
Designing an Ideal Assessment Scheme for Dual Mode Delivery

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Abstract: *Designing assessment schemes for higher level technical undergraduate courses in engineering is a challenge nowadays, especially in a changing educational environment. With more emphasis being placed on flexible learning modes and flexible assessment schemes, examiners are confronted with the review of the existing assessment schemes for the courses they teach. Traditionally, having a combination of assignments and examination has been the most popular method of assessments designed by course examiners. While different assessments give students a variety of opportunities to demonstrate their understanding of a subject, it is important to have a well-formulated assessment scheme to evaluate the students' knowledge. When such courses are delivered for both on-campus and external students, achieving the correct balance between various assessment schemes is important while maintaining the quality of assessments. The University of Southern Queensland (USQ) in Australia is reputed for its external delivery of courses where 80% of the students study through this mode. Considering two courses offered at USQ in dual mode as case-studies, this paper highlights the main issues in reaching the right balance when designing assessment schemes, and discusses potential changes to assessment schemes to enhance student learning, as well as effective course delivery.*

Introduction

Designing an assessment scheme for a course to meet the learning objectives is a challenge when we have to incorporate flexibility in the delivery of courses. At the University of Southern Queensland (USQ), about 80% of the students enrol on external mode while 20% in on-campus mode. While the on-campus students take advantage of traditional face-to-face delivery of the course, the externals mainly rely on the printed study materials and other resources offered to them in online learning management system. In recent years, the University has encouraged staff to adopt a flexible approach in delivering courses to attract and retain a large number of students in engineering. While courses are currently offered in flexible modes to cater for different needs of the students, can the assessment be made flexible enough to measure the student's learning? Before assessment practices can be improved to incorporate flexibility, the current practices need to be evaluated to understand the shortcomings.

It is necessary to critically reflect on existing assessment practices before new and flexible assessment strategies can be effectively implemented. Two courses in the environmental engineering program have been selected to investigate the success of assessments in determining students' understanding of specific course objectives. In recent years, these two courses have been flagged by the faculty as experiencing a higher failure rate compared to the other courses. Therefore, this study aims to address the research questions of how well the on-campus and external students perform in each assignment and exam respectively in these two different courses. What are the main issues for reaching the right balance when designing the assessment schemes? By critically examining these questions, this paper discusses the potential changes to assessment schemes that can be flexible enough to enhance student learning outcomes and maintain effective course delivery while reducing the failure rate.

Methodology

Course selection

The courses selected for the case study are Environmental Technology (ENV4204) and Public Health Engineering (ENV4203). ENV4204 is a course catering for a diverse cohort of students enrolled in different programs and majors. ENV4203, on the other hand, caters for students enrolled in Bachelor of Engineering program majoring in Civil and Environmental Engineering. The two courses selected differ in such a way that the assignment and examination assess mutually exclusive objectives in ENV4204 whereas they assess overlapping objectives in ENV4203.

Background on Environmental Technology

Environmental Technology is a course designed to acquaint students with a wide range of pollution and waste management issues in different media such as air, water and soil, provide them with the knowledge to assess and develop solutions for the management of these issues, create awareness of the modern environmental protection legislation and ethical considerations that form the background to modern engineering activities.

At the Faculty of Engineering and Surveying at USQ, three articulated programs are offered in nine majors including Environmental, Civil and Mechanical Engineering. These programs are the two year Associate Degree (AD), the three year Bachelor of Technology (BETC) and the four year Bachelor of Engineering (BENG). While ENV4204 is a core course offered for BENG students majoring in Environmental Engineering, it is also taken as an elective by students who are enrolled in different programs such as BETC and AD, in different majors in Engineering and also from other faculties such as Science and Arts. The students from majors such as Environmental, Civil, Mechanical and from other faculties make up 26%, 40%, 17% and 17% of the student cohort respectively. The student cohort corresponding to BENG or equivalent, BETC and AD make up a percentage of 45.7, 37.2 and 1.5 respectively, while the rest are from non-engineering faculties. Thus the student cohort is diverse, with wide ranging prior knowledge and experience.

