Building Blocks for Flexible and Engaging Learning Environments

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***Abstract**: State of the art engineering courses have to address rapidly changing content and nurture the development of graduate attributes. At the same time, students are increasingly time deprived as they have multiple competing commitments. This paper reports on an effort to provide students with multiple learning activities that address frequent changes in teaching materials, but also promote transferable skills and graduate attributes. The main focus of this study is a third year introductory course into computer systems and communication protocols. Building blocks of this innovation have been used in other courses as well. Courses operate in an environment where about 60% of students are located off-campus, many are of mature age. This makes any attempt to change the course challenging, as equity between on-campus and external students has to be preserved. Current building blocks include electronic marking rubrics, flexible assessment deadlines, peer assessment and remote access laboratories. Key goals of these innovations are to foster student engagement, offer opportunities to improve graduate attributes and expose students to a greater coverage of subject content. The aim of this study is to find a balance between lectures, activities, peer engagement and remote laboratory exercises.*

Introduction

Many engineering disciplines have to adapt to constant and rapid changes in science and technology; as well as to changes to how students learn and obtain information. In this dynamic environment, generic competencies become ever more important. This trend is enforced by professional bodies such as ABET, Inc (2007), Engineers Australia (2004) and IEEE (2002) who are pushing for the inclusion of generic competencies. Also referred to as soft skills or transferable skills, these include written communication, presentation, critical evaluation and lifelong learning skills. This is also reflected in the focus of universities world-wide on graduate attributes that address both technical as well as soft skills. The University of Southern Queensland has a large and diverse external student cohort; about 74% of students study in distance mode and are not located on campus. External students have limited opportunities to engage with lecturers and other students; and the absence of contact time makes it difficult to teach and assess generic attributes, whilst catering to individual student learning. At the same time, the student cohort is becoming more diverse. On one hand of the spectrum are the digital natives that do not know a world without an ever present Internet; on the other hand are mature age students with a wealth of professional and life experience. Interestingly, technology-use for learning does not necessarily align with this classification (Kennedy et al. 2007). This diverse environment makes it difficult to provide an appropriate mix of learning opportunities. At the same time, there is also great potential for students to share their diverse expertise and experiences. Mature age students, for example, are actively practising lifelong learning by undertaking their studies.

In a post Bradley era (Bradley, Noonan, Nugent, & Scales 2008), many Universities will have to further diversify to support the government goal of a higher percentage of bachelor-level graduates. Likely growth areas include currently underrepresented groups such as low soci-economic and remote students. Diversity in the student cohort will become more common. Current and evolving

technologies will make the distance education marked more accessible. The Australian Broadband Network, for example, will provide high speed Internet access to most Australian households within the next 8 years, enabling a wealth of new services. The changing nature of the student body and new delivery methods requires diverse leaning and teaching initiatives to cater the different groups. The approach suggested in this paper focuses on building blocks of learning activities to offer students diverse learning opportunities. The effort to diversify learning opportunities will be beneficial to all students as variation theory suggest (e.g. Pang 2003). This also reflects the likely variations in professional practice students will encounter throughout their professional life.

Context and Motivation

The focus of this initiative is a third year introductory course into computer systems and communication protocols. The course is offered to undergraduates in their final years and postgraduate master by coursework students. The goal of the course is to provide a basic introduction into computer systems and the Internet. Enrolments are 60-80 students with 60% located off-campus. The learning content is divided into six modules. Assessment is divided into 6 quizzes worth 2 % each of the final mark, a main project worth 28% and an exam worth 60%. The main project consists of report (10%), presentation (10%) and peer assessment (8%) of 20 peer submissions. The key changes in the subject structure were introduced in early 2009 and have been trialled in Semester 1 2009. Initial results were reported by Kist (2009). This initial study mainly evaluated student impressions and perceptions of the changes. Individual building blocks have also been used in another course in Semester 2 2009. The overall structure has been used in S1 2010 again. The latest offer includes practical activities using remote laboratories.

A number of reasons motivated the introduction of these building blocks. There is an increasing push towards generic skills and graduate attributes as discussed above. It is important to teach students relevant learning skills and not only content. For many students the Internet is becoming the main information source. Therefore it is important for students to develop critical thinking skills to assess this information and to be able to review their own work and that of their peers. . The content in computer system and communication networking is constantly changing and including alternative learning opportunities can assist with the currency of the teaching material and foster independent inquiry.

