Pharmacogn. Commn. 2022;12(1):28-35.
A multifaceted peer reviewed journal in the field of Pharmacognosy and Natural Products
www.phcogcommn.org

Original Article

Improving Student Outcomes and Perceptions in First Year Biosciences by Enhancing Engagement: A Case Study

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ABSTRACT

Background: Engagement of students in the biosciences is essential to ensure a continued flow of quality medical, pharmaceutical and pharmacognosy researchers into the future. **Methods:** A suite of teaching modalities and philosophies were implemented into a first year university course aimed at engaging student interest in contemporary issues and current research in the biosciences and trialled over a period of 4 years. The curriculum was developed and adapted by incorporating strategies which resulted in positive outcomes whilst minimising those resulting in negative outcomes and perceptions. All teaching methods and activities trialled have received recent interest and all are purported to enhance student engagement. Each modification was critically examined in terms of its effect on student outcomes and on student perceptions. **Results:** Results from this study strongly indicate a positive influence for incorporating teaching activities that encourage active learning and engagement (in-lecture quizzes, collaborative group presentations, writing-to-learn activities) into the course structure. **Conclusion:** A clear correlation between incorporating these teaching practices with both student outcomes and student perceptions with the course was noted.

Key words: Student engagement, First year experience, Cooperative learning, Reflective practice, Student success.

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DOI: 10.5530/pc.2022.1.6

INTRODUCTION

Following educational reforms in the Australian education system in the 1980's, there has been a shift towards mass tertiary education, resulting in dramatic increases in university enrolments. Indeed, university enrolments for the mid 1980's to the mid 1990's period alone nearly doubled.[1] Accompanying this trend towards larger student cohorts is increased student diversity of social and cultural backgrounds, levels of education and prior knowledge. Such diverse groups have a correspondingly diverse range of needs and academic potentials which need to be taken into account in medium to large cohorts to maximise student success. A number of studies have demonstrated strong correlations between student success and retention.[2,3] Thus, developing first year course curricula and teaching modalities that increase the rates of student success without compromising content depth or student comprehension is important in maximising student retention. Numerous studies have also linked student success with engagement and encouraging students to take an active role in their own education from an early stage of their academic career.[1] A number of factors affecting student success have been identified.[4,5] Of these, the linkage between student engagement and deep conceptual learning has received the greatest attention.[6,7]

Student engagement is not only a product of the course content, but is dependent on a number of other factors. Different teaching methods and learning activities have profound influences on student engagement and subsequently on student success within a course.[6-8] Bioscience education literature has long been concerned with the nature of learning of complex biological concepts. With some notable exceptions, until recently the idea persisted that teaching of the biosciences is more about the delivery of content rather than encouraging deep conceptual learning.[6,7] Over recent years, there has been a shift in the literature towards identifying different teaching modalities to enhance student engagement. Whilst several methods have been highlighted, a common theme involves fostering student engagement in the biosciences by providing opportunities for students to take an active role in their own education.[1] In particular, collaborative group learning activities[9] as well as self-research assignments[10] have been shown to actively engage students, as well as developing communication and writing skills.

The development of communication skills is an important attribute for university graduates, regardless of their discipline.[11] For a scientist, the ability to communicate effectively is vital for their contribution to their discipline and for their ability to adequately explain their field to society in general. Group work and interpersonal skills are also important attributes, allowing a scientist to work collaboratively with a wide range of people of diverse backgrounds, both within their own organisation and within the wider community.[12] Furthermore, active learning within a collaborative group environment is an important and successful method of engaging students.[12,13] Indeed, in a study which examined the effects of student-teacher interactions, the amount and quality of individual effort and the level of peer interaction, effective peer interaction was identified as the strongest predictive indicator of student engagement and of successful student outcomes.[14] Thus, it is vital that students of the biosciences develop group learning/group collaborative skills as well as the ability to communicate effectively.