Designing an assessment scheme for a course like Environmental Technology is a challenge in itself as it needs to cater for a diverse cohort of students having different backgrounds and competencies along with different prior knowledge and experience. The assignment is designed to be learner centred and is usually a research based question where the students are assessed in problem solving, information gathering, critical evaluation and analysis of such information depending on the credibility of sources, and effective communication of the findings in report format with appropriate citation. The students are also expected to gather environmental guidelines, laws and ethical considerations related to the problem presented in the assignment. The open-book exam assesses the students' capabilities and skills on the learning outcomes of the modules presented in the study guide.

Background on Public Health Engineering

Public Health Engineering is a course offered at the fourth year level and is designed to introduce to the students the principles and processes of water and wastewater treatment, and to develop skills on the design of the collection, storage, management and disposal of solid refuse. The student cohort is exclusively from the BENG majors of civil and environmental students and thus has an equivalent range of background subjects and thus do not have the great diversity as in ENV4204. The assessment scheme for this course consists of two assignments (totalling 30%) and end-of-the semester restricted exam (70%). The topics for the two assignments are selected from the design of a storm water drainage system for a subdivision, water supply scheme for a small community or a sewer system for a subdivision. These assignments are intended to create an understanding of overall design of such network systems following the guidelines set up by the local councils and assess the students' capabilities in meeting these specific objectives set in the course specification. Once the students complete the assignments independently, they are supposed to have mastered the modules. Unlike ENV4204, in this course, exam and assignment assess overlapping objectives, all within the modules presented in the study guide.

Data collection

The data related to the performance of the students in the exam and assignment for the courses Environmental Technology and Public Health Engineering were collected for the duration of 2004-2009 and 2006-2009 respectively for on-campus and external students. The feedback gathered during the formal course evaluation survey was also used where necessary for making

recommendations and qualifying and validating the quantitative data. It was mandatory until 2007 that the students need to attempt and score more than 50% in each assessment in the scheme to get a pass grade. However, commencing from Semester 1 2008, the University adopted the rule that students must obtain more than 50% of the total weighted marks available for all assessment items to get a pass grade, thus relaxing the previous rule of having to obtain 50% in each assessment. Table 1 gives the details of progressive changes that occurred in the assessment scheme during 2004-2009. The grades HD, A, B, C and F are awarded with cut-off marks being 85%, 75%, 65% and 50% respectively.

Table 1: Progressive changes in the assessment scheme during 2004 – 2009

Courses	Environmental Technology (ENV4204)			Public Health Engineering (ENV4203)		
	2009	2008	2007-prior	2009	2008	2007
Year	2009	2008	2007-prior	2009	2008	2007
Exam duration	2 hours (open)	2 hours (open)	3 hours (open)	2 hours (restricted)	2 hours (restricted)	2 hours (restricted)
Assignment 1	10%	30%	30%	10%	10%	20%
Assignment 2	-	-	-	10%	10%	10%
Exam	90%	70%	70%	80%	80%	70%

Results on case study 1 - ENV4204

The assignment, exam and overall performance of the students in the course of Environmental Technology for a period of 4 years (2004 – 2007) are illustrated in Figure 1 for on-campus and external students. There was no remarkable difference in the performance of both exam and assignment as far as on-campus and external students are concerned.

