Student reflection on physics assessment within an inaugural health foundation year

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Teaching physics- and mathematics-based courses to large cohorts of first year health science students, many of whom are not mathematically orientated, presents a significant and unique teaching challenge. This paper summarises successful teaching strategies adopted for one such physics course, while in particular presenting student reflections on assessment methods used within the course. Survey results dispel the effectiveness of traditional heavy examination-weighted modes of first year tertiary physics assessment, and support the need for greater emphasis on educational objectives such as analysis, application and creativity. The approximate ideal weighting of each assessment mode under consideration based on survey results is: end-of-semester examination (40%), mid-semester examination (20%), laboratory reports (20%), assignment (10%), periodic quizzes (8%), and oral presentation (≥2%). This ideal requires appropriate resourcing but is achievable in times of awareness of the role first year success plays in long-term academic success (Pickford, 2007) and increased funding that is available for various student engagement and support strategies.

Introduction

The physics course under review

Biophysics and Quantitative Biology (Biophysics & QB) is a course within an inaugural 2007 health foundation year within Griffith University's Health Faculty, known as Griffith Health. The foundation year includes students from the Schools of Physiotherapy and Exercise Science, Dentistry and Oral Health, Medical Science, and Pharmacy, and approximately 400 students from these Schools completed the Biophysics & QB course in 2007.

The Biophysics & QB course introduces students to the fundamental physical principles that govern a wide range of phenomena, instruments and procedures relevant to the health sciences, while also aiming to develop student problem solving skills. The course additionally introduces statistical analysis within a biological context to provide a basis for more advanced statistical studies. The course convenor delivered all lectures and is referred to as lecturer throughout this paper.

The Biophysics & QB course received positive student evaluations of teaching (SET) and student evaluations of course (SEC), achieving the highest overall SEC learning effectiveness score out of all parallel-running 2007 health foundation year courses which included two courses in anatomy and physiology, and a course in the chemistry of biological systems. The SET and SEC scores presented throughout this paper are based on a 7 point scale ranging from 0 (unacceptable) to 7 (excellent). A strict and standardised formal student evaluation procedure is used throughout Griffith University to ensure the integrity of evaluations (see Appendix A for details).

Teaching philosophy

Teaching physics- and mathematics-based courses to large cohorts of first year health science students, many of whom are not mathematically orientated, presents a significant and unique teaching challenge. This challenge necessitates a discarding of old-style "straight lecturing from the dais" approaches to teaching, perhaps even more so than for other health foundation year courses, to achieve the accepted educational objectives of Bloom (1956). An awareness of the educational importance of teaching physics within a relevant context (Lye et al., 2001; Whitelegg et al., 1999) in particular shaped course teaching, with this awareness leading to the inclusion of numerous application examples relevant to the health sciences. This deliberate effort to teach topics within a relevant health science context resulted in an associated SET score of 6.25 out of 7.00.

A deliberate point was also made of enthusiastically incorporating at least one "story" (Pickford, 2007; Whitelegg et al., 1999), in the form of an edutaining demonstration, experiment/challenge exercise (calling for volunteers), current event discussion or use of interactive teaching software, into every Biophysics & QB lecture to provide variety, reinforcement of concepts, and alternative modes of learning. When presenting such stories, the lecturer asked questions like *"what concepts are involved?"; and "can you explain the observations of this experiment?"*, resulting in the following documented student evaluation response: *"the continual requests for student involvement (was well done and should be continued) - even though most don't due to the large amount of people in the lecture theatre - its good to still be involved in the discussion."*

The lecturer volunteered an additional 2 hours per week at drop-in sessions and these sessions were specifically targeted towards students from weak mathematics and physics backgrounds. The effectiveness of the drop-in sessions was rated as 6.32 out of 7.00 by SEC. Although running drop-in sessions is an initiative employed by some others, the concept was expanded upon by effectively turning the sessions into course-based common-time sessions with embedded orientation, engagement and learning strategies (Boyde, 2006; Dearn, 2006; Kuh, 2007; Pickford, 2007) designed to promote a sense of (i) *connectedness*, (ii) *capability and resourcefulness*, and (iii) *purpose and identity* (Lizzio, 2006). The fact that the lecturer was also an experienced First Year Student Advisor for one of the Griffith Health Schools and advocate for such roles (Simeoni, 2007) was an advantage in this respect.