Inevitably, medium to large student cohorts will contain a wide diversity in terms of student backgrounds and prior knowledge base, interests, abilities and pace of new knowledge assimilation. In order to overcome the issues in medium and large class environments, previous reports have recommended the introduction of collaborative learning tasks early in the academic career to promote active learning practices[15] and to enhance engagement with the subject matter.[13] Collaborative/group learning environments provide the opportunity to develop a shared understanding of concepts.[16] The effectiveness of a collaborative group is not guaranteed by randomly putting students together and previous reports have recommended successful group practices.[17] Whilst an understanding of the factors which promote positive group interdependencies is still emerging (as are tools to effectively evaluate these processes), there is some evidence that the success of a collaborative

group is related to shared attitudes and values of team members with regards to academic aspirations, contributions and outcomes.[17,18]

Furthermore, the evidence that providing students with academic challenges and enriching experiences correlates with student engagement is compelling. In a recent study, it was reported that difficult or complex assessment tasks enhance, rather than inhibit student engagement if the tasks are supported by rapid and effective feedback.[13] There is widespread advocacy for the positive effects of using writing-to-learn as a tool to increase conceptual knowledge as well as student engagement and deeper conceptual thinking.[19,20] Furthermore, writing based learning activities develop scientific literacy and researching skills, as well as familiarising the students with the expectations, conventions and reasoning skills required for technical writing.

Taking note of these learning and teaching methods, a course was developed at Griffith University, Australia aimed at engaging students in the biosciences. Curriculum and teaching methods were designed to not only provide students with the relevant tools for a successful academic career, but also to integrate relevant contemporary topics of interest and to provide learning activities to maximise the students depth of understanding of complex biological concepts and thus further engage them in the biosciences. The course was developed over a 4 year period. During this period, reflective practice was utilised to identify what learning and assessment activities enhanced student engagement and academic outcomes, and what curricula and learning activities did not. The course was continually adapted over this period to derive a course with a high level of student satisfaction and comprehension, designed to engage student interest and enhance retention.

Context and aim of the study

This course was designed to introduce first year students to contemporary issues in biosciences, thereby helping to place their study programs in context and engendering interest in continued study in the biosciences. Through engaging student interest, the course also aims to assist in student retention and transition from first to second year bioscience study. Furthermore, the course was structured to develop the students' ability to research, present and discuss scientific issues and any related ethical issues in a clear and informative fashion.

This study aimed to develop the course Topics in Biosciences (1003BPS) at Griffith University, Australia to enhance student engagement and retention without compromising student outcomes. The study was conducted over a period of 4 years and included annual critical examination of the success of various aspects of the course content and teaching modalities. Reflective practice was used to adapt the course to retain content and teaching practices that resulted in student engagement, understanding and good student outcomes. Conversely, teaching activities and assessment practices that were not favourably perceived by the student cohort, or that did not enhance student outcomes, were modified or discontinued in subsequent years. This study reports on the development of this course and highlights the teaching practices that provided the most favourable outcomes.

METHODS

Participants

All student participants were enrolled in the course Topics in Biosciences (1003BPS) at Griffith University, Australia. This course introduces first year students to current areas of research interest in the field of biosciences. The total student cohort in 2013 was 118 students consisting primarily of students from the Bachelor of Biomedical Sciences (53.4 %), Bachelor of Science (10.2 %), Bachelor of Chemical and Forensic Toxicology (2.5 %) and Bachelor of Medical Science (1.7 %) within the School of Natural Sciences. The remaining students were mainly enrolled in the School of Environmental Sciences (30.5 %), with the remaining (1.7 %) students enrolled in dual degree programs. The cohorts in previous years consisted of similar numbers of students with similar study programs and educational backgrounds.

Course Structure

Over the 2010-2013 period, the Topics in Biosciences course was taught and convened by three different academics, each with differing teaching philosophies and practices. All 3 lecturers had considerable teaching experience and all were perceived as similarly effective and popular teachers (as judged by student evaluation surveys of previous courses). Remodelling of the course occurred in content and in teaching style and teaching activities at two time points (2011 and again in 2013) and was based on student outcomes and on student feedback via formal student evaluation questionnaires. Assessment and assessment criteria were also developed and adapted over the same period. Initially, in the period up to 2010, the course was content rich, with the first half of the course consisting of lecture blocks on research skills, scientific method and ethics in the biosciences. The latter half of the course initially consisted of keynote style lectures by invited academics who explained their areas of research to the students. The content was generally delivered by a traditional lecture format and assessed by formal examination and a written assignment. Informal student feedback (Table 1) noted that the students were not engaged with the content and wanted more of the keynote style lectures.

