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Developing assessment tasks to improve the performance of engineering students

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BACKGROUND
Assessment tasks are an important part of each course profile, which should be designed in a constructive manner that will not only allow students to achieve all learning objectives progressively, but will also help to improve the levels of intrinsic learning motivation among students, thus leading to superior learning outcomes. A good example of the assessment task can be an assignment, which is commonly used in engineering courses to grade the student's performance as well as provide timely feedback. However, it is still unclear as to how many assignments need to be offered to students to engage them in the learning process and help them develop a "deep" approach to learning. Recent research indicates that teachers tend to underestimate the time that students need to complete their assignments, which may lead to a "surface" approach to learning. The timing of assignment submission seems to also be important, and needs to be carefully designed to support the learning process.

PURPOSE
This study seeks to determine whether the use of smaller but more frequent assignments (5 assignments) given to students every other week over the whole course may produce superior learning outcomes than one large assignment with a due date at the end of semester.

DESIGN/METHOD
The course of Soil Mechanics, which is offered to 2nd year students at the Griffith School of Engineering, was selected for this study. The course features weekly lectures, tutorials, laboratory sessions and assignments. Until 2009, only one large assignment was given to the students to help them develop critical thinking and problem-solving skills. After receiving the students' feedback, changes in the assessment design were made, such that the assignment was divided into five parts and assigned to the students on a regular basis over the course. To understand the effect of such a change on the performance of students, data from the past four years, including the students' grades for laboratory work and assignments, and their performance during the mid-semester and final exams, were collected and analysed. Comparisons were made between these variables obtained for the year of 2008 and 2009 (before the change in the assignment design), and years of 2010 and 2011 (following the change).

RESULTS
The obtained results indicated that the performance of students throughout the course slightly improved when five assignments were used, which was clearly seen in the higher marks that the students received for both laboratory work and assignments. Although no significant improvement in the grades obtained for the mid-semester and final exams was observed, the number of students who failed the course slightly decreased after the changes in the assignment design were made.

CONCLUSIONS

The results of this study indicate that although some improvement was observed in the students' performance for the assignments since the changes were introduced, no effect of the new assignment design on the mid semester and final exam marks was established. No significant changes in the failure rate that can be linked to the changes in the assignment design were also observed. Although the students' feedback on the changes in assignment design was mostly positive, no statistical evidence supporting the hypothesis that it would lead to better learning outcomes was obtained.

KEYWORDS
Assessment design, assignment, engineering

Introduction

Assessment tasks, which are an important part of each course, are typically used to grade student performance as well as to provide support for the learning process. There is much research to show that “students tend to think about assessment first, rather than as their lecturers often do, as the last piece of course that needs to be considered” (Stefani 2009). It is important for lecturers to understand that the way the assessment items are designed can influence the way the students learn (Norton 2009). The available literature suggests that the assessment items should be devised in a constructive manner to support the sequence of learning (Nulty 2011) and allow students to achieve all learning objectives progressively (Biggs and Tang 2007).

The assessment is typically used to motivate student learning as well as to grade the student performance (summative assessment), and provide appropriate feedback on the student’s progress (formative assessment) (Norton 2009). Another important component of the assessment is the timing of submission of each assessment item. It is clear that no feedback can occur without assessment but assessment without timely feedback contributes little to learning (Chickering and Gamson 1987). As students need frequent opportunities to perform and receive suggestions for improvement throughout the course, the timing of assessment submission becomes essential to supporting the learning process.

Although the major principles of the “good” assessment design are well-understood and reported in the literature, there are still a few problems that need to be addressed. For example, it is still unclear as to how many assessment items need to be given to students to fully engage them in the learning process in a manner that would lead to the development of a “deep” approach to learning (Ramsden 2003). The recent practice indicates that teachers sometimes underestimate student workload and the time required for students to complete their assignments, which may force the students to become “strategic learners” and adopt the “surface” approach to learning (Stewart-Lewis and Webb 2009). Lawless (2000) noted that the time spent on tasks is strongly related to the student approach to study. While the aim of some students may be to learn the subject, other students may only wish to pass the assignment and accordingly, the course. Thus there is a concern that a large number of assignments may actually have a negative effect on the learning process and produce “surface” learners.

