Full Paper

Introduction

The competing and often conflicting time demand on today's university students have necessitated the development and implementation of flexible learning strategies (Bower et al. 2015). This has resulted in some institutions resorting to complete removal of face-to-face teaching, in favour of curriculums that are 100% online. While such learning and teaching design may be suitable for some specific courses or purposes, this approach is generally not suitable for undergraduate engineering courses due to the need for the graduates of these courses to demonstrate acquisition of pre-defined skill sets (Rashid 2013). An alternative is to replace traditional approaches with a considered blend of face-to-face and technology supported methods. Termed as blended learning (BL), the method uses face-to-face interaction assisted by self directed study, work placements, projects, and structured online activities using an appropriate learning management system (LMS). Francis and Shannon (2013) argue that BL is 'a best-practice instructional' model with the caution that this model has a potential to disadvantage less engaged students.

As a part of its BL strategy, the Western Sydney University (UWS) distributed 11,000 iPads to all incoming students and staff in 2013. The iPad initiative was one of the many curriculum renewal strategies to incorporate more flexible study options by engaging students in new ways of learning and interacting within and outside the classroom through use of new technology. The challenge then was to prepare academic staff to generate learning materials that can take full advantage of this emerging technology. A team of Blended Learning Advisors, Designers and E-learning (BLADE) specialists were appointed and embedded within each faculty to address this issue. Two BL advisors and three BL designers were placed within the School of Computing, Engineering and Mathematics (SCEM) in 2013.

Study aim

Water engineering is one of the core areas covered in Civil and Environmental engineering curricula across all engineering institutions around the globe. At UWS, water related concepts are delivered as a series of three core units (subjects) – fluid mechanics, hydraulics and hydrology. Fluid mechanics and hydraulics are taught during the second year whereas hydrology is taught during the third year of the civil engineering program. Multiple additional fluids related elective units are available that enable students to gain specialisation in their chosen area.

Students generally find water engineering related concepts difficult to grasp. This problem gets compounded when the educators themselves find that fluids related subjects are particularly challenging to teach (Cheng et al. 2002; Lu et al. 2012). Therefore, any strategy that will help change this perception is a welcome development.

This paper details one such strategy, designed and implemented, in hydraulics at UWS. The principal aim was to enhance teaching and learning practices that help improve students' understanding of fundamental water engineering principles. The purpose was to prepare students to successfully undertake the follow-up water related subjects (i.e. hydrology and water related electives). The ultimate goal was to ensure that intended learning outcomes were achieved fulfilling the Engineers Australia (EA) stage 1 competency standards.

Methodology

Benefits of BL strategies in student learning have been well established (Gecer 2013; Sucaromana 2013). However, effectiveness of these strategies depends on design pedagogy (McGee 2014) in addition to features, usability and interoperability of supporting LMS (Schober & Keller 2012). In addition, there is a need for the academic staff to recognise and embrace the changes BL brings. This requires a change in culture among the academic staff, including the need for professional development. In this venture, all can learn from the University of New South Wales (UNSW), who successfully implemented a series of complementary academic development activities to help its staff embrace the University's adoption of BL environment (Mirriahi et al. 2015). UWS took a somewhat different approach and brought in a pool of experienced professionals (curriculum designers and BLADE team members) to work with academics. The idea was to accelerate BL implementation to closely align with the iPad initiative. The BLADE team members have since then conducted a series of tailored professional development activities for academic staff. This researcher benefited from these professional development sessions and used the lessons learnt in these sessions to develop and implement BL resources in hydraulics.

BL materials for hydraulics were designed, developed and implemented following the instructional resources and environments method of Park (2015). The instructional resources were posted at weekly intervals. This was done via vUWS, the LMS used at UWS. Additional on-line practice questions were constructed and these were also released at weekly intervals; each week students were required to complete an on-line assessment task (practice quiz). These practice quizzes were developed and administered with two principal purposes, (a) as formative assessment tool and (b) to keep students engaged throughout the semester. All assessment tasks (both formative and summative assessment tasks) were designed and implemented to test achievement of unit learning outcomes. The unit learning outcomes themselves, in turn, were mapped against the course learning outcomes and EA Stage 1 competencies for Professional Engineers.