In 2011, the course content was substantially altered in an attempt to enhance student engagement. The instruction on scientific method was minimised, with a corresponding increase in lectures focussed on current research topics. After 3 introductory lectures, all of the remaining content lectures were delivered by students as part of their assessment. The assessment during the 2011-2012 period also consisted of a written assignment and a formal examination. This format received positive student feedback for the course structure, although the students commented on a perceived lack of direction in the lectures, as they were entirely delivered by students (Table 1). In 2013, the course was again redeveloped, taking positive aspects from the previous teaching philosophies and incorporating them into the teaching methods summarised in the following sections. The lecture content and assessment items were also updated to reflect advances in scientific knowledge and the current research areas of teaching staff at the university.

Keynote lectures

The first 3 weeks of lecture content were developed to provide training in basic skills including research techniques (library and internet resources) that are required by students in their learning and assessment items as the course progresses. One of the lecture sessions in the early weeks of the course also introduced ethical issues and discussed the importance of multidisciplinary approaches to the study of biosciences. These background introductory sessions were followed in later weeks by 2 hr lecture sessions, each with a different theme. The first hour of each lecture block comprised keynote presentations by a researcher in that specific field to explain their research and set the tone for that theme. The second hour of each session consisted of student group delivered presentations on a range of contemporary topics in the biosciences. Eight research themes comprising a total of 32 different questions (I e. 4 topics per research theme) were selected for their current relevance and for their relevance and interest to the student cohort. The themes were kept broad, encompassing aspects of biomedical sciences, drug design and development, forensics, ecology and conservation biology. Topics were designed to engage student's interest. Examples of group research topics across each theme for student presentations included:

Table 1: Student perceptions and suggested changes for 2010 and for the 2011-2012 period.

2010 Feedback#	2011 and 2012 Feedback
Positive aspects	
There were some interesting topics in this course. There should be more of the invited speakers.	The topics were really interesting. This course has the potential to be very engaging.
The continuous assessment helped me keep up with the subject matter.	I enjoyed learning about a wide range of topics, some more so than others.
I liked the short quizes when we had invited speakers. It ensured students attended the lectures.	Presenting our research develops our skills and gets us more involved in learning.
The workload was appropriate.	Taught me how to write in a scientific manner.
This course got me interested in cutting edge research topics. As an environment student, I especially like the plant topics.	Helped improve my group working skills and presentation preparation.
My essay topic was interesting.	Workshops provided helpful and useful feedback and the tutors were really helpful. I enjoyed relating the topics to my degree (biomed).
	Improved my group working and presentation skills.
Negative aspects/recommended improvements	
Most of this course was about library searches, how to read a scientific paper etc. There needs to be more of the invited speakers talking about their research. That was more interesting.	The group presentations were not fair as my group members are lazy and were all international students. I had to completely rewrite their work.
This course is not relevant and should be scrapped. It does not add to our knowledge in a useful way.	Having 2 groups give presentations on the same topic was repetitive and boring.
The lecturer may be passionate about 'scientific process', but I took this course to learn about 'topics in biosciences'.	The only lectures were silly library lectures and student presentations (some of which were terrible). This is a terrible way to learn. This course needs guidance, not just student presentations.
	All lectures were listening to students present rather than to lecturers. I did not enjoy that at all.
	The workload was too much on the 4 group assessment items for the marks they are worth.
	Student only presentations only in the lectures! This was quite a bore which led to most students not attending lectures.

# indicates that these comments are informal student comments as student evaluation surveys were not available for this year.

- The Hendra virus: the emergence of a new disease of significance to bats, horses and humans.
- How an understanding of ethnobotany has led to the development of new anticancer drugs such as taxol, vincristine and vinblastine.
- Crop diversity: why does our survival depend on the conservation of plant genetic resources.
- Can we rebuild them? The push to bring back the extinct thylacine.
- The war between chemical forensic analysis and designer drugs – who is winning?
- How have extremophiles advanced scientific endeavour?
- What does chytrid disease in frogs tell us about climate change?
- Do mobile phones cause brain cancer?

Student group presentations

Groups of four students, and research topics, were assigned randomly in 2011 and 2012. In 2013, more attention was paid to group formation. Heterogenous groups of four students were created with mixed academic ability.[21,22] Similarly, genders were dispersed to minimise the number of same gender groups and international students were spread through the groups to minimise the simultaneous hurdles these students face with regards to learning in a second language and integrating into a new cultural environment.[23] As with previous years, research topics were assigned randomly to each group. Resources were provided for students to work effectively in groups. Specifically, all groups were provided with tutorial times in the 2 week period prior to their presentations, with tutors experienced in the research topics to provide assistance and guidance. The course convenor also contacted each group member during this period to ensure all group members were attending and to address any interpersonal issues and/or interpretations as they arose. To further ensure that all group members were actively involved in the group learning process, assessment of the group work involved a rating for each student by the tutorial leader (which accounted for 10 % of each students final grade), as well as a rating of each group member by the other members of their group. This rating was used as a 'correction factor' to adjust the overall presentation mark provided by the course convenor for each student. The student groups were each required to present a 10 min presentation followed by a 5 min question and discussion period on their assigned topic. The content was submitted as talk notes as well as PowerPoint presentations. This content was uploaded onto the course website and made available to all students in the course.