For a number of courses in the Griffith School of Engineering, assignments are important tools for helping students develop the critical skills necessary to solve real-life problems. It is believed that students learn how to apply theories into practice through performing such activities. Assignments are also designed in a manner that will allow students to better prepare themselves for other assessment tasks with heavier weighting such as the mid semester or final exam. Although it is a common practice for the teacher to design assignment tasks (that is, the number of assignments per semester, and the submission time for each of them) on the basis of the University/School recommendations, the decision as to what type of assignments and how often these assignments should be given to the students to get them better engaged in the learning process is left for the teacher. As there is no “easy answer” to this, the teacher often needs to use his/her experience and students’ feedback to design assessment items that would lead to stimulation of the learning process and result in better learning outcomes.

It is clear that more research needs to be conducted to better understand the effects of assessment design on the performance of students. This study seeks to determine whether the use of smaller but more frequent assignments (5 assignments) given to students every other week over the length of the course may produce better learning outcomes as compared to assigning one large assignment with a due date at the end of semester.

It is noted that as this research involves the analysis of previously collected data, and all identifiers are removed before the analysis, this work is considered to be outside the scope of the University's human research ethics arrangement, and it is exempt from ethical review.

Method

The course of Soil Mechanics, which is offered to 2nd year students at the Griffith School of Engineering, was selected for this study. It is noted that, since 2008, the number of students undertaking this course has significantly increased year to year (Table 1). Although the growing demand for civil engineers in the Gold Coast area is a positive development for the Griffith School of Engineering, it also indicates that the teachers of civil engineering courses are now required to accommodate more students in their classes, and, more importantly, adjust their teaching styles to keep up with larger class sizes.

Soil Mechanics is a core course that offers lectures, tutorials, and a number of assessment tasks such as laboratory sessions, assignments and exams. The laboratory work plays an important role in developing students' practical skills, while assignments are designed to help students develop critical thinking and problem-solving skills. The course of Soil Mechanics is designed for 2nd year students, and it is typically seen as a prerequisite course for "Geotechnical Engineering", which is offered to the 3rd year students. During the course of Soil Mechanics, students are provided with opportunities to learn the fundamentals of soil behaviour including soil classification and more advanced topics such as consolidation and shear strength.

Until 2009, due to the large amount of laboratory work that students were required to undertake during the course, only one large assignment was given to students with the submission due date being close to the end of semester. This assignment contained a number of questions which were related to all the major aspects of soil behaviour covered in the course. The questions were taken from real-life geotechnical engineering practice, and students were required to use their knowledge and critical thinking skills to solve the problems at home and submit their papers at the end of semester. This large assignment was not only an assessment item, but it also served as a means to encourage students to review the course before the final exam.

The student feedback received in 2008 and 2009 indicated that the assignment was instrumental in their preparation for the final exam; however, the due date's timing was considered poor as it was at the end of the semester, thus clashing with assignments from other courses. Some students also suggested that this assignment could be divided into a few parts and offered throughout the course because it would encourage students to work on it during the course, and not just at the end of semester as most of students did. Also, there was a concern among students that the feedback on this assignment in the forms of marks and solutions to the problems came at the end of semester, just a few days before the final exam, and for this reason, they did not have enough time to better understand the strategies used to solve the problems.

After receiving students' feedback, it was decided that appropriate changes would be made to the assessment design, such that the assignment would be divided into five parts and assigned to the students on a regular basis (every two weeks) over the length of the course. Each assignment consisted of 3 questions, and the time needed for completion was estimated to be about 1.5-2 hours, on average. In addition, as the total number of questions as well as the time needed to perform these assignments increased compared to those used in the large assignment in 2008-2009, the weighting of this newly-designed assessment task also increased from 10% overall (till 2009) to 15% overall (each assignment is worth 3%) in 2010-2011. The greater weighting was believed to encourage students to spend more time on learning, and it was seen as a means to improve the students' overall learning experience. It is noted that the questions used in assignments were different every year to prevent students from "recycling" assignments from the previous years.