Another important motivation is to provide students with greater flexibility than traditional assignments. This is particularly relevant to mature age students and students with other commitments. Students have developed a culture of taking the path of lowest resistance and part of the efforts in this course is to encourage students to work outside their comfort zone and try new things. Last, but not least, the engagement of external students with the course and subject material is an important driver for the changes in this course. The overall aim is to foster student engagement, provide tools for lifelong learning and naturally teach the relevant technical content.

The building blocks centre on a number of educational concepts, such as assessment rubrics, peer and self assessment and remote access labs. Rubrics are systematic scoring methods that use pre-determined criteria to measure student learning for grading assessment. This leads to a more objective and consistent assessment of student work (Brodie & Gibbings 2009). They also help to clarify grading criteria, demystify the marking process and encourage student self-judgement. Tierney & Simon (2004) offered some suggestions, examples, guidelines and principles of how to design effective rubrics. The benefits of self and peer assessment have been widely acknowledged in the literature (Brown et al. 1994, Bostock 2000). Potential benefits include improved motivation and ownership, critiquing and evaluation skills.

If graduates are expected to develop as lifelong learners, then they must also become adept at objectively assessing their own learning (Williams, 2008). Rather than disempowering learners with strict summative assessments, greater emphasis should be placed on technology-supported tools and techniques to assess context based learning (Brodie & Gibbings 2009). Cassidy (2006) suggests the peer assessment also improved ‘soft skills’ which are increasingly important graduate attributes.

Bostock (2000) proposes that student assessment of other students' work has potential learning benefits to both students by encouraging student autonomy and higher order thinking skills.

Technology to enable remote labs has been discussed in the research community for more than a decade (e.g. Aktan, Bohus, Crowl, & Shor, 1996). Primary considerations in designing laboratory activities are the learning objectives that they aim to achieve. ABET, inc. has formulated a list of thirteen potential learning outcomes gained from laboratories in engineering education (Feisal & Peterson, 2002). The effectiveness of remote labs depends on the extent to which they help students to attain course and program objectives (Arango, Chang, Esche, & Chassapis, 2007).

Building Blocks

The course employs a number of components to assist student learning and the learning activities can be broadly divided in content building and skill developing tools. StudyDesk, a branded Moodle installation is used as the Learning Management System (LMS). It is the main means to communicate with students. All course material is hosted online. Assignments are also submitted and marked electronically. The course has a study book, a comprehensive resource that presents most of the study content. Due to the rapid changes in technology and the time lines for printing and updating study material, it is difficult to keep the printed material up to date.

Traditionally, lectures are the key vehicle to interact with students. To achieve parity with external students, lecture material is available online and all lectures are recorded using a combination of Camtasia Relay. This includes audio, video and white board annotations. Whiteboard annotations are captured with an eBeam device. Each of six study module in the course include a set of activities that consist of important readings, but also formative assessment tasks.

Online quizzes are used as means to keep students on track with their learning journey and provide instant feedback. The main assignment requires the students to research an individual topic that extends the course content. Topics are selected at the beginning of the semester and presentations are scheduled to coincide with study module content throughout the semester. Individual deadlines for the main assignment allow students to select a timeslot thought the semester that is most appropriate for their study and work schedule. Students disseminate the results of their research in presentations to the class along with a written report. Both, presentations and reports are assessed by peers.

20 topics are randomly assigned to students for peer assessment. To do the assessment online marking rubrics are used. All presentations are recorded so they can be viewed and assessed by all students, on-campus as well as external. At the end of the semester detailed results and comments are moderated and made available to students.

In an effort to include practical tasks, this course includes three activities that focus on Linux and shell scripting. USQ has developed a mechanism to provide access to software and hardware experiments for on-campus and external students. This enables instant access to Linux and also allows interaction with networked hardware relays.

Evaluations

This section discusses two aspects that have been evaluated in this course: exam results over the last four years and student interviews.

Exam Results

After the first offering of these changes in 2009, anecdotal evidence suggested that the new assignment structure was of greater benefit to external compared to the on campus students. This trend has continued in 2010. The final grades for the on-campus as well as the external cohort for the last four offerings are depicted in Figure 1. The absolute results fluctuate from year to year and it is hard to draw any meaningful conclusions. However, the relative difference between the on-campus and external cohort are different. In 2007 and 2008 there has been no significant difference between the on-campus and external cohorts. However, in 2009 and 2010 when the new structure was introduced, the rates of HDs and As in the external student body is much higher.

