Leading a horse to water: An intervention to encourage student-centred learning by transitioning first-year engineering students

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CONTEXT

Face-to-face delivery has been the foundation of transitioning students' pre-tertiary pedagogical experiences. The introduction of blended, online and flipped delivery at tertiary level has resulted in the reduction of face-to-face contact hours. Because of competition by subjects for students' time, the time-poor amongst them continuously battle to keep focusing on subjects/topics that have percolated to the top of their priority list. The increased requirement for student-centred learning has become the logical compensation for the disappearing contact hours. Transitioning first-year engineering students experience difficulties with their exposure to student-centred learning. Identifying the success of interventions aimed at remedying their approach to learning at tertiary level can be extremely challenging.

PURPOSE

To investigate the effect on student's various assessments of an intervention that was designed to encourage their ongoing engagement with topics in an undergraduate first-year subject.

APPROACH

The data collected consisted of the cohort's de-identified on-going and final assessment results. Statistical comparisons were conducted between the students who took advantage of the intervention and the control group who did not.

RESULTS

The assessment marks for the students were grouped into those who did not upload any "Conceptual Hurdle" question attempts (85 students), and those who did upload on at least one occasion (91 students). Statistical analysis indicated that significant improvements in all marks were achieved by those who uploaded on least one occasion.

CONCLUSIONS

Transitioning first-year tertiary engineering students are faced with a number of subjects which zealously compete for their limited study times. Their previous teacher-centred learning experience has prepared them to prioritise ongoing teacher-set tasks ahead of any other work. It is expected that the intervention outlined in our work will introduce transitioning first-year engineering students to the successful practice of student-centred/life-long learning.

KEYWORDS

First-year students, intervention, knowledge-centred/life-long learning, transitioning students.

Context

Researchers have described good teaching as a conversation (Laurillard, 1993; Ramsden, 2003) or as an interactive engagement with the students (Chickering & Gamson, 1987; Lizzio, Wilson, & Simons, 2002; Newlin & Wang, 2002). The exposure to different learning/teaching strategies and techniques for students transitioning into tertiary courses has been identified as particularly important (Britain, 2004). Therefore, there are clear benefits from researching the introduction of novel interventions into subjects (units), which are in the early years of undergraduate courses.

Student engagement is the 'holy grail' for educators. Enabling the learners to take "responsibility for self-regulation in the learning process is a value that universities aim to encourage among their first year cohort." (James, Krause, & Jennings, 2010:43). The identified enabler for these outcomes is engagement by the learner. It is interesting to note that disengagement is an equally instructive metric. Students have identified one indicator for disengagement as "coming to class without completing readings or assignments" (Krause, Hartley, James, & McInnis, 2005:38).

Findings of one research study conducted over twenty years asserted that students who were enrolled in Australian universities, were spending less and less time in private study outside of class in the critical first-year of their courses (Baik, Naylor, & Arkoudis, 2015). For an increasing number their priority appears to be paid work hence the need exists for innovative techniques that could elevate engagement with course work higher up in their 'to-do' lists.

In our context the practised pedagogy rested on an instructor-dependent relationship, where student self-reliance was promoted through "open-ended problem solving requiring critical and creative thinking (Felder & Brent, 1996). Over the past ten years, teacher-set ongoing tasks (different forms of interventions) were systematically introduced in the delivery of a subject that was part of a common first-year undergraduate tertiary engineering course; outcomes of which were reported at past conferences (Banky, 2005, 2010, 2013). For this intervention the primary differentiator was the mode of response by the students. On this occasion the activity was based on the "writing is a form of learning" paradigm (Bangert-Drowns, Hurley, & Wilkinson, 2004). At the conclusion of each week's lectures the students were given "Conceptual Hurdle" problems, which required them to reflect on the necessary theorems covered in their lectures. The students then wrote their detailed solutions on paper and submitted photos/scans of these to an electronic portal by the start of the following week's lectures.

Purpose

To investigate the effect on students' various assessments of an intervention that was designed to encourage their ongoing engagement with topics in an undergraduate first-year subject. The assessments investigated were progressive (assignments, laboratory and tutorial participation) and final (closed book written examination).