Although the above mentioned changes in the assignment design were prompted by student feedback, it was not clear whether it would result in better learning outcomes as the larger number of assignments could, in fact, significantly increase the time needed for its completion. This raised the concern that due to the increased amount of work, students

would not be fully engaged in the learning process and probably would be forced to adopt the "surface" approach to learning.

To study the effect of such changes on the performance of students, data from the past four years, including the students' marks for laboratory work and assignments, and their grades for the mid semester and final exams, were collected and analysed. The major objective was to establish whether there was any effect of the new assessment design on the performance of students in the course. This mostly includes changes in the students' marks for assignments, and the mid semester and final exams. There was also a concern that a larger number of assignments might result in lowering of the students' marks for their laboratory reports. The reason for that was that a greater number of assignments could require even more time that students needed to invest into this course at the expense of time spent on laboratory reports.

To achieve the goal of this study, the students' average marks were calculated for all assessment tasks such as laboratory reports, assignments, and mid semester and final exams. Comparisons were made between the data obtained for the years of 2008 and 2009 (before the change in the assignment design), and the same variables obtained after the change in 2010 and 2011. The obtained results are presented and briefly discussed below.

Results and discussion

Figures 1-3 summarize the obtained data in the forms of students' average marks for different assessment items: laboratory reports and assignments (Figure 1), mid semester and final exams (Figure 2), and total mark for the course and the rate of failure (Figure 3).

Table 1: Number of students undertaking the Soil Mechanics course from 2008-2011

Year	Number of students
2008	129
2009	151
2010	183
2011	158

The performance of students throughout the course is shown in Figure 1 in terms of the average marks for laboratory reports and assignments. It can be inferred from this figure that the students' marks have improved since five assignments were introduced (years 2010 and 2011). This improvement can be seen for both activities: laboratory work (from the average of 72.4% for 2008 and 2009 to 83% for 2010 and 2011) and assignments (from the average of 70% for 2008 and 2009 to 83.4% for 2010 and 2011). It is evident from Figure 1 that the performance of students during laboratory sessions and assignments has improved in the past two years, on average, by 15% and 19%, respectively.

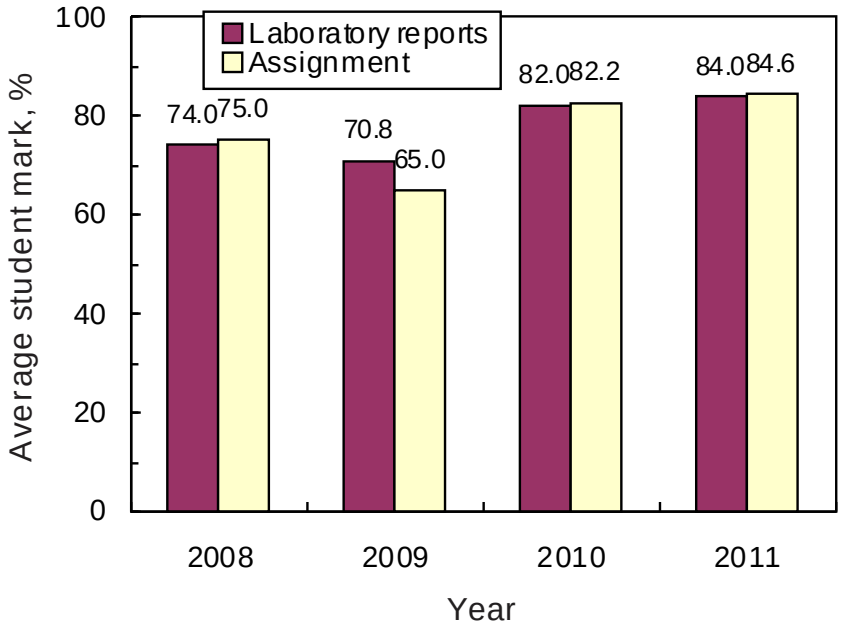

Figure 1: Students' average mark for laboratory reports and assignments for the past four years

The students' feedback was also positive as students liked the opportunity to work on problems during the semester, and that helped them better understand the material taught during the course.