There were no changes to the exam format or to the content that was examined. Mark distribution between assignments and exams also remained the same. Both offerings featured the changed assignment structure and the additional learning opportunities. As the assignments cover only 40% of the course marks, it suggests that the activities help external students to engage with the subject and improve learning outcomes. External as well as on-campus students had access to the same resources. The reason and the nature of the difference between the two modes will be a key focus of future research.

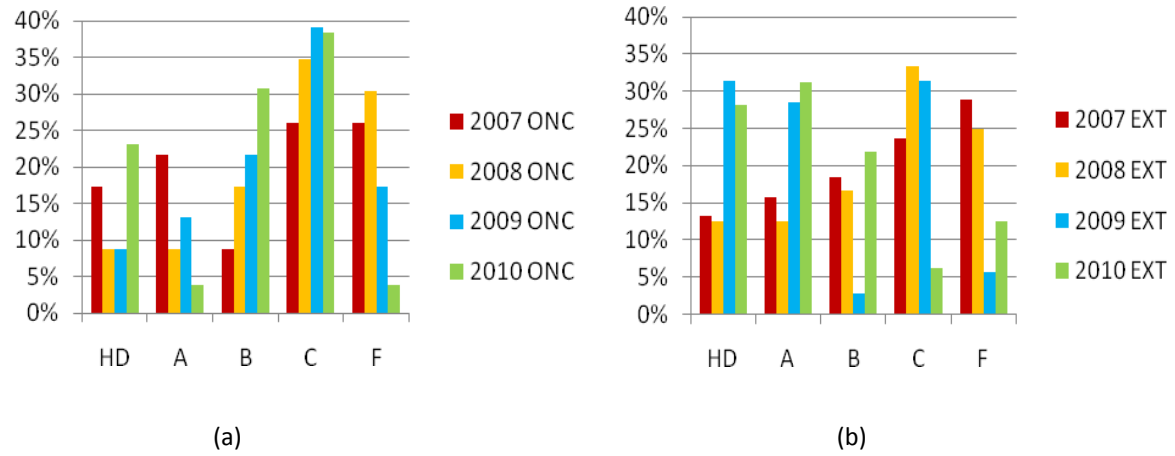

Figure 1: Grade Distribution – (a) On-campus and (b) External Students

Student Interviews

This section discusses some preliminary results from interviews that where conducted with students who took part in the course ELE3305 in Semester 1 2010. An external interviewer spent 30 minutes with each of five self-nominated students discussing their responses to the course over the telephone. Some of the preliminary findings from the interviews about the building blocks are summarised below. Responses to *recorded lectures* were very positive. Students appreciated the "human contact" and the occasions when the lecturer modelled how to think about the content. Through the semester students have provided similar feedback via emails and telephone calls.

The *study book* in this course, traditionally the main learning tool for distance students, was not meant to be very significant in this course. This was appreciated by students, however, one commented that he is used to relying on the study book in other courses so he needed more notification that this course would be different in this regard. Interestingly, he was a remote student who found it easier to have the book by him to do some work in quiet moments during his day, rather than having to get online. All the other interviewees were happy with online provision of information.

The *study desk* is the main interface with the course and provides a number of interactive tools such as online forums, however these have not been a significant component of the course for students with no or little online discussion. The *remote access laboratory* component was not directly integrated in to the course and this is reflected in the student responses. Three of the five interviewees did not do the RAL component either because they couldn't get into the system or because they couldn't be bothered. Those who did do it commented that they needed more clarity in the instructions for what they were supposed to do.

All of the students commented that they learned a lot out of doing the report since it introduced them to IEEE standards, but they were less enthusiastic about the peer assessment component. One student who does a lot of assessment of reports in his daily job at a mine thought that the peer assessment was an important learning opportunity for such professional tasks. One student was very much against the use of this kind of peer assessment because he felt that he was not sufficiently sure that other students

were giving good information. The other three students were lukewarm with minor criticisms such as that it was very boring for them.