The LMS was also used to track and record user activities. These user activities were extracted, in the form of reports (using various evaluation tools), at regular intervals. These reports were merged with student results (at the end of the semester) and the data de-identified before any analyses were performed. The results from the LMS were used to draw inferences on student engagement in the subject. At the other end of the spectrum, student results were used as an indicator of student performance; which itself was linked to student understanding of the subject material (hence the unit learning outcomes).

Student responses, conducted at the end of the semester, were used to gauge student perception on the effectiveness of blended learning activities used in the delivery and assessment of the subject material.

Results and Discussions

LMS usage

A total of 139 students were enrolled in hydraulics during the semester. Of these, less than 10% were female students (Figure 1), which is typical for a second year civil engineering subject at this institution. All lectures and tutorials were held on Fridays. In addition, two laboratory demonstration sessions were held during weeks 7 and 14 of the semester. While there were weekly on-line quizzes (used as formative assessments), two in-class quizzes (of 30-minute durations, each) were held during weeks 5 and 13. The mid-term exam (in class) was held during week 8 of the semester. The final exam was held during week 17.

The daily vUWS usage is shown in Figure 2. Over half of the usage occurred over two days

– on Thursdays and Fridays. This is attributed to the scheduling of lectures and tutorials. All lectures and tutorials were scheduled for Fridays – students tend to do the required tasks on 'just-in-time' basis. This may explain why there was heavy usage of the LMS on these two days. The usage increased steadily from Saturdays to Wednesdays.

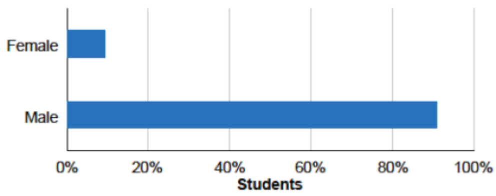


Figure 1: Gender mix proportion

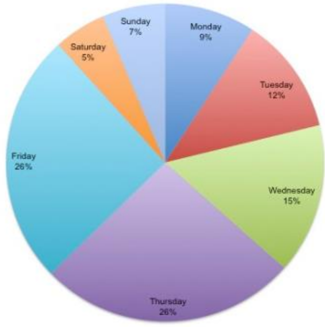


Figure 2: LMS daily usage (as a of total usage)

The weekly LMS usage pattern is shown in Figure 3. There are clear increases in LMS usage during the weeks when assessments were scheduled. The spike in LMS usage by all students during weeks 5 (326 hours) and 13 (317 hours) coincided with the two quizzes scheduled for these weeks. The LMS usage went up to 829 hours during week 8, the week the mid-semester exam was held. During the last two weeks before the final examination, the LMS usage spiked to a total of 1029 hours.

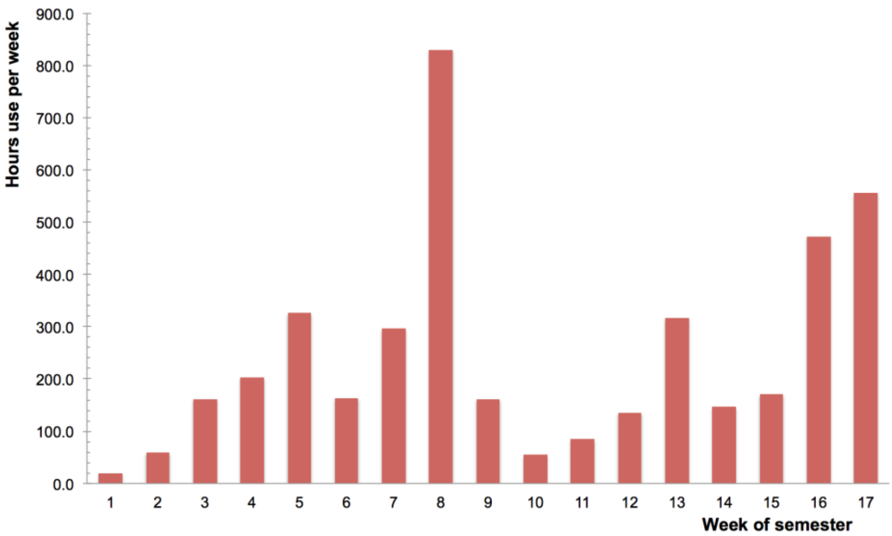


Figure 3: LMS usage (weekly pattern)

