiovascular system dysfunction; *describe the aetiology and manifestations of shock; *outline the primary pharmacological interventions used in the treatment of cardiovascular disease; *describe the pathogenesis of common respiratory dysfunctions; *describe use of pharmacological agents in the treatment and management of respiratory pathophysiological states; *describe the major types of musculoskeletal pathology including both mechanical and physiological injuries; *demonstrate understanding of the origin and main theories of pain; and *explain the pharmacological treatment of inflammation and pain.	*Upon successful completion of this subject, students should* be able to: *describe the pathogenesis of major central nervous system dysfunction *outline the primary pharmacological interventions used in the treatment of central nervous system dysfunction *describe the pathogenesis of peripheral nervous system dysfunction *outline the primary pharmacological interventions used in the treatment of peripheral nervous system dysfunction *discuss the infections of the nervous system *describe the pathogenesis of the hypothalamic-pituitary system dysfunction; *describe the pathogenesis of thyroid, endocrine pancreas and adrenal gland dysfunction *outline the use of pharmacological agents in the treatment and management of hormonal dysfunction *describe the pathogenesis of disorders of the gastrointestinal system and accessory glands *outline the pathophysiology of constipation and diarrhoea *outline cancers of the digestive system *explain the use of pharmacological agents in the treatment and management of gastrointestinal dysfunction *name and describe the common disorders of the urinary system *describe the different types of renal failure *distinguish between obstructive, infective and glomerular disorders of the renal system *discuss the origin and manifestation of urinary tract infection *explain the use of pharmacological agents in the treatment and management of renal and urinary tract dysfunction *describe the common structural and functional alterations of the male and female reproductive tract and organs *describe the consequences of endocrine dysfunction associated with the testis and ovaries *discuss the cancers of the reproductive system *describe the common infections of the reproductive system *identify the common causes of infertility *explain the use of pharmacological agents in the treatment and management of reproductive system dysfunction *discuss the pharmacological management of fertility (contraceptives and fertility drugs) *discuss the disorders and infections of the integumentary *discuss the mechanism of wound healing *define immunity and differentiate between natural and acquired, and between primary and secondary immune responses *discuss cellular and humoral defence mechanisms *discuss the different types of hypersensitivity reactions *discuss congenital and acquired immunodeficiencies.

Table 2: The progression of changes to each subject over time (*Amended to* is followed by changes made) NB changes to BMS192 followed a session or two behind BMS191 changes**.**

2007 to 2012	BMS191	BMS192	BMS291	BMS292
Laboratory (compulsory attendance) /Residential school or **Tutorials**	Non-experimental exploratory sessions / DE students completed all labs at residential school *Amended to* Commercial laboratory manual introduced – doubled as a study guide *Amended to* 2011 – introduction of in-house laboratory manual	Non-experimental exploratory sessions / DE students completed all labs at residential school *Amended to* Commercial laboratory manual introduced – doubled as a study guide *Amended to* 2011 – introduction of in-house laboratory manual	No laboratory *Amended to* Residential school introduced to facilitate face-to-face tutorial contact. *Amended to* Tutorials structured around a complex question/scenario. Residential schools were replaced with live online tutorials in 2013.	No laboratory *Amended to* Residential school introduced to facilitate face to face tutorial contact *Amended to* Tutorials structured around a complex question/scenario. Residential schools were replaced with live online tutorials in 2013.
Lectures (Non-compulsory attendance) Lecture recording as an mp4 has become available through CSU Replay since 2011	Topic objectives from curriculum document expanded and inserted into beginning of each slide set. *Amended to* Slide set content reviewed *Amended to* Audio recordings of live lectures made available to students through subject website *Amended to* Topic sets re-invented as questions which slide set material then answered – questions repeated at end of slide sets Lecture mp4 files made available to all students	Topic objectives from curriculum document expanded and inserted into beginning of each slide set. *Amended to* Slide set content reviewed *Amended to* Audio recordings of live lectures made available to students through subject website *Amended to* Topic sets re-invented as questions which slide set material then answered – questions repeated at end of slide sets Lecture mp4 files made available to all students	Topic objectives from curriculum document expanded and inserted into beginning of each slide set. *Amended to* Audio recordings of live lectures made available to students through subject website *Amended to* Topic objectives reduced to 10: Five objectives content based; 4 objectives concept based; final objective designed to link concepts and required application of material to a specific pathophysiology Lecture mp4 files made available to all students	Topic objectives from curriculum document expanded and inserted into beginning of each slide set. *Amended to* Audio recordings of live lectures made available to students through subject website *Amended to* Topic objectives reduced to 10: Five objectives content based; 4 objectives concept based; final objective designed to link concepts and required application of material to a specific pathophysiology Lecture mp4 files made available to all students
Distance cohort resources **all students given access	Printed study guide Chat room (Live) tutorials *Amended to* Printed study guide broken up into topic modules and loaded to course website. ** *Amended to* Recorded mp4 lectures and live online tutorials	Printed study guide Chat room (Live) tutorials *Amended to* Printed study guide broken up into topic modules and loaded to course website. ** *Amended to* Recorded mp4 lectures and live online tutorials	Printed study guide Chat room (Live) tutorials *Amended to* Printed study guide broken up into topic modules and loaded to course website. ** *Amended to* Recorded mp4 lectures and live online tutorials	Printed study guide Chat room (Live) tutorials *Amended to* Printed study guide broken up into topic modules and loaded to subject website. ** *Amended to* Recorded mp4 lectures – live online tutorials