One student did not do the *online quizzes* but three of the remaining four thought they were good in that they split up the marks over smaller tasks and over time. The final student said he did not like them because he does not do well in exam situations but he got a HD for the course so he was not going to complain. The *exam* was felt to be fair overall but there were two areas where students had concerns. One was in including a question about the remote labs (this was from the student who hadn't done them) and the other was from several students about the requirement to remember two of the reports written by other students that they had read. One student who didn't trust his peers' work thought that this was not a good basis for an exam question and the others just wanted to have some advance warning that this was going to be required. Overall, students agreed that this was a fair and productive course, well organised and giving them good learning opportunities. The workload was considered to be appropriate.

Observations

Each quiz is only worth 2% of the final mark. Most students used this opportunity to test their knowledge and collect some marks. However, there is evidence that a number of students "mistook" these as group assignments. Access-logs indicate that up to six students were doing the quiz on the same computer within the same timeframe only minutes apart. Results improved with every submission. This indicates collaboration; unfortunately these were also the students that barely passed the exam. There is the potential to leverage this as a peer learning opportunity and make these tasks collaborative. However, this raises the issues of equity for external students.

Recent changes include incorporating practical activities with the use of RAL. The main purpose of these activities is to exposed students to the Linux operating system. It was made clear to the students that these activities are relevant and that there would be an exam question related to this activity. However, it appears that very few students undertook the activity. The aim for future offerings is to more actively promote RAL activities through the semester to ensure that students make use of this opportunity. The focus will also be on how practical activities can be included in the course material to actively engage students.

There was one student that repeatedly voiced his misgivings and his opinion with the peer assessment component. The student even included a statement, "Students should not assess other students" as part of his peer assessment. A discussion revealed that the student did not have a problem with the peer assessment as such, but was concerned that what he was doing had an effect on the outcome of other students' results. This is despite the fact that the effect of individual students peer assessment was minimal or made no difference at all. The key issue with the activity is that it challenges student's ideas about learning and attitudes that suggest: "I paid me fee, so please teach me". Even so the assignment specification featured section that explained the motivation of the assignment and outlined the key aim to develop professional judgement and feedback skills, the student responses indicate that they were not aware of the purpose. This leads to the question if there are better ways to motivate the activities and justify the tasks to students.

Since the assignment deadlines for the main assignment are individual and flexible, the notional deadline for reports and presentations was a specific week in the semester. These were not enforced, but students were sent frequent reminders. Some students simply ignored the deadlines and some peers where unhappy about this and simply marked the assignments down even though the marking rubrics do not include any category for late submissions. The course structure requires student to participate in the activities as subsequent tasks rely on the effort of others. The leads to the question if there are any opportunities how the student participation could be ensured?

As discussed above, the results of the external cohort are much better than on-campus results. This indicates that external students get more of the additional teaching materials. Informal inquiries suggest that on-campus do not used the resources as much, if at all. On-campus students are mainly relying on traditional face-to-face lectures. At this stage these results can only be indicative of a trend and more research is required to sustain this outcomes.

The quality of student submissions varied greatly. Generally, good to excellent students excelled doing the assignment, poor students struggled. Even though this is a third or fourth year subject, students generally struggled with open ended, unstructured nature of the tasks. Instead of reading the making rubrics, for example, students asked the lecturer how much they have to do to pass this assignment. This observation generally applies in a much broader context as well.

During the peer assessment process, many students did not take the marking rubrics literally; even so some of the descriptors were very specific. This was obvious for objective questions in the marking rubric, e.g. presentation timing. There is also the issue that not every criterion carries the same meaning for everyone. However, since the final results are calculated as an average, these issues are not reflected in the final assessment marks, in fact, most assessments were right on the mark.

Conclusions

The overall offer seems to encourage wider participation and students are generally happy with the learning opportunities offered by this course. Interestingly, students have different opinions on which building block offered the most learning benefits. Results have been encouraging and it seems that this innovation benefits good and excellent students. Average students, particular from environments that do not encourage independent inquisition of content seem to struggle. Overall this work raises more questions than it can answer. Each of the observations could be used to generate new research questions. It seems to be clear that the changes foster student engagement, but more research is required to provide better explanations of which learning opportunities are effectively used by students. There are a number of methodical issues that will have to be addressed, for example, the feedback for the presentations and reports is not timely as it is only available at the end of the semester. Lastly, as with most teaching innovations the question to which extent the results are due to the structure and how much is due to the lecturer remains open. This will be addressed when this approach is used in other course as well.

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