Statistics on LMS usage by students enrolled in the subject during the semester are listed in Table 1. The usage varied from 1.1-hr to 144.8-hr during the semester, with the average of 28.9-hr and the median of 23.9-hr. The distribution of LMS usage is shown in Figure 4.

Table 1: Total LMS usage during the semester (hours)

Statistics	Mean	Std. Dev.	Minimum	Maximum	Q_1	Median	Q_3
Usage (hours)	28.9	23.5	1.1	144.8	15.0	23.9	34.2

Student performance

The distribution of grades obtained by the student cohort, in the subject, is shown in Figure 5. This grade distribution was marginally better than the grades received by the student cohort enrolled in the subject in the preceding year – this distribution shows slight improvement among the students receiving the Pass and the Credit grades

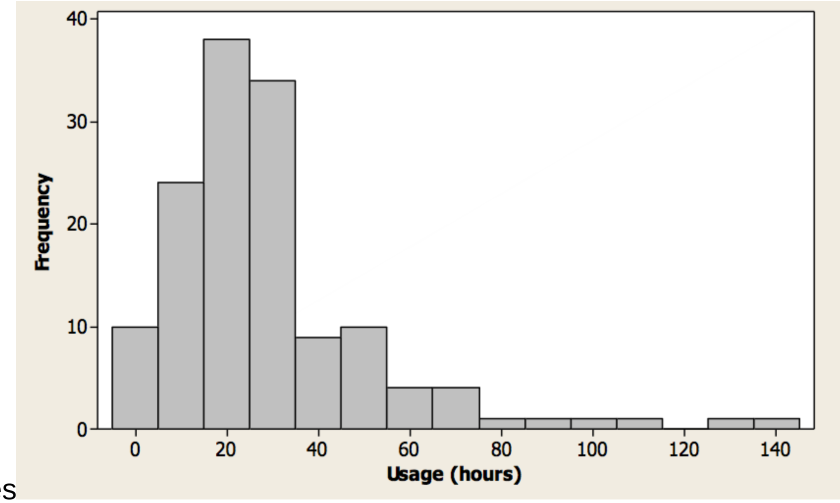
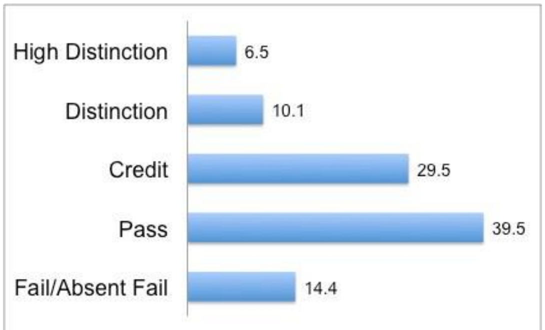


Figure 4: LMS usage distribution (by students)



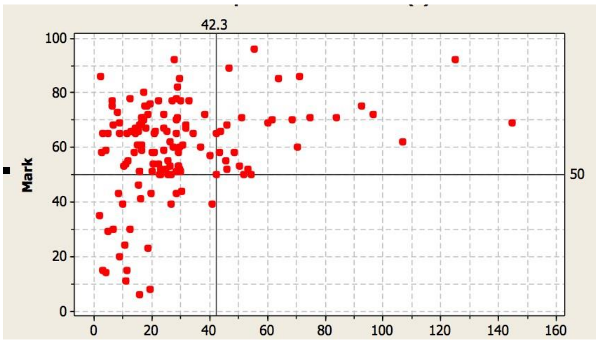


Figure 5: Grade distribution (in percentage) achieved

Figure 6: Scatterplot of mark versus time spent on the LMS

Mark received by individual student and his/her LMS usage is shown in Figure 6. While there seems to be no apparent relationship between the time students spent on line and the mark they received in the unit (r = 0.326), every student who spent more than 42.3hr during the semester passed the unit (Figure 6). Similarly, all students, except two, who spent more than 60hr on line received Credit or better grades. When compared with the students' results from the previous year, the most significant shift was among the students who received either Pass or Credit grades. A total of 11.5% more students received Credit grades when compared with the student cohort in the previous year.