Individual research project

The learning activities also encompassed an individual self-directed learning project. Students were randomly allocated one of five individual research topics of interest in the field of biosciences. Each student was required to prepare a 1500 word essay in the style of commentary style article published by journals such as Nature. The research topics were:

- Are biofuels a viable source of energy in a carbon-conscious world?
- Type 2 diabetes: Why is this an emerging issue for Australia?
- What caused 'Black death" and could a similar worldwide disasters happen again?
- Depression, psychosis and cannabis – is there a link?
- Growing tissue for human transplantation: What are the technical and ethical issues?

End of semester exam

An end of semester exam was used to assess the students learning across the entire semester. This ensured that all students had an understanding of all aspects of the topics in this course, including those they did not research themselves.

Data collection

Student assessment scores

The assessment components (Table 2) within the course were designed to develop and assess student's generic skills (research, written and oral presentation skills, the ability for both independent work and work within a group environment) and to engage their interest in the biosciences. A weighting of 10 % of the students' final grades was allocated for in lecture quizzes. These were short multiple choice quizzes which students were able to complete within the lecture. This aimed to (1) maximise student attendance at the lectures as all lectures had a small assessment component and (2) increase student comprehension of the issues and ability to recognise the salient points in each lecture. Group presentations were also incorporated into most lecture times. These presentations accounted for 20 % of each students overall assessment and were based on their individual abilities to present their research in a logical and comprehensible format, as well as their ability to function effectively within a team environment. This is the first chance that many students of the biosciences at Griffith University have to research and present as a team and much of the student's feedback (both in 2013 and in previous years) focussed on this aspect of the course. A guided peer discussion grade was also included as an assessment item. This item related to the students ability to work collaboratively within the group environment and to provide logical and helpful input into the group work. The student groups were required to attend workshops to discuss their research topics and prepare their presentations. Each student was awarded a mark based on their contribution to the group work within the workshops. This item accounted for 10 % of the total.

Students were also expected to individually research and submit a written assignment on a further topic of interest in the biosciences. The individual assignment accounted for a further 30 % of the total course grade. A further end of semester exam (30 %) tested comprehension of all topics covered throughout the semester. The exam not only included questions specifically related to the research topics presented both by the student groups and the keynote presenters, but also covered ethical issues and scientific method. The scores from all assessment items were totalled and students were assigned a grade based on the overall percentage they achieved over the course of the semester. The grades awarded were:

- ≥ 85 % was awarded a grade of high distinction (HD)
- 75-84.9% was awarded a grade of distinction (D)
- 65-74.9% was awarded a grade of credit (C)
- 50-64.9 % was awarded a grade of pass (P)
- ≤ 49.9 % was awarded a grade of fail (F)

Table 2: Assessment summary and weighting of assessment items for 2013.

Assessment item	Comments	Weighting (%)
Weekly lecture quizes	Short multiple choice quizes held during each week during the keynote lecture. As well as assessing student conprehension, these quizes were included to maximise student attendance at lectures.	10
Group presentation	Group presentations were assessed during the lecture period by the course convenor and 2 tutors and provided as a group mark. Students were required to provide a confidential ranking of each group member's participation and this was used as a 'correction factor' to adjust individual student's scores to correct for the other group members efforts affecting other group member's scores.	20
Guided discussion with peers	This mark was provided by the workshop tutor to evaluate each student's participation and involvement with the preparation of the group presentations during the workshops.	10
Individual written assignment	Assessed on comprehension, research, writing style and presentation.	30
End of semester exam	Multiple choice exam, testing students comprehension of all aspects of the course (both keynote and student presentations)	30

Questionnaire

A survey was conducted during the final week of semester to obtain perception data from the students on the course and the teaching methods (Table 3). The majority of the questions were multiple choice style questions, although 2 final questions asked students to outline what they liked about the course and any suggested improvements. Participants were permitted to skip questions they did not wish to answer. For the multiple choice questions, the students were required to provide a score relating to the following scale:

- 5 = strongly agree
- 4 = agree
- 3 = neutral
- 2 = disagree
- 1 = strongly disagree

The scores for each question were averaged and are presented as a mean value.