Components of these drop-in sessions designed to facilitate independent learning included the development of a personalized concept map (Brown, 2002; Novak 1990) by each student and peer teaching (shown to be the most effective form of student learning in science, technology and engineering (Stuart, 2006)) with the sharing of mistaken problem solving steps and subsequent positive peer-led discussion (e.g., *"I find it easy this way"*). An email support group established specifically for Biophysics & QB also proved useful towards fostering independent learning, as demonstrated by the following student email comment sent to all students in the support group: *"…everyone can pitch in and see if we can find the answer"*. In addition, drop-in sessions involved: a "tell me your concerns" component; presenting concepts and problems more slowly; extended use of interactive learning software; and facilitation of student introductions to reduce student isolation. "Tell me your concerns" discussions led to the negotiation of more examination preparation time (allocating lecture time to go over past examination paper questions). The SEC question "I had not done physics before and Biophysics & QB was made relatively non-threatening" received a score of 6.13 out of 7.00 (approximately two thirds of respondents had not done physics at school).

Because of the wide-ranging student demographic (in terms of achieved university entry score) within the Griffith Health foundation year, it was equally important to cater for (challenge) high achieving students (e.g., physiotherapy students). As such, the lecturer also incorporated extension topics into lectures. For example, the concept of terminal (maximum falling) velocity of a parachutist was taught to all students. Then, as an extension, students were invited to stay for a "part 2" session which developed a differential equation to model terminal velocity. The lecturer then raised questions like *"will two parachutists with different mass attain the same terminal velocity?"*; and *"what cross-sectional area would a person without a parachute need to land safely (in relation to new gliding suits)?"*. The class together then solved the model differential equation numerically to answer these questions. Other examples of extension topics include three dimensional biomechanical vector analysis and a selection of process/complex reasoning tutorial problems. However, students who were not from strong mathematics and physics backgrounds were encouraged to try and not be discouraged by extension topics by the lecturer expressing sentiments like *"give these a go and try to understand the concepts within, but if you find these questions confusing then concentrate on the fundamental tutorial questions"*. The SEC question "I had done physics before at school but still found Biophysics & QB interesting" received a response of 5.31 out of 7.00.

Assessment modes

Whilst adopting a philosophy of constructive alignment between course objectives, learning outcomes and assessment (Biggs, 2003), the assessment breakdown for Biophysics & QB was nevertheless relatively uncomplicated, as displayed by Table 1. In deed, it is the aim of the present study to assess student reflection on the employed modes of assessment so as to improve the course (Alexander and Krause, 2007) and optimally complement the successful teaching and learning strategies outlined above.

Table 1. Biophysics & QB modes of assessment

Assessment Mode	Weighting (%)	Description
End-of-semester exam	60	Multiple choice and written sections; concept- and calculation-type questions
Mid-semester exam	25	Multiple choice concept- and calculation-type questions
Laboratory report	15	Six laboratories in total

Multiple choice questions designed for the end-of-semester and mid-semester examinations were a mixture simple completion (type A), multiple completion (type K) and relationship analysis (type E) questions, as defined within Case and Swanson (2001). Question construction techniques were adopted so as to optimise the relevancy and focus of questions, and to avoid common technical flaws (Case and Swanson, 2001; Collins, 2006). Although a significant number of the concept- and calculation-type questions were "fundamental", in that they were deliberately designed to test basic knowledge and skills (aimed at students from weak physics and mathematics backgrounds who had made an effort), the ideal of assessing the application, rather than the recall, of knowledge (Alexander and Krause, 2008) was also incorporated (e.g., by incorporating questions with links to high interest theory application lecture discussion topics such as torque considerations within the gear selection of a racing bicycle).

In addition to the above, through open discussion with all students, students were encouraged to "help design their own examination". This concept involved asking students questions like *"what topics have you understood and would like to see on the exam?"*, *"why more questions from that particular topic?"*. These questions also served as disguised revision and a means of identifying the areas in which the students displayed both confidence and apprehension. The efficacy of this examination ownership approach is also supported by the general recognition that the facilitation of student ownership of a task is motivational (Ramsden, 2003).