From the data presented in Figure 1 and students' feedback, it can be inferred that the new assignment design resulted in better performance of students in their assignments. The students seemed to be more motivated to complete these assignments as they considered it as a good practice before the mid semester and final exams. In addition, students, especially those who struggled with the assignments during the course, were provided with opportunities to receive timely feedback that came a week after the assignment submission, which allowed them to better understand the strategies they needed to know to solve the problems.

Although the statistics indicated that the overall performance of students slightly increased, some negative aspects of the new design were also highlighted. Some of the students did not submit one or two assignments for different reasons (sickness or no time to finish it by the deadline) and did not receive marks for this. It may have been that these students did not see this loss of marks (3% for each assignment) as a significant threat to their overall score for this course.

It is interesting to note that the students' performance during laboratory work has also improved in the past two years (2010-2011). In this course, students are required to perform five different laboratory tests and provide laboratory reports that are assessed by the teacher. Laboratory reports are submitted a week after each laboratory session to provide students with time necessary to correctly interpret the obtained results and write a report using the appropriate structure. Although students obtain different results every year, the test procedure of each lab and the report structure remain the same, which make it possible for students to use laboratory reports from previous years as examples of good and bad practice. This may increase the quality of student reports each year, thus leading to better marks. However, an improvement in the laboratory marks became pronounced only in 2010, suggesting that there may be other factors that contributed to this change. At this juncture, it is not yet clear as to what was the source of this improvement, and more data from the next few years are needed to establish whether this trend is sustainable or not.

The performance of students in mid semester and final exams

To determine whether the changes in the assignment design could lead to better student performance in the mid semester and final exams, the obtained data were plotted in Figure 2 in terms of the students' average mark for the aforementioned activities against the past four years. It is rather difficult to identify any tendency in these data as the student performance before the change seems to be similar to that which was observed after the change in 2010 and 2011. For example, in 2008 the average mark for the mid semester exam was relatively high and comparable to the one obtained in the years of 2010 and 2011. Also, although the average mark for the mid semester exam in 2009 was relatively low (56%) compared to the values of 75% and 82% in 2010 and 1011, respectively, the average for the final exam (58%) was the highest score recorded in the past four years.

Although it was believed that the new assignment design would encourage the students to spend more time studying during the semester, and thus allow the students to be better prepared for the mid semester and final exams, the data in Figure 2 fail to support this hypothesis. No effect of the new assignment design on the students' marks for mid semester and final exams can be attributed to the fact that students generally spend extra time for preparations for these assessment items regardless of their level of engagement in the learning process throughout the course. In this case, even "surface learners" can produce results which can be satisfactory to pass the mid semester and final exams.

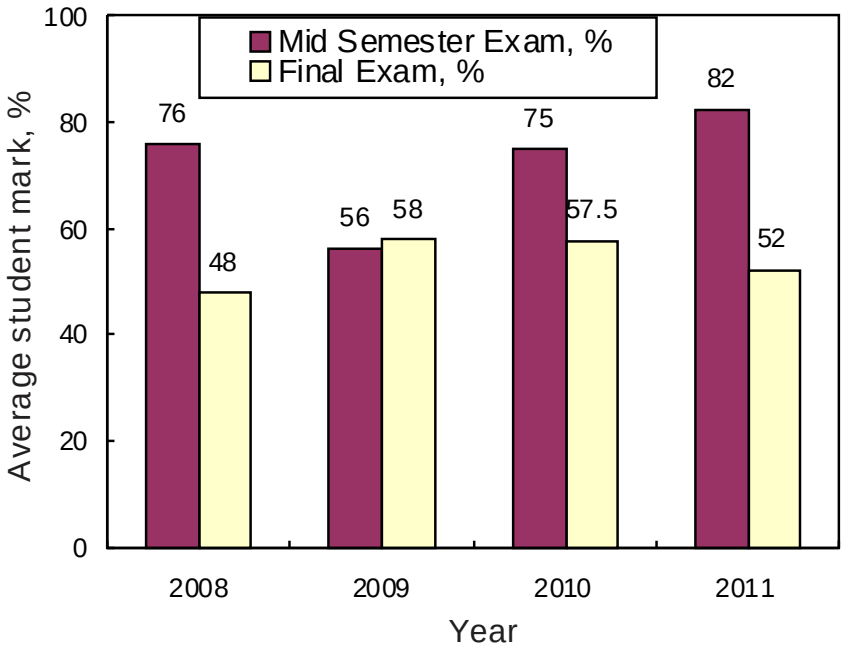

Figure 2: Students' average mark for mid semester and final exams for the past four years