Assessment Tasks				
Written assignments	Question and answer style – fully referenced *Amended to* Weekly questions, answers text based, delivered via forum postings –collated and submitted as assignment task 1. (not referenced)	Question and answer style – fully referenced *Amended to* For given topics the student wrote their own questions and then answered them. *Amended to* Written assessment task using data collected during a laboratory session with journal article references supplied using Library Electronic Reserve (eReserve).	Question and answer style – fully referenced *Amended to* Question and answer style – fully referenced – pathogenesis, derived signs and symptoms, interventions related to a specific disease. *Amended to* Essay and Poster (A3) poster – present rationale for a appropriate pharmacological intervention for specific disease (from topic options)	Question and answer style – fully referenced *Amended to* Question and answer style – fully referenced – pathogenesis, derived signs and symptoms, interventions related to a specific disease. *Amended to* Essay – using peer reviewed journal evidence outline the rationale for a preferred pharmacological intervention for a specific disease (from topic options)
Mini tests	10 questions weekly delivered during first 10mins of laboratory for internals. *Amended to* Moved mini tests to online tests for equity across cohorts *Amended to* Dropped as a weekly task - one mid-session test introduced	10 questions weekly; delivered during first 10mins of laboratory for internals. *Amended to* Moved mini tests to online tests for equity across cohorts *Amended to* Peerwise assessment – students deposit their questions to a cohort database and their peers provide critique.	Open book topic associated mini tests accessed Online – random allocation of questions to students within topics. *Amended to* Dropped as a testing device –retained as a study tool and revision device. *Amended to* Re-introduced in 2013.	Open book topic associated mini tests accessed Online – random allocation of questions to students within topics. *Amended to* Dropped after students compiled database of questions. Retained as a study tool and revision device.
Exams	Covered all content – weighted as 60% of summative mark *Amended to* Covers latter weeks of content not covered by mid-session Online test. Weighted as 60% of summative mark.	Covered all content – weighted as 60% of summative mark	Covered all content – weighted as 60% of summative mark *Amended to* Overtime this weighting has been changed in combination with other tasks. Currently weighted at 50%	Covered all content – weighted as 60% of summative mark *Amended to* Overtime this weighting has been changed in combination with other tasks. Currently weighted at 50%
Pass criteria	Summative assessment mark 50% or better; must achieve a minimum of 40% or better for the exam	Summative assessment mark 50% or better; must achieve a minimum of 40% or better for the exam	Summative assessment mark 50% or better; *Amended to* Summative assessment mark 50% or better; must achieve a minimum of 50% or better for the exam.	Summative assessment mark 50% or better; *Amended to* Summative assessment mark 50% or better; must achieve a minimum of 50% or better for the exam.

Table 3: Subject passes, fails and attrition – sessions with a mixture of study modes; all campuses