Approach

In order to encourage engagement by the cohort, students who were enrolled in a first-year subject dealing with electronic circuit behaviour (which was taught into all engineering degree courses offered at Swinburne University of Technology) were asked to prepare answers to questions on a weekly basis. Each of these activities were titled: "Conceptual Hurdle". The questions were based on the material presented during this subject's completed lectures thereby encouraging deep learning. The students were asked to submit their attempts online via the University's learning management system, Blackboard (http://www.blackboard.com). The solutions were discussed in detail at the start of the next lecture. Figure 1 shows an

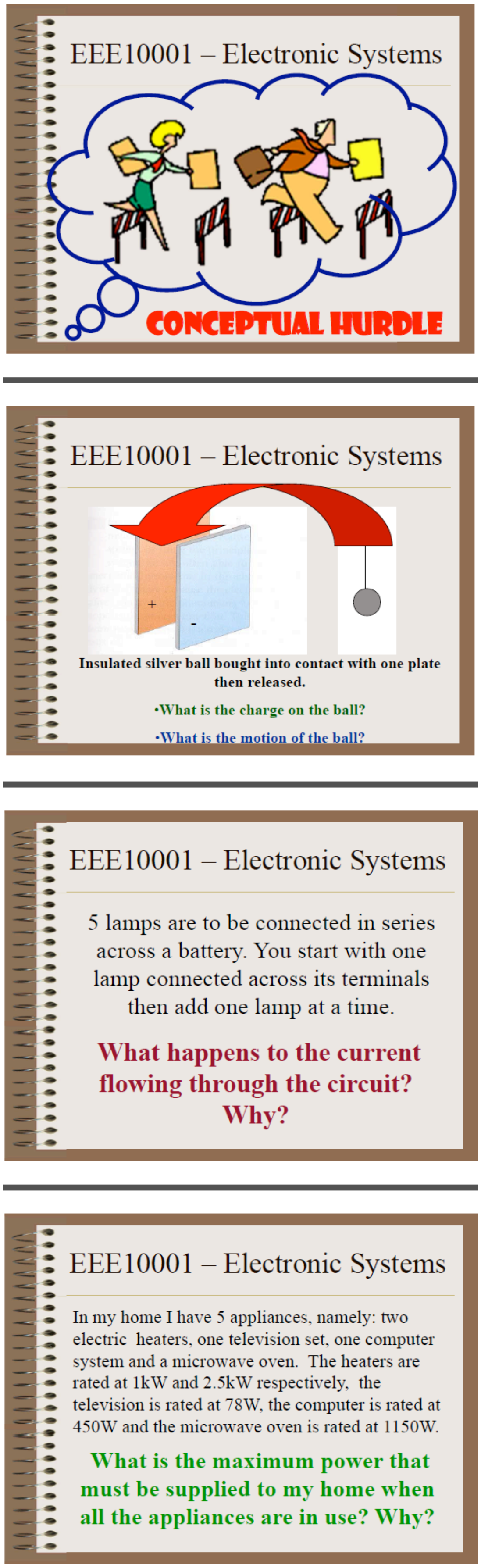

Figure 1: Typical "Conceptual Hurdle" problems