Student uncertainty over assessment expectations has been identified as a key student concern within first year Griffith University students (Griffith University, 2006), and strategies such as not making the first assignment or laboratory report count towards summative assessment has thus been suggested by others (Wilson, 2007). This philosophy was taken on board by making available an example ideal laboratory report and additionally applying the policy: "if students obtain marks for laboratory reports 2 to 6 (there were 6 reports in total) that are all higher than their first laboratory report mark, then their average mark will be based on laboratories 2 to 6 only". This strategy was announced after the first laboratory report submission deadline to avoid students choosing not to submit what effectively could be considered a voluntary piece of assessment.

With the approval of the Dean of Learning and Teaching for Health, a “second chance” assessment policy was also adopted. This policy, which allowed a supplementary examination to be awarded for students who achieved a minimum of 40% (and less than 50%) overall, recognized that a subset of students might struggle with physics- and mathematics-based courses yet understand many concepts contained within and otherwise be hard working students educationally solid in other areas such as anatomy and physiology. The following student evaluation comment from a pharmacy student highlights a positive policy outcome while also identifying the importance of Biophysics & QB for her later pharmacy program material: *“having a 2nd chance was very useful, because it made us understand the main concepts properly and made sure we understand it because during the pharmacy course 2nd year we had to do a lot of math based calculations that were related to biophysics.”*

Assessment outcomes

Table 2 summarises the percentage of students who obtained a fail (<48%), Pass Conceded (48 to 50%), Pass (50 to 65%), Credit (65 to 75%), Distinction (75 to 85%) or High Distinction (85 to 100%) grade, after the second chance assessment policy was applied. The average percentage of all students was 66% with a standard deviation of 19%.

Table 2. Breakdown of course results

Grade Achieved	(%)
High distinction	14
Distinction	18
Credit	22
Pass	38
Fail	6
Other categories	2

Method

The 2008 survey group was a subset (*N*=21) of the health foundation year student cohort who undertook Biophysics and QB in Semester 2, 2007. This group (largely the physiotherapy cohort) was chosen as it was readily accessible in 2008 within the Semester 1 second year course, Bioinstrumentation, which the Biophysics & QB lecturer also convened and lectured. This survey group was also chosen because the lecturer was able to distribute the survey as a means of introducing a graphical computer programming language taught within the Bioinstrumentation course. A figure displaying the control panel (user interface) of the designed reflective ideal assessment feedback program distributed to students for this two-fold purpose is shown in Figure 1. As displayed by Figure 1, the program allowed students to select a recommended weighting towards overall assessment for a range of assessment modes including: end-of-semester examination; mid-semester examination; written assignment (with the option to select type); oral presentation; quiz (with the option to select number and type); laboratory reports (with option to select number); peer teaching reward; and maintenance of a reflective journal and workbook. The option to repeat assessment items could also be selected where appropriate.

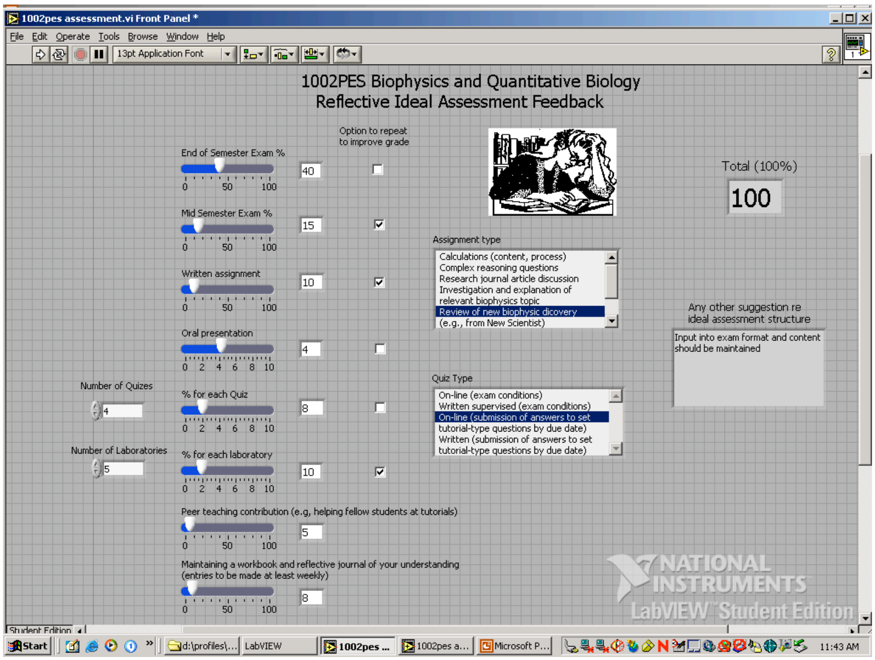

Figure 1. User interface of a reflective ideal assessment feedback program used as both a student evaluation tool for the first year course Biophysics and Quantitative Biology, and a means of introducing a new computer programming language within the second year course Bioinstrumentation.