Year of cohort (session)	Number of students	% Pass	% High Distinction grades	% Attrition Enrolled less non-completions	% Fail
BMS191 Human bioscience 1					
2007 (1)	422	62	0.47	10.9	12.5
2008 (1)	484	62	0.0	6.2	15.9
2009 (1)	389	46	0.77	4.4	37.6
2010 (1)	547	69	2.64	2.4	11.4
2011 (1)	527	63	1.9	3.2	18.2
2012 (1)	572	73	5.68	4.4	8.8
BMS 192 Human bioscience 2					
2007 (2)	226	76	0.0	9	6.5
2008 (2)	319	64	0.63	4.1	21.3
2009 (2)	218	72	1.83	1.0	9.8
2009 (1)	197	74	4.57	7.1	14
2010 (2)	428	60.5	2.1	2.6	20
2011 (2)	383	73	2.09	1.8	11
2012 (2)	500	69	2.4	2.6	4
BMS291 Pathophysiology and Pharmacology 1					
2008 (1)	202	60	0.0	2.9	25
2009 (1)	218	67	0.0	6.4	22
2009 (2)	156	77	0.64	5.1	13
2010 (1)	257	77	0.39	3.5	12
2011 (1)	340	75	2.35	0.5	21
2012 (1)	428	55	3.04	2.3	22
BMS292 Pathophysiology and Pharmacology 2					
2008 (2)	137	62	0.0	1.4	14
2009 (1)	100	48	0.0	1.0	31
2009 (2)	218	73	0.0	1.8	15
2010 (2)	331	80.5	0.0	3.9	13
2011 (2)	286	90	2.45	3.5	3
2012 (2)	381	79	2.1	12	15.5

% Fail is calculated from those students who completed all assessment tasks.
Subjects presented in sequence of progression i.e. student enrolled in 2007 (1) for BMS191 moves to 2007 (2) BMS 192. Pass percentage indicates the percent of those who gained a grade between and including Pass to High Distinction. Student with grades yet to be determined were not included nor were students who withdrew (attrition).

Table 4: Subject passes, fails and attrition – sessions with Distance enrolled students only

Year of cohort (Session)	Number of students	% Pass	% High Distinction grades	% Attrition	% Fail
BMS191 Human bioscience 1					
2008 (2)	131	58	1.53	19	15
2009 (2)	196	35	1.02	14.8	37
2010 (2)	167	58	1.8	7.8	7
2011 (2)	179	71	3.91	14.5	6
2012 (2)	107	50	3.7	15.9	17
BMS192 Human bioscience 2					
2008 (1)	112	51	0.0	4.5	16
2010 (1)	97	70	0.0	3.1	3
2011 (1)	195	80	2.56	3.6	5
2012 (1)	176	66	1.14	4.6	10
BMS291 Pathophysiology and Pharmacology 1					
2008 (2)	102	54	0.0	5.9	20
2010 (2)	108	74	0.0	4.6	18
2011 (2)	166	62	1.2	1.8	20
2012 (2)	156	47	0.63	1.3	25
BMS292 Pathophysiology and Pharmacology 2					
2010 (1)	118	82	0.0	2.5	10
2011 (1)	92	89	3.26	1.1	0
2012 (1)	112	70	4.5	6.3	7

Subjects presented in sequence of progression i.e. student enrolled in 2007 (1) for BMS191 moves to 2007 (2) BMS 192, then BMS291 and then BMS292 each being a pre-requisite.
% Fail is calculated using only those students who completed all assessment tasks. Pass percentage indicates the percent of those who gained a grade between and including Pass to High Distinction.

There has been improvement in student evaluation ratings (Online Evaluation System - OES Scores) over time ($p<0.05$). Evaluation by students is voluntary and completed anonymously online. The system is centralised and lecturers receive the results after grades are finalised for the session. The students assign a rank using a Likert scale for responses to statements, the scale maximum being seven and minimum one. These are then reported to individual cohort co-coordinators. There are 11 core statements common to all CSU courses to which the students respond in the evaluation. The scores reported in Figure 1 reflect the averaged responses for all core questions for all cohorts irrespective of campus.