Statistical analysis

Survey scores across the 4 years of this study were subjected to paired Students' *t*-tests for each individual question (two-tailed; confidence intervals of > 95%). Analysis of individual assignment and group presentation scores was accomplished by one-way ANOVA.

RESULTS

Student outcomes

Figure 1 summarises the student outcomes as a proportion of the total student cohort for each year of the study. Whilst student engagement in 2010 was not as high as in subsequent years (based on student

Table 3: Student survey questions to evaluate student perceptions of the course and the teaching methology.

Student Experience of Course (SEC)	Student Experience of Teaching (SET)
Quantative (multiple choice) responses	
This course was well organised.	The material was presented in a clearly organised way.
The assessment was clear and fair.	The material was presented in an interesting way.
I received helpful feedback on my assessment work.	Students were treated with respect.
This course engaged me in learning.	The teaching staff showed a good knowledge of the subject matter.
The teaching (lecturers, tutors, online etc) on this course was effective in helping me to learn.	The teaching staff communicated their enthusiasm for the subject.
Overall I am satisified with this course.	
The assessment of this course was appropriate to its credit point value. #	
The course developed my ability to find, evaluate and use information appropriately (eg. for reports, debates, presentations etc.) #	
Qualitative (written) responses	
What did you find particularly good about this course? *	What aspects of the teaching staffs teaching were most valuable to your learning? *
How could this course be improved? *	How could the teaching of this course be improved? *

# denotes questions which were only in the 2013 surveys. * denotes questions that were not asked in the 2010 survey.

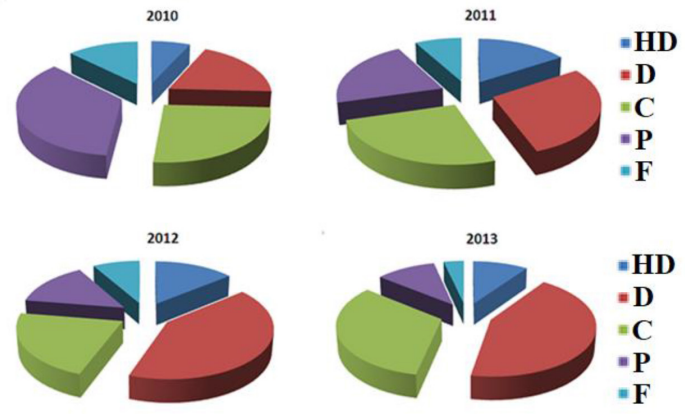

Figure 1: Student grade outcomes in 2010 – 2013 expressed as a proportion of each cohort. HD = high distinction (≥ 85 %); D = distinction (75-84.9 %); C = credit (65-74.9 %); P = pass (50-64.9 %); F = fail (≤ 49.9 %).

feedback, Table 1 and Figure 2), the outcomes in terms of student grades demonstrated that student comprehension was relatively high, with a fail rate of 13.8 %. The largest proportion of students (39.1 %) obtained a passing grade, with a slightly lower proportion of students obtaining a credit (28.4 %). It is noteworthy that a relatively low proportion of students obtained higher grades in 2010 (20.8 % and 7.5 % for the grades