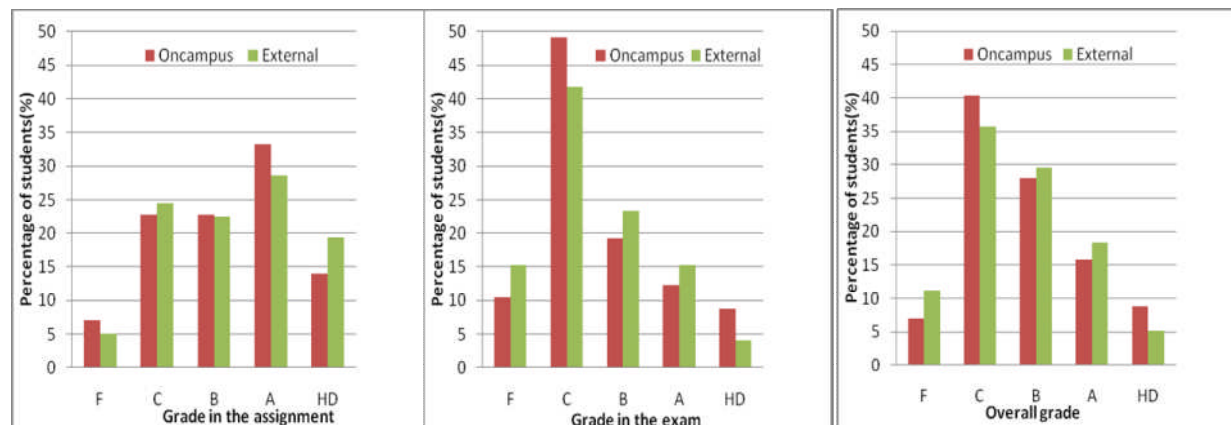


Figure 1: The overall, assignment and exam performance of on-campus and external students

About 48% of both on-campus and external students scored more than 75% (A and HD) for the assignment. However, about 49% and 41% of students get a C for the exam in on-campus and external delivery. The percentage of on-campus and external students who scored more than 75% (A and HD) in the overall assessment fell down to 24.6% and 23.4% respectively when 30% and 70% weightings were applied to both assignment and exam respectively. About 7% and 11% of on-campus and external students failed in the courses during this period.

From Figure 2, it can be seen that those who got HD and A in the exams performed equally well in the assignments. A very small proportion of the students (1.75%) who got B grade in the exam failed in the assignment. About 5% of students who failed in the exam got an A in the assignment. Similarly, among the students who got C in the exam, about 8.7% and 7.7% of the students got HD and A in the assignment. This is contrary to the hypothesis that the students who excel in the assignment would also do the same in the exam.

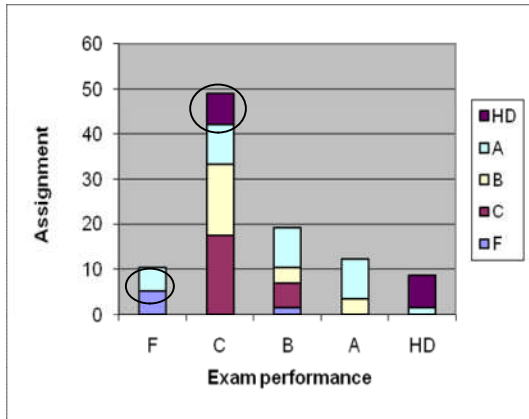


Figure 2: Comparison of Exam and assignment performance

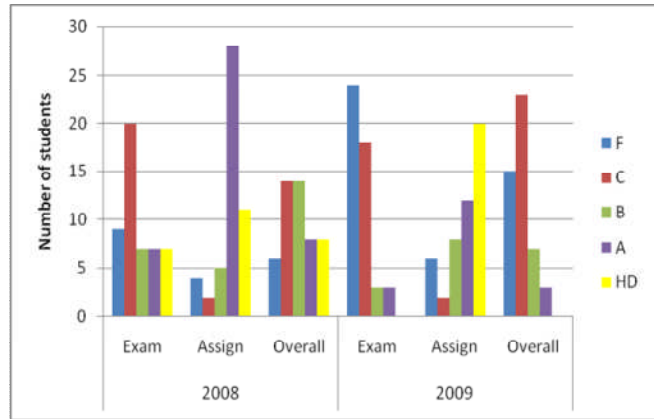


Figure 3: Overall performance during the years 2008 and 2009

The introduction of 2 hour exam duration along with the overall 50% rule in the assessment scheme to achieve a pass grade came into implementation in 2008. Since it was felt that the strategic students tried to maximize their performance in the assignment (which, in this course, a research based question), the weightings for assignment and exam were changed from 30:70 from 2008 to 10:90 in 2009. As shown in Figure 3, number of students who got grades HD, A, B, C and F were 0, 3, 7, 23 and 15 respectively. In this particular year, there was a very high failure rate of the students in the exam that can be attributed to the higher weighting applied to the exam compared to the previous years.