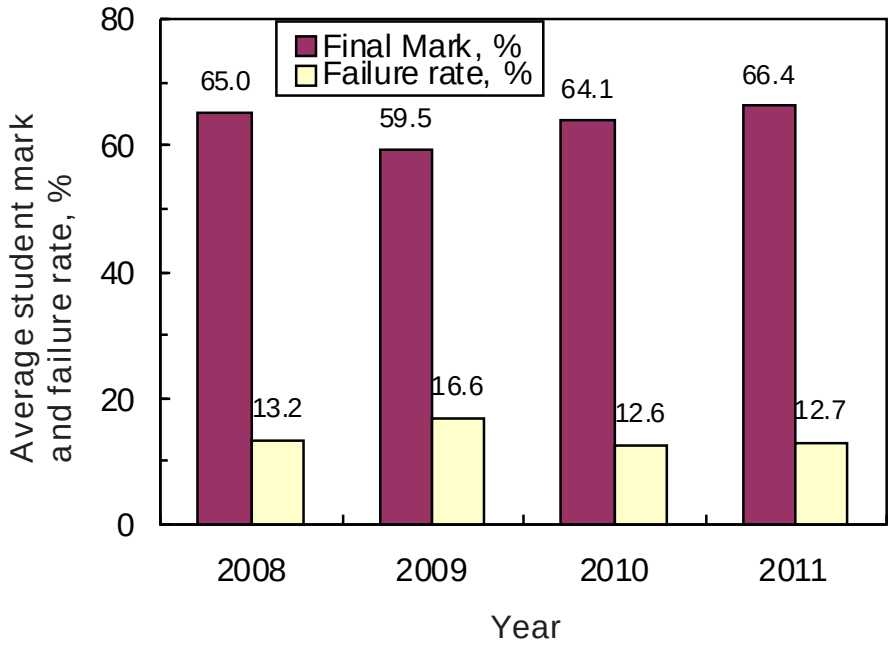

Figure 3: Students' average total mark for the course and failure rate for the past four years

The overall performance of students during the course

Figure 3 shows the variation of average final mark for the course in the past four years. With the exception of 2009, the average mark seems to be in a narrow range from 64% to 66%. However, the failure rate (that is, the number of students who failed the courses versus the total number of students) seems to have slightly decreased in 2010 and 2011. However, this small reduction in the failure rate may not be significant enough to link it to the better performance of students in assignments, primarily because it was not possible to establish a correlation between the students' marks for the assignments and their exam marks.

Limitations

Although this study provides useful insights in the effects of assessment design on the performance of civil engineering students, there are a few questions that still need to be addressed. For example, the comparisons were made between different cohorts of students with different abilities and problem-solving skills. This may affect the obtained results when the data from different years are compared. In addition, compared to the year of 2008, the number of students in the following years increased by 20% to 40%, which may also influence the relationships established in this study. For example, in larger classes, the time the teacher generally spends on one student providing help and support will be significantly reduced, and this may lead to a drop in the overall performance of students.

Conclusions

In this work, the assignment design was changed to cater to the students' feedback, providing students with opportunities to get more involved in the subject throughout the course and encouraging them to develop a "deep" approach to learning. The results of this study indicate that although some improvement was observed in the students' performance for the assignments since the changes were introduced, no effect of the new assignment design on the mid semester and final exam marks was established. No significant changes in the failure rate that can be linked to the changes in the assignment design were also observed.

Although the students' feedback on the changes in assignment design was mostly positive, no statistical evidence supporting the hypothesis that it would lead to better learning outcomes was obtained.

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