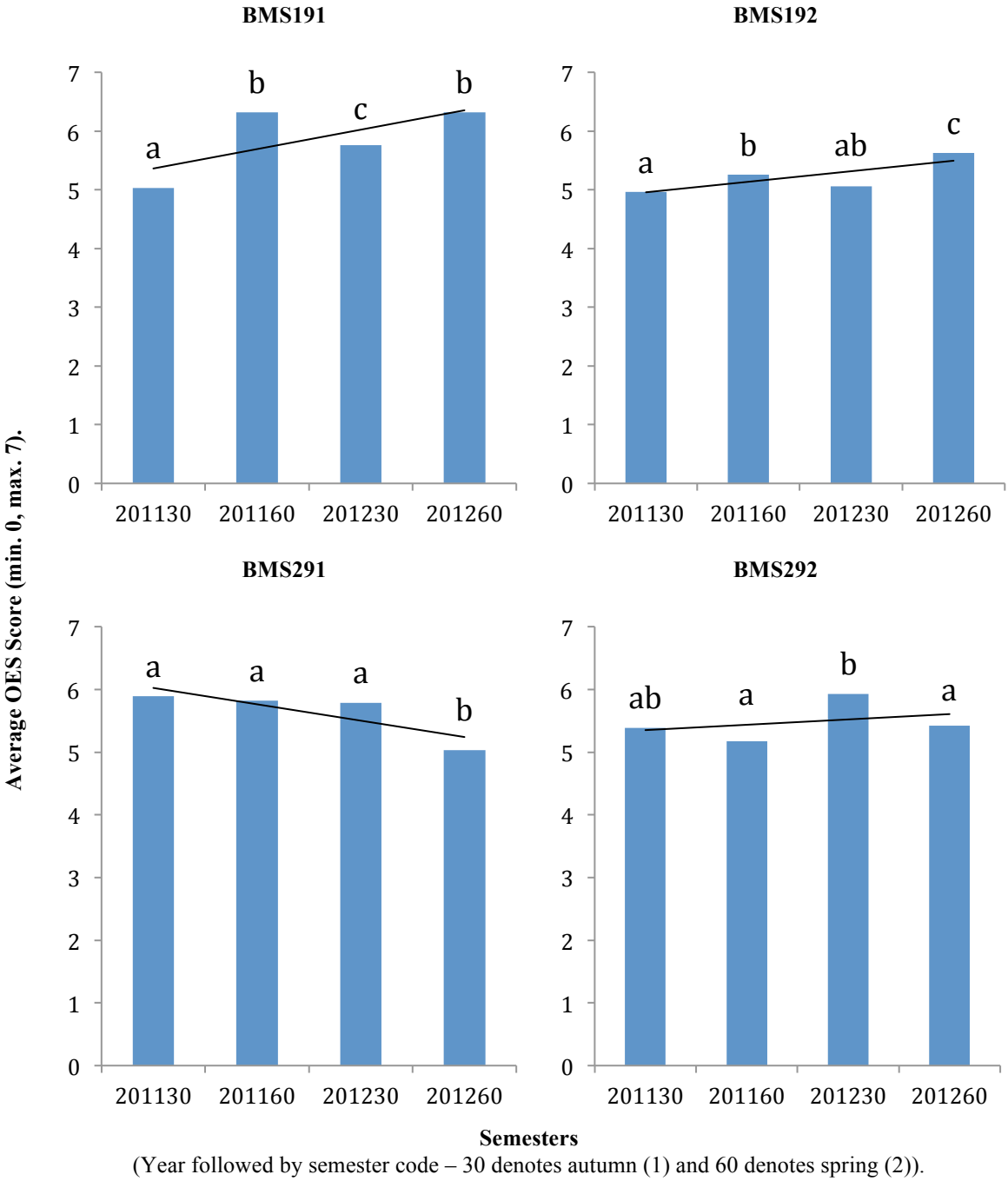

Figure 1: Student online evaluation (OES) results by cohort. When more than one cohort was operating the range of scores has been combined in the average. Means with the same letter are not significantly different ($p<0.05$) using the Fisher LSD test.

The OES data over time is patchy and only scores for 2010-2012 are available due to lecturer changes. At CSU each lecturer has carriage of the OES evaluation so that they can customise a section of questions for their subject. That means that each lecturer for a particular cohort owns their evaluation data and only the Core item averages are reported centrally. This limits the accuracy of the results presented in Figure 1 as the number of students from each cohort who responded to the survey is lost. However, workload has been highlighted as a consistent issue from their viewpoint with the final subject BMS292 having the smallest spread of scores for this question. The rankings by the distance education students indicate they are happier with the courses than the on campus students. All students have access to all materials, the main differences between the cohorts being the timing of the practicums and

that the distance students are usually full time workers and part-time students whereas the on campus students are usually full time students.

Discussion

The work of John Biggs (2003) indicated that structural alignment for education would result in students valuing the content and skills taught rather than learning material just for the purpose of passing exams. Content dense courses taught over short periods of time are at risk of becoming superficial through didactic strategies of 'covering content' and causing students to devalue the material to be learnt (Ironside, 2004; Giddens & Brady, 2007). The review of the quality assurance data indicates a challenging journey as the many changes have been instigated to try and generate a consistent improvement in the results. The recent changes associated with aligning the courses to Bloom's taxonomy are showing promise. There is some indication of an overall improvement of student perceptions of the courses as shown by the increasing number of scores of six and even seven (out of seven) in more recent teaching sessions. Feedback from students indicates that redesigning the slide sets into questions that are then answered by the presentation material used in classes is of considerable help with negotiating the large amount of content. It is to be noted that the students, who are not enrolled in degrees within our school, have recently been known to ask their own discipline school to implement similar changes to their courses. The suite of courses was previously known as difficult and the 'gate-keeper' courses and so having a negative student and staff reputation for any of the degrees that accessed them. They remain 'gate-keeper' courses but their reputation has improved as indicated by the student evaluations.