Results on case study 2 - ENV4203

In order to evaluate the student performance in the exam and assignments in a course where objectives assessed overlap, another environmental engineering course ENV4203 has been taken as a case-study. As illustrated in the Figures 4 and 5, about 63% and 87 % of the on-campus students scored more than 75% in both assignments 1 and 2; however, only 31% scored more than 75% in the exam. The performances of the on-campus students in the assignment 1 and 2 shows a linear and steady increase in assignment 1 and an exponential increase in assignment 2. However, their exam performance had a skewed-right distribution (the tail is on the right), showing peak performance in the range of C, even though 14% of the students got HD. When corresponding weightings were applied to the assessment scheme, the percentage of students who got HD, A, B, C and F in overall assessment were 16, 28, 19, 20 and 17% respectively.

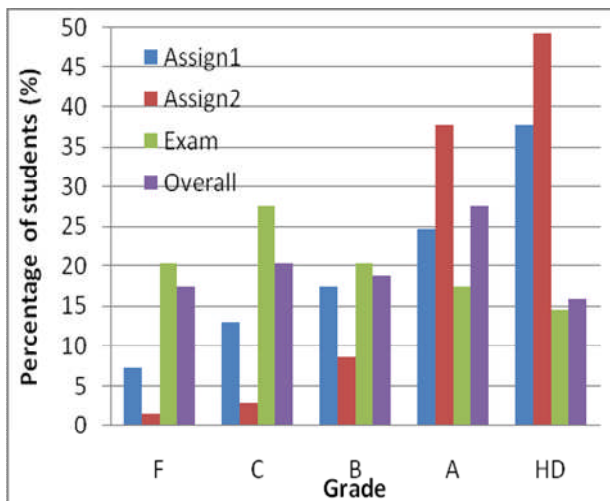


Figure 4: Assessment performance of on-campus students

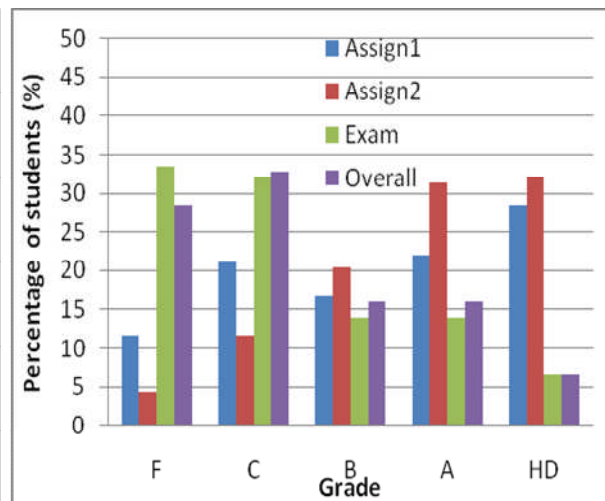


Figure 5: Assessment performance of external students

What about external students? About 50% and 63% of external students scored more than 75% in the assignments but only 21% scored more than 75% in the exam. While the assignment

performance had a skewed-left distribution that had a plateau towards A and HD, exam performance tends to be a skewed-right distribution having a plateau F and C. The observation is the same as the on-campus-mode.

The performance of on-campus students in the assignments and exam had been better than that of external students. The percentage of students failed in the course during this period has been 17% for on-campus students and 28% for externals.

It is hypothesized that the higher performances of on-campus students in the assignments and exam compared to externals could be due to the facts that they take advantage of face-to-face lectures and lecturer input in quantitative aspects of tutorials. On-campus students also have direct means of communication with teacher as well as peers to have input into the preparation of their problem-solving nature of the assignments. On the contrary, external students take control of their own learning with minimal teacher input but making use of comprehensive study guides provided in the absence of any face-to-face lectures. They also tend to use the available on-line resources including discussion forums and quizzes with immediate feedback. Considering the fact that they learn more independently compared to the on-campus students, their performance in the quantitative aspects of assignments is remarkable.

