Encouraging students' deep learning through assessment

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Structured abstract

BACKGROUND
It is important to engage students in deep learning in order to achieve the desired course objectives. Engineering students are required to study a wide range of subjects to develop the skill set required for their chosen career. These include technical skills that are heavily reliant on mathematics and natural sciences while other subjects are more aimed towards developing their soft skills, for example; communications and management skills. Numerical and Data Analysis is often seen and approached as a technical course which requires extensive mathematical and programming skills but is rarely seen as the place to develop the communication skills of engineering students.

PURPOSE
This paper provides observations on how changing the assessment regime encouraged students' engagement in deep learning.

DESIGN/METHOD
A new assessment approach was introduced in the 2012 offering of the Numerical and Data Analysis course which favoured formative assessment and placed more emphasis on developing the critical thinking and independent learning skills of students. To assess the performance of the new assessment approach, a comparison of key learning performance indicators is conducted on the 'before' and 'after' the introduction of the new approach.

RESULTS
Comparing the results obtained from the course offering before and after the introduction of the changes indicates that the approach has enhanced students' satisfaction in the course, increased retention rate and reduced failure rate.

CONCLUSIONS
Assessment items offer opportunity to link theoretical subjects to more practical engineering skills, hence engaging students in deep learning.

KEYWORDS
Deep learning, engagement, student centred learning

Introduction

It is important to realise the different learning styles and needs of individual students. Nevertheless, students can generally take one of either of two approaches to learning; deep or surface learning approach(Biggs & Tang, 2007). Research has shown that adopting a deep learning approach to learning is preferable because it gives meaningfulness to the material being learnt, greater depth of processing, it is more compatible with higher education aims and objectives, results in greater personal satisfaction with performance and leads to higher academic achievement (Fowler, 2003). This is particularly so when the course forms a pre-requisite for other more advanced courses. Wandel (2010) noted that the consequences of not engaging in deep learning causes issues beyond difficulties in advanced courses; for example, students' enrolment retention rates (Froyd & Ohland, 2005).

Almeida et al (2011) investigated students' learning in a chemistry class and found that students who achieved lower grades generally engaged in surface learning and preferred teaching activities and styles that promoted surface learning. On the other hand, students who achieved higher grades, engaged in deep learning and preferred study and teaching strategies that promoted deep learning. Stewart et al (2012) surveyed 132 second year engineering students on their learning approaches and assessment preferences. They found that although many students engaged in surface learning and preferred surface assessment types, students were aware of the need to engage in deep learning in order to develop the engineering attributes required by the profession (Stewart et al., 2012). It is, therefore, important to engage students in deep learning in order for them to be able to extend the knowledge and apply skills they learn in class to their future carriers.

Assessment is an important component in learning. It can be instrumental in driving students' learning and engaging them in the subject (Ramsden, 2007). In addition to measuring the level of understanding in the subject; assessment should also be used to motivate students to acquire new knowledge (Ooi & Buskes, 2011). According to Rushton (2005), formative assessment is a key component in deep learning. Nevertheless, designing assessment activities for diverse cohort of students, such as the common courses in engineering, is a challenging task (Aravinthan, 2010).

This paper presents observation on the effect of changing the assessment regime in the offering of Numerical and Data Analysis course over two years, 2011 and 2012.

Material and Methods

Course description

Numerical and Data Analysis is a common course in the Engineering Program at Griffith University. It was first offered as a common course in the second semester of 2011. Students are expected to have completed two courses of university mathematics and an introductory course in programming before they enrol in the course. As the name suggests, the course is composed of two components; the Numerical Methods and the Data Analysis. The objective of the course is to introduce students to the applications of numerical and statistical methods in engineering.

Description of assessment items

A variety of assessment types were used in the course which included both summative and formative assessment items. Assessment items used in the course are summarised in Table 1.