Results

Figure 2 displays survey results giving the average recommended weighting of each selectable assessment mode together with the actual weighting of assessment modes employed in 2007 for the Biophysics & QB course.

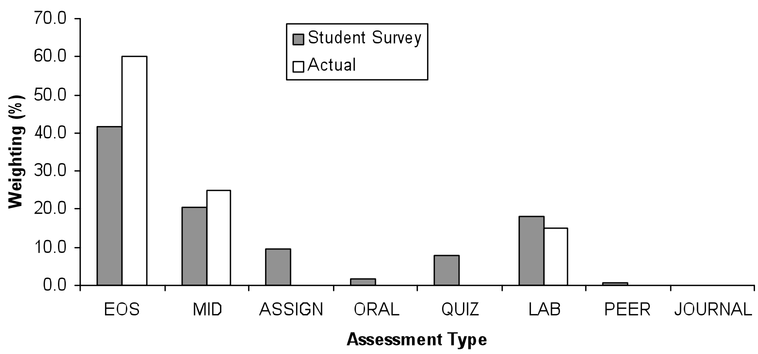

Figure 2. Reflective ideal assessment student survey results displaying the average recommended weighting of each assessment mode under consideration for the course Biophysics and Quantitative Biology. Also shown is the actual assessment weighting adopted for the surveyed student cohort (EOS=end-of-semester examination, MID=mid-semester examination, ASSIGN=assignment).

Discussion

As the survey was intended to be reflective, its timing was considered suitable given that the inaugural health foundation year students, who were starting their second year at the time of the survey, had the maturity and opportunity to reflect back on their first year of study. Additionally, the novel approach of combining the survey with an introduction to a new computer programming language (proven in the second year Bioinstrumentation course to have student appeal because of its applications within instrumented clinical research and enjoyment of use) appeared to enhance the depth of student reflection due to the enthusiasm to learn the fundamentals of the identified new programming language.

Figure 2 highlights a desire for less emphasis on the end-of-semester examination with a recommended reduction in assessment weighting from 60 to approximately 40%. A recommended 5% reduction from 25 to 20% for the mid-semester examination weighting is also highlighted. The recommended reductions, particularly that for the end-of-semester examination, will in part be associated with expectation uncertainty, known to be a key concern among first year students (Griffith University, 2006; Pickford, 2007; York, 2006). As indicated by some students, even if set weekly problems or discussion topics in Biophysics & QB are understood, more progressive summative assessment would be welcomed to provide "travelling ok" reassurance. The recommended 8% for quizzes (there was a mixed result in response to whether these should be under examination conditions or require completion of tutorial questions by a due date) again highlights the need that first year students have for such reassurance through progressive summative assessment.

The above examination weighting reductions are offset in part by a recommended addition of an approximately 10% weighted assignment (the review of a new biophysics discovery from a publication such as the New Scientist was a popular choice of assignment type). This finding is supported by general Griffith Health graduate student survey results (Alexander and Krause, 2008) which have recorded the following student comments re perceived positive aspects of their study experiences: *"Being able to choose areas that interest us individually and incorporate these into assessment items, i.e., flexibility on topics of assessment to research."; "Some assignment work was highly relevant, most was interesting."; "Workload was reasonable, assignments mostly interesting."*. Given that a communications course was controversially omitted from the health foundation year program of study, with the subsequent recognition of an even greater need to embed scientific literacy skills into each foundation year course, a significantly weighted and well designed assignment task would thus serve both student wants and the educational objective of developing scientific literacy.

The recommended increase in laboratory report weighting to almost 20% is also supported by the fact that *"Laboratories, hands on experience, feedback on my progress"* was identified as another positive aspect by the above graduate student survey. This unexpectedly high recommended laboratory report weighting is perhaps reflective of the facts that: students want to be rewarded for effort (in this case the effort of writing 6 laboratory reports); much time was devoted by the lecturer to making the laboratories interesting and relevant; and laboratory assessment does not carry the pressure of a formal examination.