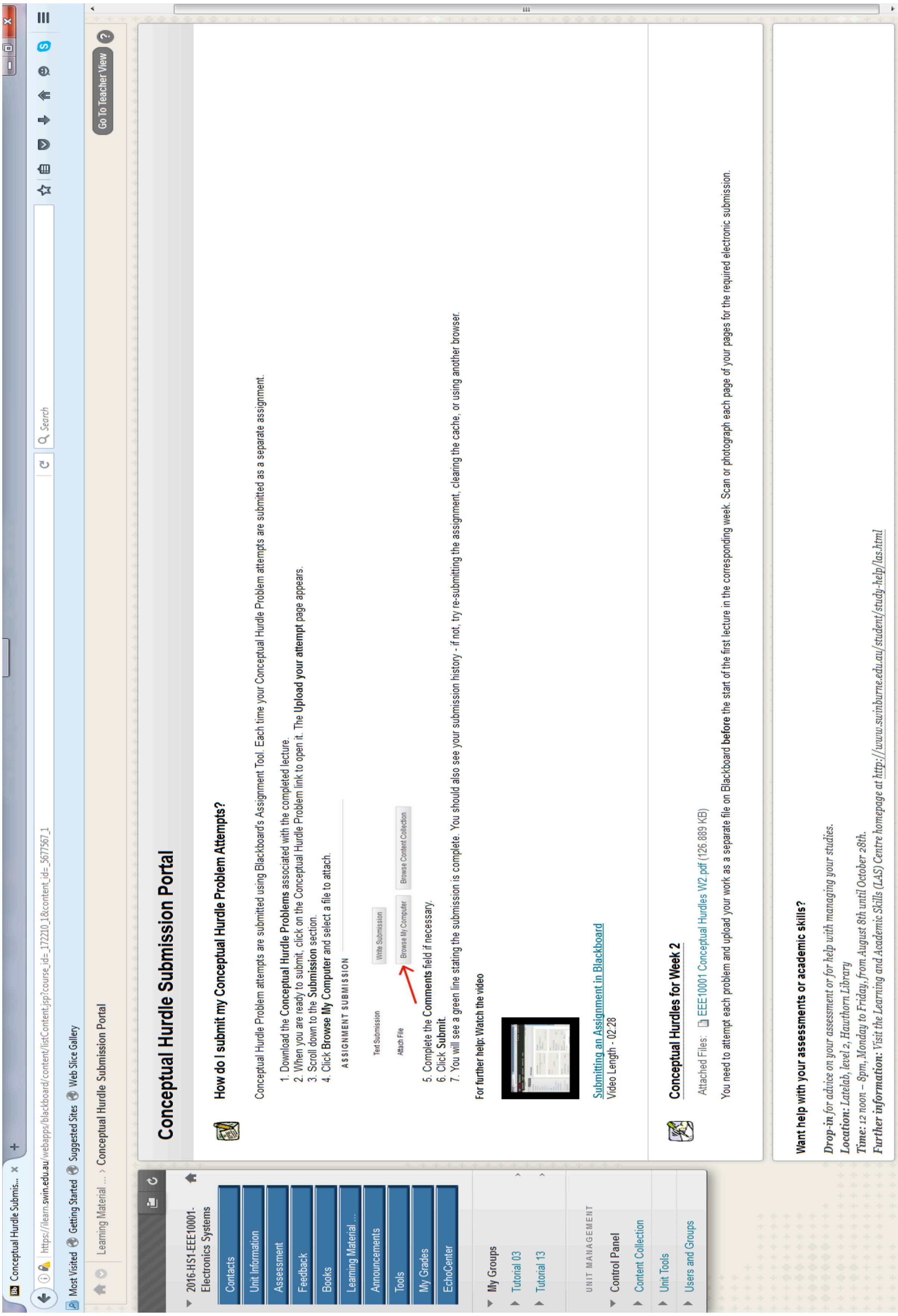

Figure 2: View of "Conceptual Hurdle" attempt upload portal on Blackboard

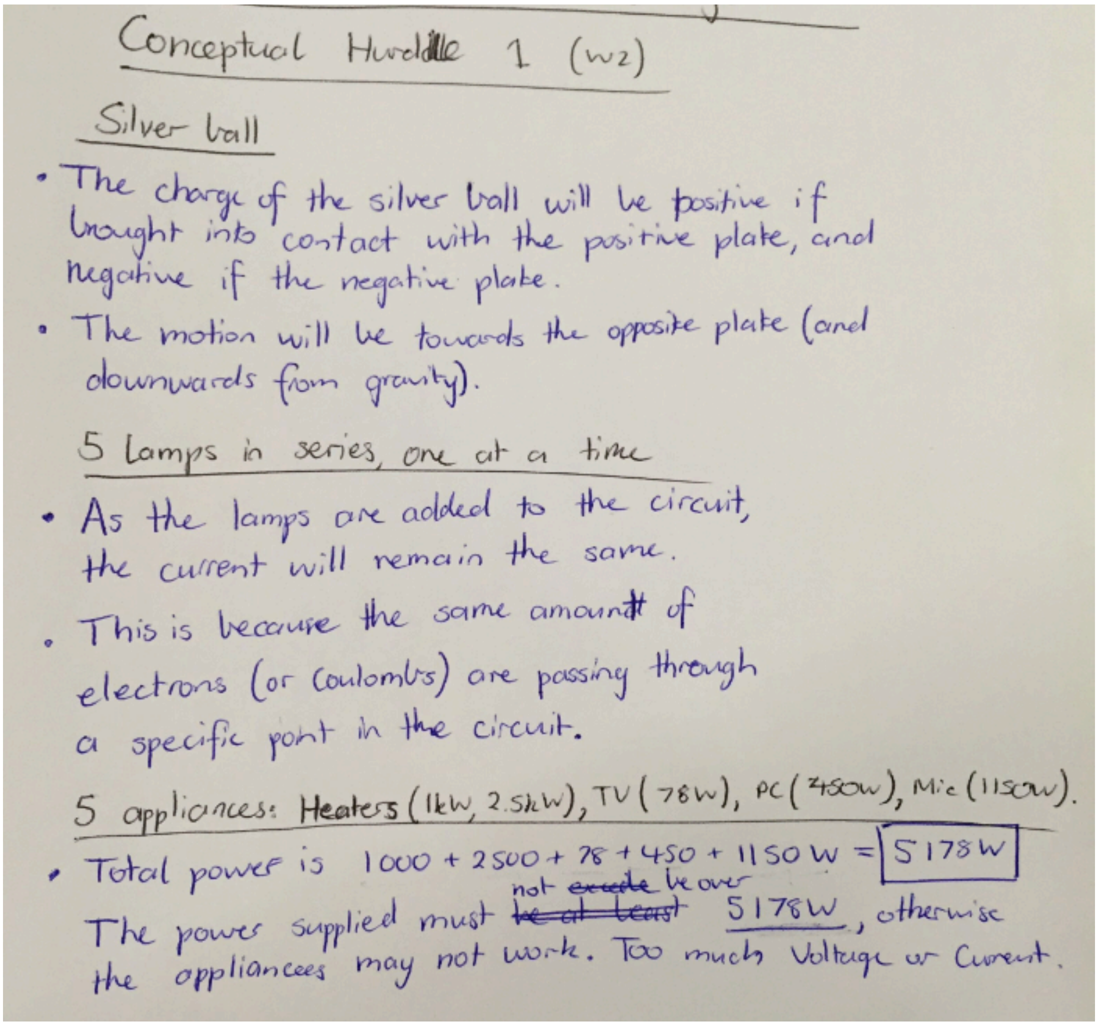

Figure 3: Typical uploaded "Conceptual Hurdle" attempt

example "Conceptual Hurdle" asked from the students. Figure 2 shows the date-and-time controlled upload portal as seen by the students. Figure 3 shows an example of a student's uploaded attempted answers to the questions shown in Figure 1. The data collected for this study consisted of the cohort's de-identified ongoing and final assessment results. Statistical comparisons were conducted between the students who took advantage of the intervention and the control group who did not.

Results

The students were grouped into those who did not upload any "Conceptual Hurdle" question attempts (85 students), and those who did upload on at least one occasion (91 students). The analytics software, IBM SPSS 14 (http://www.ibm.com/analytics/us/en/technology/spss/), was used to obtain group means for each assessable subject component and to conduct an independent sample t-test on the group means.

Assignments

An independent-sample t-test was conducted to compare assignment results in situations where students attempted or did not attempt a hurdle activity. There was a significant difference in the scores for no hurdle attempt ($M=3.97$, $SD= 2.57$) and a hurdle attempt ($M=5.75$, $SD=2.14$), conditions; $t(174)=-5.00$, $p<0.001$. These results suggest that a hurdle really does have an effect on assignment results. Specifically, our results suggest that when students attempt a hurdle activity, they perform better on assignments.