Comparison of the two case-studies

The two courses in these case-studies differ in the assessment scheme, where the students are assessed in mutually exclusive objectives in ENV4204 in the assignment and exam, whereas they are assessed in overlapping objectives in ENV4203 in both assignments and exams. While the assignments are quantitative designs in ENV4203, the same in ENV4204 is a research based question. Regardless of the differences in the nature of the assignments and mode of delivery, it is evident that the students tend to score higher marks in the assignment but not in the exams. There can be a number of reasons that can be attributed to the above:

- The assignments are intended to assess the deeper understanding of the learning objectives of one or two modules covered in the courses; For example, in ENV4203, the students are required to design a sewer network for a subdivision and a design of a water supply scheme. These two designs are covered in two out of 10 modules in ENV4203. This means that the students have to master only these two particular modules and be familiar with the methodology to perform the design. They get better at the assignments and get a deeper understanding of designs that are based on two modules.
- The students perform better when they have plenty of time to work on the assignment. Usually, the assignments as well as the marking schemes with due dates are all made available to them during the commencement of the semester. While there are no statistics available on the actual time spent on the assignment by on-campus and external students respectively, they are expected to spend approximately 20 to 30 hours in the assignment according to the course specification. Total time allocated for each course according to the course specification is 155 hours including 85 hours of self-study.
- The exams are now strictly two hours maximum in duration. During this time, the overall objectives of the course encompassing most of the modules may be assessed. Since all the objectives cannot be assessed in two hour exam duration, the students need to have a guess on where the exam questions may be set. Many students may not perform as expected under pressure in an exam environment. This may be one of the reasons why their exam performance has been generally lower than that in the assignment
- Regardless of the mode of delivery, the students also have the means to collaborate in doing the assignment by means of getting peer assistance and instructor feedback. While on-campus students can achieve the collaboration by face-to-face communication, external students can go through discussion threads in the online learning management system.
- While there was little difference in the performance of research based assignment in ENV4204 as far as dual mode delivery is concerned, the performance of on-campus students is better than the externals in design based assignments in ENV4203. While this could be attributed to the ability of on-campus students to collaborate, the students need better training in handling quantitative type of questions generally in both modes. The students are better in addressing research type questions, where they collect information, critically analyse and write in report format, whereas

they tend to possess lower mathematical or analytical skills needed to tackle design questions on environmental problems.

- Students have diverse backgrounds and competencies that affect their learning abilities and aspirations of this course. The influence of their prior learning and experience, their entry grade and preferred learning styles on the performance needs to be further investigated.

Discussions

Main issues in reaching the right balance in designing assessment schemes

Dual mode delivery

While 20% of USQ students are enrolled in on-campus mode and about 80% of the students are distance students. Figure 6 indicates the general age distribution of the enrolled students in USQ courses. The majority of USQ students are mature aged and have returned to formalise work experience or to facilitate a major career change (Brodie 2009). In on-campus mode, the teachers mainly follow a didactic mode of teaching where they transmit the expert knowledge they have to the students via traditional lectures. On the contrary, external students must be sufficiently motivated to work through printed study materials; supported by interaction with the academic on the learning management system should they have specific questions. They need to be more independent learners. With all courses offered by distance education, many of our students are already working in the engineering disciplines (Brodie & Porter 2008). Compared to on-campus students, the external students are on average, older and they study in the distance mode because they are mostly already employed in some capacity in industry (Gibbins & Brodie 2008).

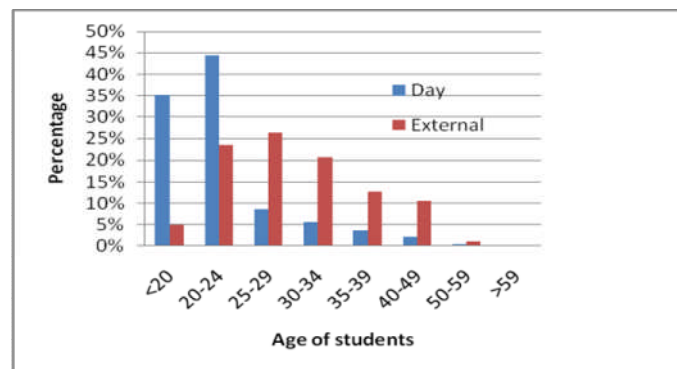


Figure 6: Age of students enrolled in USQ courses

Since most of the USQ students are adult learners, the examiners need to understand the learning principles and styles of the adults to facilitate student learning for successful outcome. According to Knowles et al. (1998) adults are internally motivated, self-directed and goal-oriented who bring life experiences and knowledge to learning experiences. They resist learning when they feel others are imposing information, ideas or actions on them, but will engage in learning if they have to use the skills in problem solving in their courses (Fidishun 2000). The design of assessment therefore needs a fresh outlook to ensure the needs of the students and their desire for problem solving, while maintaining the assessment of key learning objectives. Therefore, the open-ended assignment designed for ENV4204 course which requires the students to research a topical environmental issue along with the detailed real-life design problems given as assignments in ENV4203 are entirely appropriate to cater for the problem-solving needs of the adults.