Table 1: Summary of Assessment Items

Assessment type	2011	2012
Mathematical and programming problem	3	1

solving		
Case study and Report	0	1
In-class assessment	1x6	1x5
Formal exam	2	2

In the 2011 offering, assessment items were mainly focused on assessment of learning with the exception of the in-class assessment which included elements of assessment for learning. However, in 2012 the style of assessment was changed to include more assessment for learning particularly in the in-class assessment items.

According to Kuh (2003), students who are more engaged in educationally productive activities are more likely to develop good habits of continuous learning and personal development. Prince (2004) noted that creating collaborative environment in class influences learning outcomes positively including improving academic achievement. Furthermore, formative assessment has been reported to play a role in encouraging students to adopt deep approach to learning (Gijbels & Dochy, 2006). Therefore, the in-class assessment in 2012 was designed to enhance students' engagement with class activities and interaction with the class community. In order to do so, the session was divided into two parts. During the first part, formative assessment was used. Students were given exercises that assessed their knowledge of important concepts taught earlier in the lecture. After assessing their own understanding, students were then encouraged to search the internet, refer to lecture notes as well as extra resources on the course website in order to acquire the knowledge to complete the activities at hand. Students were also encouraged to collaborate and seek assistance from each other as well as the session tutor. To give students full flexibility to explore the activities, there was no mark assigned to the first part of the session. However, students received personalised feedback on their work and a summary feedback was given to the class at the end of the session.

During the second part, students were given exercises which built on the skills they learnt in the first part of the session. Students worked on these activities individually but they were only allowed to refer to their own work from the first part of the session. The session tutor then marked students' work and provided verbal feedback to the student as and when the student was ready to show his/her work.

The case study and report assessment item was introduced during the 2012 offering to replace 2 mathematical/computer programming problem solving assessment items from the 2011 offering. The aim of this assessment item was to contextualise the skills the students learned in class by exposing them to a realistic engineering application. This assessment item included a component that required students to do active library research and use their critical thinking skills to integrate prior knowledge they acquired in other subjects to interpret the results. Another objective of this assessment item was to give students the opportunity to practice their report writing skills in an engineering context. Therefore, students were asked to assume the role of a consultant and present their findings and recommendations in a proper report format to a management board.

Data Collection and Analysis

Data were extracted from the student management system and the course evaluation survey. The course evaluation survey is an anonymous survey conducted centrally by the university. Students receive an email to fill an online survey that requires them to rate various aspects of the course offering. The number of valid responses was 35 and 41 students representing 44.3% and 47.1% of the enrolment in 2011, 2012 respectively. Respondents registered their responses to each item on a five-level Likert scale: Strongly Agree (SA), Agree (A), Neutral (N), Disagree (D) and Strongly Disagree (SD). As the data were collected at ordinal level, Mann-Whitney U-test (Tamhane & Dunlop, 2000) was used to test if the difference between the two cohorts was statistically significant.

Results and Discussion

Improvements on multiple fronts including: enrolment retention rate and passing rate as well as students' overall satisfaction in the course were observed.

Figure 1 shows the number of students enrolled in the class at three important dates of the semester. Students' retention was one of the obvious and fastest to observe benefits. In the Australian universities, the end of the fourth week of instruction is an important date because it marks the 'census date'. Census date is the date after which students who continue their enrolment in the course become financially liable. In the 2011 offering, 13% of the students withdrew from the course before the end of the 4^{th} week of instruction. This percentage decreased to 7% in 2012. This may indicate that students had more confidence in their ability to pass the course. It also acted as a feedback to the course convenor that students conceived that they understood the material being taught. Another interesting date is the end of week 9 of the semester. Students who withdraw from a course after the end of week 9 have a grade of 'Fail' recorded against their transcript. Therefore, students during this week make a decision if they want to continue with the course and sit for the final exam or opt out without academic penalty. Interestingly, 98% of the students in the 2012 offering opted to sit for the final exam compared to 89% in 2011. This observation may again be interpreted, at least in part, that students were more confident in their ability to pass the course and therefore are willing to sit for the final exam. The lower failure rate in 2012 compare to 2011 may provide support to the prior notion.