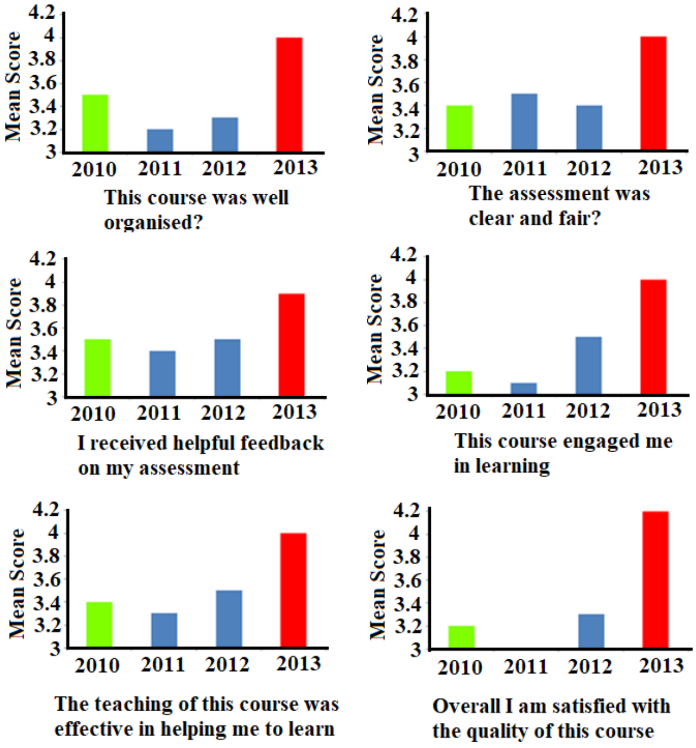

Figure 2: Student feedback collected in the final week of teaching in 2010-2013. Student evaluations were obtained by formalised surveys and are presented as mean values. For individual student surveys, 5 = strongly agree; 4 = agree; 3 = neutral; 2 = disagree; 1 = strongly disagree.

of distinction and high distinction respectively).

The course modifications in 2011 and 2012 which aimed at engaging students and providing deeper learning, also had notable effects on student outcomes. The proportion of students who did not achieve a passing grade decreased to 8 % and 7.3 % in 2011 and 2012 respectively. This would be likely to directly impact on student retention rates as successful, engaged students are more likely to continue their studies than less engaged students with lower success rates.[2-4] Another noteworthy feature of the student outcomes was the increase in the higher achievement categories (distinction and high distinction) with a corresponding decrease in pass grades for both years.

In 2013, the course was further modified by retaining and expanding aspects of the course which achieved positive feedback (Table 1), whilst providing a more realistic workload. Figure 1 shows that the proportion of students who did not achieve a passing grade decreased even further (to 4 %) in 2013, which is expected to have further flow on effects on student retention. Interestingly, there was an evident trend for students to not just achieve passing grades, but to achieve within the higher grade levels. The proportion of pass grades decreased to 12 % in 2013, with a corresponding increase in the proportion of students achieving a grade of credit or higher (credit, 37 %; distinction, 49 %; high distinction, 11 %). The increased student outcomes with the adaption of the course attests to the success of the modified teaching methods, learning activities and assessment items.

Student Perceptions

Questionnaire results

Student perceptions of the organisation of the course, the course assessment, the course feedback, the teaching modality and student

engagement and their overall satisfaction with the course were examined by a formal end of semester survey (Figure 2). To examine the student's perception of the course organisation, the students were asked to respond to the statement "This course was well organised". A significant decrease was evident from 2010 to 2011 and ($p<0.01$). This result was interpreted as being due to student's appreciation of the structured nature of the lectures, with keynote lectures providing the foundation for each topic. Whilst the mean score did rise from 2011 to 2012, this increase was non-significant. The lecture organisation, including keynote lectures, was reinstated and expanded in 2013 to include a greater reliance on keynote lectures. This was accompanied by a significant increase in mean score from 3.3 to 4. Interestingly, the 2013 score was also significantly higher than 2010 score, indicating that whilst the reinstatement of keynote lectures may have significantly influenced student satisfaction with course organisation, other factors also influenced their views. It is likely that the tutorials and the student's perception of the assessment also influenced this score.

To evaluate student perceptions of the assessment within the course, students were asked to respond to 2 statements: "The assessment was clear and fair" and "I received helpful feedback on my assessment". No significant increase was seen between 2010 and 2012 for student's perceptions of the clarity and fairness. However, a significant increase was evident in 2013. This is noteworthy as the same general assessment strategy was employed in 2013 as in 2011 and 2012 in terms of assessable items. However, in 2011/2012 the students were required to prepare 4 group presentations (a presentation every second week throughout the second half of the course), as well as undertaking their other assessable tasks. Student feedback consistently indicated that students believed that this was an unrealistic workload (Table 1). For this reason, the number of presentations was decreased in 2013 to a single group presentation with the expectation that students aim for quality of presentation rather than quantity. Students responded by focussing their attention on a single topic and engaging much more deeply with it. As well as increasing student satisfaction (Table 4), the more realistic workload enabled students to properly engage with their topic and produce a more interesting, higher quality presentation. This was reflected in student comments regarding both their own topics and the quality of presentations by other students (Table 4). Students were also provided with constructive feedback throughout the learning process. Tutors within weekly tutorials provided instant feedback to students regarding the preparation of their group presentations and their individual written assignments, allowing them to improve the quality of their work and ensuring that they were focussing their attentions in the correct areas. Furthermore, students were provided with timely feedback following the completion of each assessment item. Generally, students were given feedback within 48 hr, enabling them to rapidly adapt and modify their learning strategies as required. This is typified by student comments such as "Our results were returned very quickly. Sometimes Ian had the results back to us the same day!!!" (Table 4). This may account for the significantly higher mean score in 2013 for the feedback of assessment question compared to all other years.