Thus, whilst the actual assessment employed was designed to incorporate Bloom's taxonomy of educational objectives (Bloom, 1956) to various degrees, viz., application, analysis, comprehension, evaluation, knowledge and (the newly-added) creativity, the survey responses regarding assignment and laboratory assessment show that greater emphasis should be placed on the objectives of analysis, application and creativity.

Interestingly, although it is recognised that peer teaching is the most effective means of student learning in science, technology and engineering (Stuart, 2006), approximately only 1% of students thought that peer teaching should be rewarded via a contribution to overall assessment (perhaps indicative of the volunteer mentoring culture and subsequent student support network that has been fostered within the Griffith Health foundation year). Oral presentations achieved a recommended weighting of approximately only 2% which is no doubt suppressed by many students' inherent dislike of public speaking, especially at an early stage in their degree. Thus, when one also takes into account the benefits of public speaking practice that most students do not appreciate (e.g., developing self confidence and scientific presentation skills), the 2% recommended weighting is considered significant and perhaps indicative of a true ideal oral presentation weighting of approximately 5%.

No student indicated a desire to maintain a reflective journal for assessment purposes. However, it should be noted that, although the concept of such a journal was explained to survey participants, the students had not yet been exposed in practice to such an assessment item. The option to repeat assessment items also gave a mixed response, indicating some sentiment of giving an unfair advantage by those not feeling "at risk". However, the "second chance" policy described previously and adopted by the Biophysics & QB course was generally positively received.

The findings of the present study are important because of the tradition and subsequent expectation of conservative, heavily calculation-based assessment (examination) modes for first year tertiary physics courses. Although commendable physics teaching strategies are adopted by many dedicated physics lecturers, it would be difficult to find a first year tertiary physics course that meets the recommended ideal assessment breakdown indicated by the reflective survey at hand. Again, these recommendations are considered particularly important when teaching students from weak mathematics and physics backgrounds, as found in the health sciences. Of course, the implementation of such an ideal range of assessment modes needs to be adequately resourced for large student cohorts (e.g., marking and sessional staff support). This ideal is achievable in these times of awareness of the important role that first year success plays in setting up a student for long-term academic success (Pickford, 2007) and increased funding that is available for various student engagement and support strategies.

Conclusion

Although multiple (greater than three) assessment items is ideal and not always possible due to available resources, first year health science students studying physics have shown a desire for reduced emphasis on examinations (particularly the end-of-semester examination) and the need for greater emphasis on the educational objectives of analysis, application and creativity. Thus, survey results dispel the effectiveness and appeal of traditional heavy examination-weighted modes of first year tertiary physics assessment. The novel student evaluation approach employed, whereby the survey also served as a means of introducing a new computer programming language within a subsequent second year course, appeared to increase the depth of student reflection and the principle of such an approach is thus recommended where it can be practically implemented. The identified ideal assessment method, together with the summarised successful teaching approach, serves as a guide to teaching physics to first year health science students.

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Appendix A: Griffith University Student Evaluation Procedure

An overview of Griffith University procedural information relating to the integrity of student evaluations (Griffith University, 2007) is given below:

- Student Evaluation of Teaching (SET) and Student Evaluation of Course (SEC) forms are each designed with 10 mandatory standard questions. Additional questions may be added.
- An envelope is addressed to the Off Campus and Assignment Handling Service (OC&AHS) which is later used for mailing students responses.
- On the day of the evaluation, the Course Convenor must arrange for a mature student (or an independent colleague) to take responsibility to administer the evaluation.
- Response sheets are distributed by the Course Convenor.
- The Course Convenor then hands over remaining administration duties to the nominated person of responsibility, and then leaves the room (the Course Convenor must not be present while any of the students write their responses).
- At least 15 minutes is allowed for students to complete evaluation.
- Response sheets are collected, inserted into provided envelope, sealed, and posted directly to the OC&AHS for scanning by the nominated person of responsibility who must sign the following declarations:
    - The lecturer who requested this evaluation was absent throughout the evaluation.
    - The lecturer did not have access to any of the completed response sheets.
    - The lecturer did not post the completed forms to the OC&AHS.