Student evaluation

There are mixed views on usefulness of student evaluation in gauging teaching effectiveness and student learning. Young (1993) passionately argues that students are not in a position to evaluate teaching effectiveness; hence use of student evaluation tools to gauge teaching effectiveness is 'indefensible.' On the contrary, Wilson, Lizzio and Ramsden (1997) suggest that student evaluation tools are highly useful to gauge the quality of university teaching. Zabaleta (2007) takes the middle-of-the-road approach and proposes that student evaluations are useful when used in conjunction with other evaluation tools; but warns that these should not be used in isolation.

In this paper, the student responses have been used as one of the indicators of student perceptions on whether the BL approach adopted in this subject helped them learn the subject material. Towards the end of the semester, a five-level Likert scale questionnaire was distributed – the five choices were (a) strongly agree, (b) agree, (c) neutral, (d) disagree,and (e) strongly disagree. The survey was administered on line, allowing for anonymity. In addition, the on-line administration allowed for the students to respond to the questions at their own pace and during a time of their own choosing. Responses to a series of questions related to learning activities, learning styles and assessments are presented on Table 2.

Table 2: Student survey response

Question	Response rate (%)				
	SA	A	N	D	SD
Learning activities helped learning	55	26	11	3	5
Assessment activities helped learning	49	34	7	3	7
Assessment feedback helped learning	37	47	8	3	5
Learning resources helped learning	44	34	16	1	5
Learning style provided reasonable flexibility for study	45	42	6	2	5
Overall satisfactory learning experience	52	35	6	2	5
SA: Strongly agree A: Agree N: Neutral D: Disagree SD: Strongly Disagree					

The survey responses show that more than 78% of respondents agreed or strongly agreed that the learning design helped in their learning. Similarly, more than 83% of the respondents agreed or strongly agreed that the assessment design (assessment activities and feedback) helped in their learning. The high satisfaction rate (agreed or strongly agreed responses) of 87% on overall satisfactory learning experience can be taken as an indication that the student cohort perceived the BL design as providing them the experience they were expecting. This is corroborated by the pass rate of over 85% in the subject.

Conclusions and recommendations

The BL strategy developed and implemented in hydraulics provided mixed results. When compared with student cohort from the preceding year, there was no marked improvement in the student performance at the higher end (those receiving above distinction grades). However, the marginal students performed better and were able to either pass the unit or score higher grades. In addition, the student feedback suggested that the students found on- line practice quizzes to be helpful in reinforcing the fundamental concepts. In this sense, the principal objective of implementing the strategy (i.e. to prepare students to successfully undertake follow-up higher level water related subjects) was partially achieved. A follow-up analysis of these students' performance in the follow-up subject needs to be undertaken to verify if this indeed has happened.

The weekly LMS usage pattern reinforces the argument that students are selective in use of their time in learning activities. The spike in LMS usage just before the four assessments (two quizzes, mid-semester and final examination) supports the argument that students spend time on learning activities 'just-in-time' to prepare for assessments. This is also supported by the weekly LMS usage pattern - over 50% LMS usage occurred either on the day before or on the day the on-line quizzes were due (Figure 2).

It is noted that this study was undertaken in a single unit in a single semester of a single cohort of students. While comparison was made on the distribution of grades received [in this subject] by this cohort with the cohort from the preceding year, general conclusions on student success cannot be drawn from this study alone. Furthermore, whether the students achieved the desired learning outcomes can only be tested by following up this student cohort in the follow-up subject. This is currently underway and the results will be published elsewhere. The positive result will go some way in addressing the challenges of teaching water engineering related subjects.

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