Allowing students a greater amount of time to engage more deeply with their research topics was well received as is reflected by student responses to the statement "This course engaged me in learning". A significant increase was evident in student perceptions of engagement from 2010 to 2012. During this period, the course was remodelled to include several topics of contemporary interest for the student demographic (e.g. do cell phones cause brain cancer?). End of course survey comments (Table 1) indicated that students appreciated the inclusion of topics which they found interesting and believed to be relevant to them. Due to the students positive perceptions of these topics, they were retained in 2013 and further topics relevant to the demographic were developed and keynote lecturers whose research field encompassed these topics were recruited to present lectures and to provide a framework for the students to work within. Student engagement is evident through the further significant increase in student evaluation of engagement (Figure 2) and through student comments such as "Overall, the course was very interesting and gave an insight into the different areas of biosciences that is currently under investigation by scientists" (Table 4). Comments such as this were common and only a representative sample are included in Table 4.

It is likely that the students satisfaction with engagement, assessment and the course organisation also influenced their responses to the statements "the teaching of this course was effective in helping me to learn" and "overall I am satisfied with the quality of this course". Responses to both of these questions would be likely to be heavily influenced by the level of student satisfaction in other categories, and with student success in this course. From the student responses to all survey statements (Figure 2 and Table 4) it is evident that student satisfaction was significantly increased in all areas. It is therefore not surprising that overall satisfaction with the course showed a significant increase in 2013 compared with all other years. Furthermore, student outcomes (Figure 1) would also be likely to have a substantial influence on their overall impression of the course. It is not surprising that a student that is excelling in a course would rate a course more highly than a student who is not achieving as highly. Whilst this may contribute to the overall student perceptions of the course, it is unlikely that it is solely responsible. Student outcomes were similar in 2011 and 2012, yet student satisfaction with the course was significantly increased in the same time period. Similarly, whilst only a slight increase in student outcomes was evident between 2012 and 2013, significant increases were noted for student's perceptions of their satisfaction with the course. Other factors, including those assessed in the end of semester survey, must also contribute to student satisfaction.

DISCUSSION

Development of effective courses that actively engage students in the learning process and foster interest in the subject matter requires considerably more than a well-developed curriculum, a sound understanding of the subject matter by the teacher, and effective management skills. The provision of successful teaching requires educators to not only have a solid understand and enthusiasm for their own subject matter, but also to deliver the curriculum and provide learning activities that engage student learning.[1] Through engagement in the learning process, students develop a greater understanding of the key concepts, a greater depth and breadth of knowledge, and the ability to use their acquired knowledge in higher learning processes. As the modern classroom is a highly dynamic environment with ever changing student cohorts, effective teaching requires more than just the management of instruction, as well as ensuring that students remain on task and managing student behaviour. Instead, the modern educator must be highly adaptable rather than being tied to a single teaching philosophy and method of teaching. They need to develop the ability to modify their skills, integrate new teaching philosophies to match changing contexts and to develop new teaching strategies. Unless teachers engage in critical reflection and ongoing development, they with not be able to adequately adapt, and risk developing less engaging courses and becoming less effective educators.[24]

Reflective practice is essential to maintain and improve course development standards and teaching practice.[25] Reflection allows educators to critically evaluate their teaching practice and assess the effects that their teaching philosophies and information and the forms of learning that they use are having on student engagement and student learning outcomes. Furthermore, reflective practice allows teachers to evaluate whether they are current in both their knowledge base and

Table 4: Student feedback collected in the final week of teaching in 2013. Student evaluation and comments were obtained by anonymous formalised surveys.