While the students are interested in solving real world engineering problems, they are supposed to retain short-term memory (Cercone 2008). Therefore, many are not good enough in handling exams which tend to assess a wide range of learning objectives within limited time. The design of assessment therefore has to be flexible enough to ensure the needs of the adults, to satisfy their shortcomings and to encourage their desire for problem solving motives that are related to the concepts presented in the courses. While it is not possible to design different assessment schemes for on-campus and external students following the same course, the difference in their learning and study approaches needs to be taken into account in achieving a right balance in designing the assessment scheme.

Diversity

The majority of the students, being enrolled in external mode brings a pool of prior knowledge, skills and experience as well as cultural and age differences (Brodie and Porter 2008). In ENV4204, we need to cater for a diverse cohort of students from different majors and programs coming from different backgrounds and competencies. The design of the assessment therefore needs to satisfy the learning needs of a diverse student cohort in a variety of majors and programs. The assessment needs to accurately evaluate student learning in line with the course objectives and in a way that engages students in their learning rather than learning for assessment. The aspirations of an Associate Degree student need to be satisfied while the desired learning outcomes required by the fourth year Environmental Engineering students are not compromised.

Approaches to learning and assessment

It is believed that most of the students in these courses follow a strategic approach to assessment seeking to maximise their marks whilst minimising their workload. Therefore, the design of assessment has to be in such a way as to encourage deep learning of the subject matter, which rewards students for understanding the key concepts. In both courses, the students displayed higher grades in the assignments and therefore possibly deeper understanding, because the assignments cover one or two topics in depth where students have plenty of time to address the problems. The assignments are normally released at the commencement of the semester and the submission date is set at least two months after the release. However, in an exam situation they have to demonstrate their understanding of the key concepts presented on a wide range of topics within a limited time normally two hours.

There is a great debate if exams are the best way of assessing the students. As cited in Greenberg et al. (2009), pressure to perform on exams often results in cheating, in students “playing games” in order to succeed, and in an overall lack of depth of understanding. Furthermore, the emphasis on grades in a performance-centered environment often has emotional consequences on students’ overall sense of self, their health, and their motivation (Weimer 2002). As cited in Felder and Brent (2009), engineering exams tend to have problems that have lots of time-consuming mathematical analysis or problems that have unfamiliar twists that may take a long time to figure out, which resulted in students dropping the engineering curriculum. In the same paper, it was cited that studies that have attempted to correlate grades of graduates with subsequent career success have found the correlations to be negligible. Therefore, the weightings for the exams and the exam questions need to be carefully considered to assess the mastery of students’ knowledge while not giving complex problem-solving.

Potential changes in assessment scheme to enhance student learning

The current assessment scheme in our courses needs change to promote deep learning and achieve the desired learning outcomes while accommodating the learning needs of the students. The assessment scheme also needs to satisfy the discipline specific graduate attributes as accredited by Engineers Australia. Considering the above, the potential changes to the assessment scheme for the two courses will be discussed as follows:

In Environmental Technology (ENV4204), two assignments will now be introduced. Assignment 1 will be quantitative which is relevant to the modules where the students will be given a real-life scenario of water or air pollution aspect, and required to come up with a pollution mitigation design. The second assignment will be qualitative where the students will be asked to research a topical environmental problem and critically review the information. In the report submission, they are expected to show an understanding of the linkage between technical, social and political aspects of this environmental issue. These assignments cater for the diverse students who are enrolled in the subject and will be flexible in recognizing their competencies and backgrounds. In addition, since the assignments will be designed as authentic real-life problems, it is believed that students will find them interesting, relevant and meaningful.