There has been increased pressure to maintain and improve pass rates that has occurred due to both the shortening of the on campus cohort's sessions and government requirements for measuring teaching outcomes. Of course any good teacher will make the effort to create a learning environment where all students can maximise their potential. Many variables impact on student performance as noted by Pitt and colleagues (2010) in their review of factors that impact on student success. The lack of improvement in the average marks for the courses might in fact reflect that the alignment of the courses to Bloom's taxonomy has offset the impact of the shortened sessions. Since the distance students, overall, bear little of this impact they have further benefited from the changes.

Attrition, as one would expect, is highest in the first session of the first year. This reflects the number of students who undertake full time university study only to realise in those early weeks that the chosen course may not be for them or university is not what they expected. However, in addition to high fail rates evident in BMS191, BMS291 also has high fail rates and poorer student evaluation scores. This may be a result of several factors. There is an increased expectation for second year students given they have completed their first year. The shortened on campus session may also be a factor. The curriculum documents for the suite have not been revisited since they were originally written yet the number of teaching weeks for on campus students has been decreased twice; once due to the inclusion of practicum within the semester and then again when the university moved to a three session year model from a semester model.

The impact of the practicum cannot be underestimated. Studies have provided contradictory advice as to the benefits of previous health care experience for student success (Whyte, Madigan & Drinkwater, 2010; Dante et al., 2011) and it has been proposed that practitioners are not overtly aware of the foundational science supporting their practice in order to keep the theory-practice relationship central for students (Titchen & McGinley, 2004). For our students the timing of the practicums may be an additional factor for risk. The large number of students dictates that not all can attend practicums at the same time and so a rotation

system operates between campuses. This means that all students across all campuses are in attendance for the first five weeks, but after that only two cohorts are on campus at any one time except for the week before the examination period. Any effect upon academic results due to the timing of placement has yet to be explored. It is however, one of the aspects that lead on campus students to base some of their complaint that distance students are advantaged. Distance students undertake placements in a different order of events due to being part-time and this can result in these students having more weeks available for study of the courses within a session. On campus students not enrolled in nursing can also make use of the time the nursing students are off at practicum if they choose. All the recorded lectures are available to all students regardless of the cohort they are enrolled in.

The review highlighted the nature of the multi campus, multi-cohort structure of CSU and the limitation of individual lecturer ownership of student evaluations where only averaged scores are recorded centrally. Despite this limitation, the alignment with Blooms taxonomy has had a positive effect across the cohorts regardless of the entry pathway of an individual student. The majority of our students are first in family to attend university and from the lower ends of the socioeconomic scales. Many enter without university entry scores. The success of our students supports entry to university by non-traditional pathways. The mode of entry has become far less important in contrast to those studies that indicate the best predictor of success is a university entry score (Whyte, Madigan & Drinkwater, 2010; Madigan, 2006). The steeper adjustment curve to university life as noted by Collier and Morgan (2008) challenges these students as does the study of bioscience. The treatment of these four subjects as a suite, rather than individually meeting the individual course curriculum documentation requirements has proven a worthwhile challenge.

Conclusion

The ‘gate-keeper’ suite of courses – BMS191 through to BMS292 has a new reputation within the school and faculty. Student evaluations have improved and although not entirely consistent, attrition and fail rates have decreased. Aligning the courses to Bloom’s taxonomy has had a positive impact from both the student’s and the teaching team’s viewpoint. It is evident more work needs to be done to address the increase in the fail rate between first and second year. Finding ways of identifying students at risk of failure or attrition independent of university entry scores would enable targeted strategies to assist them and, importantly, help maintain diversity within the student body and consequently the graduating workforce. The review supports that the mode of entry to university is not important and that university entry scores are perhaps redundant. The 2013 intake has already expanded enrolments in these courses with the commencement of the CSU Port Macquarie campus and consequently new teaching team members. The data presented in this review will be used to further monitor and inform the development of these courses to assist student success.

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