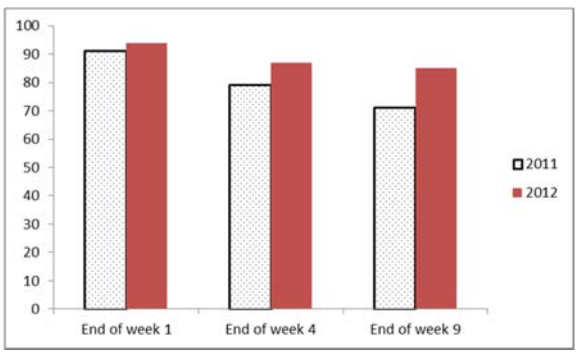

Figure 1: Student enrolment at different stages through the semester

Comparing the results of the course evaluation surveys in 2011 and 2012 reveals interesting observations particularly regarding the relationship between the level of overall satisfaction in the course and the level of learning engagement. Figure 2 and 3 show students' responses to the statements: *"This course engaged me in learning"* and "*Overall I am satisfied with the quality of the course"*, respectively.

The trend in students' responses about their level of satisfaction in the course almost mimicked the perception of their engagement in the course. Figure 2 shows that students felt that they were more engaged in learning during the 2012 offering than in the 2011 offering. As can be seen in figure 2, 51% of the respondents in 2012 'agreed' or 'strongly agreed' with the statement "*This course engaged me in learning"* compared to 31% in 2011. This represents a significant change (α=0.1) between the 2011 and 2012 cohort as the Mann-Whitney U-test suggested (U=550, $U_{critical}$=560).

The level of students' satisfaction of the course also improved as evident from the results of the Mann-Whitney U-test (U=545, $U_{critical}$=560, α=0.1). Figure 3 shows that 68% of the respondents in 2012 agreed or strongly agreed with the statement: "*Overall I am satisfied* *with the quality of the course"* compared to only 37% in 2011. Students' perception of engagement and overall satisfaction was reflected positively in their overall performance in the class. For example, only 65.4% of those who sat for the final exam obtained a grade of 'Pass' or better in the 2011 offering. This percentage increased to 80.9% in the 2012 offering.

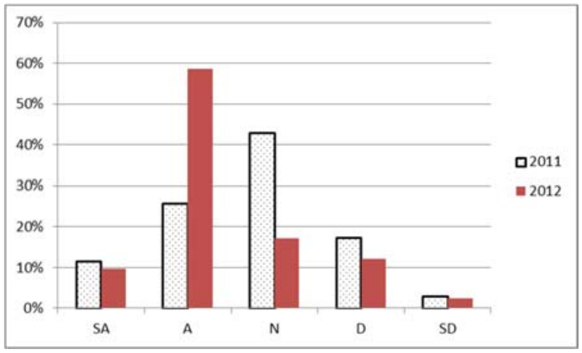

Figure 2: Students' response to "this course engaged me in learning"

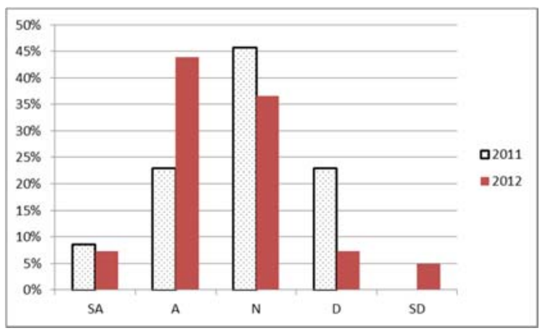

Figure 3: Students' satisfaction in the course

Conclusions

Students' engagement in learning is important for achieving satisfaction in the course offering. Assessment items may be used to motivate students to adopt deep approach to learning and in turn be more engaged in the learning process. A positive trend was observed between students' perception of their engagement in learning and their overall satisfaction in the course.

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