Tutorials

An independent-sample t-test was conducted to compare tutorial participation results in situations where students attempted or did not attempt a hurdle activity. There was a significant difference in the scores for no hurdle attempt (M=3.82, SD= 3.14) and a hurdle attempt (M=7.27, SD=2.82), conditions; $t(174)=-7.69$, $p<0.001$. These results suggest that a hurdle really does have an effect on tutorial results. Specifically, our results suggest that when students attempt a hurdle activity, they perform better on tutorials.

Laboratory Sessions

An independent-sample t-test was conducted to compare laboratory participation results in situations where students attempted or did not attempt a hurdle activity. There was a significant difference in the scores for no hurdle attempt (M=13.30, SD= 3.67) and a hurdle attempt (M=15.65, SD=2.51), conditions; $t(174)=-4.98$, $p<0.001$. These results suggest that a hurdle really does have an effect on lab results. Specifically, our results suggest that when students attempt a hurdle activity, they perform better on laboratory activities.

Examination

An independent-sample t-test was conducted to compare examination results in situations where students attempted or did not attempt a hurdle activity. There was a significant difference in the scores for no hurdle attempt (M=50.29, SD= 21.05) and a hurdle attempt (M=64.75, SD=23.22), conditions; $t(174)=-4.32$, $p<0.001$. These results suggest that a hurdle really does have an effect on examination results. Specifically, our results suggest that when students attempt a hurdle activity, they perform better on examination activities.

Total marks

An independent-sample t-test was conducted to compare overall results in situations where students attempted or did not attempt a hurdle activity, There was a significant difference in the scores for no hurdle attempt (M=46.33, SD= 15.46) and a hurdle attempt (M=61.32, SD=15.37), conditions; $t(174)=-6.447$, $p<0.001$. These results suggest that a hurdle really does have an effect on overall results. Specifically, our results suggest that when students attempt a hurdle activity, they perform better overall.

Effect of sample size

The calculated Cohen's *d* coefficient for effect sizes (Cohen, 1965) is between "medium" (0.5) and "very large" (1.3) (Coe, 2002), meaning that the intervention resulted in a substantial effect on the students' marks (Field, 2013:376).

Discussion

Table 1 summarises the percentage improvement, by those students who uploaded a "Conceptual Hurdle" attempt at least once, over the marks obtained for the same assessable components by those who did not upload an attempt during the semester.

As seen in Table 1, for the group that participated in the intervention, there were significant percentage improvements recorded for each assessable component of the subject. It must be noted that the comparative analysis of the mean marks for each assessed component is not endorsing statements such as: "exam marks are a good indicators of student learning", however it probably does articulate a lot about the appropriateness of the "how", the "why" and the "what" of the assessment given to the students.

An independent-samples t-test was conducted to compare results in five different activities where some hurdles and no hurdles were attempted. There was a significant difference in scores for student results where at least one hurdle was tried and submitted. These results suggest that an intervention (ongoing hurdle activities) prior to any of the five assessable activities (assignments, tutorials, labs, examinations and overall results) really does have a positive effect on results.

Table 1: Improvement obtained for assessable components of the subject

	percentage improvement
(Mean Assignment Mark)/10	44.7%
(Mean Tutorial Participation Mark)/10	90.3%
(Mean Laboratory Participation Mark)/20	17.6%
(Mean Exam Mark)/120	28.7%
(Total Mark)/100	32.3%

Specifically, our results suggest that when students attempt a hurdle/intervention, their results improve. It must be noted that, there could have been a sample-selection bias (Heckman, 2010), in that the better students may have been more engaged and subsequently participated in the intervention. Other potentially biases may include: student aptitudes, student motivations, student learning styles and student interaction preferences.

Conclusions

Since students tend to learn in many different ways (Kolb, 1976), it is imperative that teachers, at all times, try different teaching techniques in an attempt to match their students' learning styles. Therefore, even if not all the participants were affected positively by this intervention, the implementation of ongoing teacher-set tasks is highly recommended, particularly in light of the fact that the on-campus contact time for students has been and continues to decrease significantly (Baik et al., 2015:13). Moreover, it is expected that the intervention outlined in our work will introduce transitioning first-year engineering students to the successful practice of student-centred learning, as a foundation for life-long learning - an indispensable attribute for practicing engineers in the 21st century (Dutta & Patil, 2012).

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