Positive aspects of course	Student Comments
Content and organisation	This course covered a wide range of science topics which was interesting.
	The implementation of keynotes on the different fields of biosciences was very interesting and allowed students to broaden their minds on the topic of biosciences.
	A lot of interesting topics were covered.
	I like the diversity of material. I am studying biomed so it was really nice to learn about some other issues in the wider scientific community. Plus Ian is a legend.
	I really feared this course from hearing from previous students. I really got a surprise. This course is very well organised and interesting.
	I learnt a lot of new interesting stuff.
Engagement	This course was ACTUALLY interesting. :D
	The keynote speaker's portion of this course was great as we were lectured by several professionals about a diverse variety of science topics.
	Overall, the course was very interesting and gave an insight into the different areas of biosciences that is currently under investigation by scientists.
	It was good to have guest speakers who specialised in their field to give us lectures.
	Hearing from people in their own fields talk about their research was good and engaging.
Lecture presentation	Everything was clearly presented and interesting.
	I like the mixture of topics covered in this course. There was some very interesting subject matter
	Everything was presented clearly and interestingly. Not only the keynotes, also the group presentations.
Group work and group assessment items	I was lucky and got assigned an incredible group of work partners because I'm not really a people person. It made my spoken presentation a breeze.
	I was pretty surprised that a big class audience didn't bother me. This has definitely helped my confidence.
	The student presentations in the lectures was a good aspect and definitely should be implemented again in the future.
	This course enabled me to develop skills necessary for the study of science that normally would not be provided in my other classes.
	Every talk was good!
Individual work and individual assessment items	Assignment questions were interesting.
	I now have a major interest in my research topic and would like to take this further in the future.
Assessment	Lots of continuous assessment meant that my failing this course was not likely.
	The assessment strategy was excellent.
	All of the assessment was explained at the start of the semester - no nasty surprises.
	The assessments were fair and good.
	Our results were returned very quickly. Sometimes Ian had the results back to us the same day!!!
	Having small quizes in each lecture ensured that I turned up and listened for easy marks.
	I like the variety of assessment as it let me develop different skills.
	The quizes in each lecture engaged my learning.

in their teaching modalities, and if their teaching methods are having a positive impact on student learning that they will be able to apply to their future academic endeavours. It also encourages teachers to critically examine alternative teaching practices and philosophies, and where appropriate, adapt these towards their own courses. It is through reflective practice teaching that good teachers are able to improve their courses and their own teaching, by retaining and improving the teaching practices that result in positive outcomes, and changing those aspects that are not effective.

This case study exemplifies what is possible to achieve using an unbiased critical reflection of teaching practices approach to course development. The course Topics in Biosciences (1003 BPS) at Griffith University, Australia was developed with the aim of engaging first year university students in the biosciences and thereby aid in increasing student retention rates and the transition of students to the second year of their studies. The course incorporated learning activities that have previously been shown to have positive effects on student engagement including collaborative group work, writing to learn activities, as well as oral and written presentations.[9,10] Incorporation of other teaching practices which have been established to positively influence student engagement and success such as clear and rapid feedback on assessment, directed approaches to group assignment and in lecture activities to engage student participation were all included. The result was a well rounded course that achieved good student engagement and success rates and that was positively received by the student cohort.

CONCLUSION

Through the use of ongoing reflective practice, a course has been developed which aims to engage student interest in the biosciences as well as providing them with a solid foundation to understand the ethical and technical issues associated with contemporary research within the biosciences. The course has been extensively tested of a 4 year period and positive teaching modalities, learning activities and assessment philosophies were identified and retained (and where possible, enhanced). Conversely, teaching practices and activities that did not positively influence student outcomes or that were not viewed positively in annual student evaluations were not retained within the course structure. The result is the development of a first year course examining general topics in biosciences that students find interesting and engaging and that has positive outcomes in terms of student engagement, student success rates and student retention within the critical first year of university study.

ACKNOWLEDGEMENT

This study was undertaken within the School of Natural Sciences, Griffith University Australia. I am grateful to Michael Wieble and George Mellick of Griffith University for providing access to their teaching resources and evaluations which enabled the adaption and enhancement of this course as outlined in this study.

CONFLICT OF INTEREST

The author declares that there is no conflict of interest.

SUMMARY

- A suite of biosciences and pharmacognosy teaching methods were trialled over a four year period.
- Curriculum was adapted with the aim of enhancing student engagement
- Activities aimed at engagement achieved positive outcomes.
- A clear correlation between between some teaching methods with student outcomes and perceptions was noted.

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Cite this article: Cock I. Improving Student Outcomes and Perceptions in First Year Biosciences by Enhancing Engagement: A Case Study. Pharmacognosy Communications. 2022;12(1):28-35.