In Public Health Engineering (ENV4203), the two current assignments are designed to satisfy the environmental engineering specific attributes such as design of a water supply scheme or sewer design for a subdivision, and therefore need little alteration. However, the exam questions will be designed to examine their mastery of knowledge with inclusion of short answer questions on key-concepts rather than their ability to solve complex problems within the limited exam duration. This might reduce the current failure rate this course experiences.

In both courses, in order to facilitate the learning of the key-concepts presented in the modules, on-line quizzes have been developed from a question bank and released periodically, for the students to enhance and test their understanding. The quizzes are currently formative. Instead of letting the students try the multiple choice questions developed by the teachers, it is possible to let the students prepare the quizzes and that will have added benefits of student engagement and enhance deep-understanding of key concepts.

As Denny et al., (2008) describe that

the activity of writing a question requires a student to think carefully about a topic in the course and how it relates to the desired learning outcomes. Creating distractors requires a student to consider possible misconceptions. The act of writing an explanation requires students to express their understanding of a concept in their own words, deepening their own knowledge and enhancing their written communication skills; evaluating existing questions incorporates higher-order cognitive skills, requiring a student to consider not only the content, but what makes a particular question more effective than other questions.

They also reported some quantitative results that suggest students who participate in quiz preparation actively perform better in final examinations than students who are not active as the activity of writing questions contributes to deep learning. Therefore, the *PeerWise*, a software developed by Denny et al. (2008) in which students can develop quizzes and allow their peers to try the questions will be experimented with to find out how it promotes learning.

In both courses, in order to induce critical thinking, the author stimulates discussions by asking thought-provoking questions in the on-line learning management system. But it was found that a few students participate in the discussion forum while others tend to remain as observers. In order to motivate all the students contribute equally to the discussion forum, the feature of question and answer type discussion forum available in the Moodle online management system will be explored. In this type of forum, discussions by others will be accessible only when a student contributes to the particular forum.

In addition, there will be an incentive given in the form of 15% of marks for those students who participate in the quiz formation and respond in the discussion forum. The flexibility will be introduced so that the students can choose to participate either in the discussion forum or in quiz development or in both. These measures in the assessment scheme will undoubtedly increase student engagement and involvement in learning the key-concepts. They will encourage a strategic learner to move into a deeper approach of learning and put the students in control of their learning. Assessable online discussion groups have been introduced by Devine (2009) to civil engineering students undertaking a construction engineering course in external mode. By encouraging students to engage in discussions with peers and academics they can “*enrich and expand students’ educational experience beyond the classroom and for distance education students they can provide both the social and educational conversations which can be missing in traditional distance education settings*” (Devine, 2009). Students are able to reflect on course material in their own time, provide commentary and ask questions, which can lead to greater learning and skill development (Weisskirch et al. 2003). The various weightings proposed for the assessment scheme are listed in Table 2. The weightings of each assessment were also carefully designed so as to encourage progressive learning with the weighting for exam reduced that minimizes their stress of having to perform in the exams.

Table 2: Proposed weightings for the assessment scheme

	ENV4203		ENV4204	
	Current	Proposed	Current	Proposed
Assignment 1	10%	10%	30%	10%
Assignment 2	20%	10%		10%
Assignment3 (Quizzes / discussions)	-	15%	-	15%
Exam	70% (restricted)	65%(restricted)	70% (open)	65%(open)

Conclusions

In a changing educational environment, with a growing emphasis on flexible learning modes using on-line resources, the traditional assessment schemes that are used to evaluate the student knowledge also need to be critically reviewed. Current assessment consists of assignments and an exam for both courses. It was found out that students perform better in assignments than in exams regardless of the assignments being research based or quantitative in nature. Due to the heavy weightings assigned for the exams, their overall grade tends to peak at around 65% and leading to higher than normal failure rate. In order to improve the current practices, a new assessment scheme is now proposed that encourages the strategic and surface learners to move to deep learning of the course objectives to achieve the desired outcomes. While still maintaining the assignment and exam structure, new concepts of quizzes and discussion forums will be included with the incentive of a 15% award in their final marks to encourage progressive learning with consequently less weighting on exams. These potential changes in the assessment scheme hopefully engage the students and motivate them to be self-directed and independent learners meeting the course objectives, while reducing the failure rate.

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