Promoting student engagement in lectures through a trial use of response clickers

Gavin Buskes
The University of Melbourne, Melbourne, Australia
buskesgj@unimelb.edu.au

Brice Shen
The University of Melbourne, Melbourne, Australia
bshen@unimelb.edu.au

David Shallcross
The University of Melbourne, Melbourne, Australia
dcshal@unimelb.edu.au

Abstract: *In many tertiary institutions, the change to more 'active' methods of teaching engineering has led to the creation of small problem-based learning classes employing small group work. While these classes have evolved away from the usual teacher-led tutorial and laboratory class, the traditional lecture has changed little and could be seen as a relic of the passive teaching paradigm of the past. The increased availability and accessibility of lecture material through university learning management systems and the wide range of multimedia resources offered by the internet means that promoting student engagement in lectures is becoming a more difficult challenge for educators. This paper presents our experiences in the trial use of an electronic voting response system to promote student engagement in lectures, based on survey evidence that students prefer a more active learning environment. The results gathered and lessons learned in this trial will shape plans to adopt a full-scale, subject-wide deployment of the technology.*

Introduction

The Australasian Survey of Student Engagement (Australian Council for Educational Research, 2009) is a study conducted to help "stimulate evidence-focused conversations about students' engagement in university study across a wide range of institutions" and measure the level of student engagement according to six factors. The results of the study indicate a positive correlation between each of the identified engagement factors and six measurable outcomes ranging from "higher-order thinking" to "overall satisfaction". One of the biggest difficulties to overcome in order to engage students is adapting teaching practices to the available teaching environment. Most courses at the tertiary level have lectures as the primary focus of their subjects; these lectures are the sign posts that point to all of the required learning content. Lectures are seen as an efficient means of teaching large amounts of students - material can be delivered at a predefined pace to a passive student audience, although it is difficult for the lecturer to determine if the students understand the material. Other classes (i.e. laboratories, tutorials) tend to be treated as ancillary to lectures and act in more of a supporting role to reinforce the theory presented in lectures; often these other classes are held some time after the lecture. Smaller workshop or tutorial classes are seen as a more effective way to teach students (Prince, 2004), especially when employing an active learning approach such as Problem-Based Learning (PBL)(Hmelo-Silver, 2004). Questions can be posed, discussions opened up and individual staff-student interaction encouraged which leads to a higher level of feedback. It is easier for students to get to know each other and group work can be supported more easily. The level of student engagement in these types of classes is therefore much higher.

On the other hand, numerous studies have found that student attention span during lectures is roughly fifteen minutes (Wankat, 2002) and after this period the number of students paying attention begins to drop dramatically. This attention drop shows up as a resulting loss in retention of lecture material (Prince, 2004). One of the emerging techniques to avoid this drop off is the use of Electronic Voting

Response Systems (EVRSs), or "clickers" (C Fies & Marshall, 2006; Siau, Sheng, & Nah, 2006; van Dijk, van den Berg, & van Keulen, 2001). In addition to the main goal of enhancing classroom interactivity, use of clickers has also been shown to improve lecture attendance, student enjoyment and provide feedback to both students and staff on their learning (Caldwell, 2007; Draper & Brown, 2004; Felce, 2007; C Fies & Marshall, 2008; Kay & LeSage, 2009).

Motivation for clicker usage in lectures

A core element for most students in the first year engineering program at The Melbourne School of Engineering is the multi-disciplinary subject *Engineering Systems Design 1* (*ESD 1*). This subject aims to develop important generic engineering skills such as problem solving, planning of designs, decision making, how to work successfully in groups and an introduction to professional engineering ethics. In addition, technical modules on system modelling, fluid mechanics and programming with *Lego Mindstorms* robots are covered. This subject is usually taken by a first year student in the first semester of their degree program and was designed primarily to facilitate collaborative learning and encourage students to take a more active role in their education. The key ingredient in the facilitation of collaborative learning was the creation of "workshop" classes, of around 50-55 students, which provide the main opportunities for active learning (Buskes, Evans, Ooi, & Shen, 2009). In these classes, students work in groups of three or four on assignments and in-class design projects, are given time to discuss subject material with both staff and other students, and are given hands-on practical projects where possible. The workshop classes place a heavy emphasis on collaborative group work, and 30% of a student's final mark is tied to group work performed in workshop classes

Regular scheduled lectures present the required theory to support the activities in the workshop classes and help to provide the direction for the subject. While the workshop classes provide ample opportunity for active learning, the lectures could be seen as largely passive by comparison. Indeed, it was noticed in the first few semesters after the creation of the subject that the attendance rate of lectures sharply drops off as the semester progresses (typically down to 50-60% by the end of semester); on the other hand, the workshop attendance rate remains consistently very high (95%). Although this could partly be attributed to the fact that the tasks in workshop classes are usually assessed or lead to material that will be assessed in the future, a survey of students was performed in an effort to understand if there were any other contributing factors. The results of this survey, for a sample size of over 600 students taking *ESD 1* in 2009, are presented in Table 1 and Table 2. Table 1 focuses on questions about sources and activities for learning and understanding where the response scale used was a 5 point Likert scale (Babbie, 2005) that had the following choices

> 1 – nearly nothing; 2 – little; 3 – a moderate amount; 4 – a fair amount; 5 – a significant amount.

Question	Source / Activity	Mean score
How much have the following sources contributed to your learning in the subject?	Lecturers	**3.42**
	Tutors	3.23
	Workshop group members	**3.40**
	Friends	2.83
	Notes / Reference books	**2.36**
How much have the following activities contributed to your understanding of the subject material?	Attending lectures	3.25
	Attending workshops	**3.72**
	Completing written assignments	3.09

Table 1: Learning sources and activities

Table 2 focuses on a question to identify students' preferred learning environment where the response scale used had the following choices

1 – greatly prefer lectures; 2 – prefer lectures; 3 – balanced; 4 – prefer workshops; 5 – greatly prefer workshops.

Question	Mean score
Do you prefer a workshop-style environment or a lecture-style environment?	**3.71**

Table 2 : Preferred environment

This survey indicated that

1. lecturers played an equally important role in perceived student learning in the subject as workshop group members;
2. attending workshop classes is perceived to be a bigger contributor to student understanding of subject material;
3. there is a preference for a workshop-style learning environment over a lecture-style environment.

Based on the results of the survey presented above, it was decided to incorporate a trial use of the clickers into several early lectures for *ESD 1* in semester 1, 2010 to improve student engagement and interactivity. The objective of the trial was to evaluate how the clickers could be used in lectures without requiring large-scale redesigning of subject material.

How the clickers were used in lectures

The system used for the clickers was produced by Turning Technologies LLC, with approximately 200 "KEEpad" response units purchased, shown in Figure 1 below.

Figure 1: KEEpad response clicker

This system required the installation of the free software, TurningPoint 2008, on a laptop and the lecturer to bring the response clickers and a USB dongle "base station" to every lecture with planned clicker use. The base station captures the unique responses from every clicker and passes them on to Microsoft Powerpoint, where they can be displayed as a chart after allowing for an appropriate response time. More detailed statistics can also be gathered in a "session" file for later review.

Clickers were handed out to students upon entering the lecture theatre. With three streams of approximately 200 students each, it was likely that some students would miss out on using the clickers in some lectures. This was not seen as an issue as use of the clickers was purely voluntary and not subject to any assessment. At the end of the lecture, students would return the clickers. For all lectures, the responses were made visible to the class after allowing for an appropriate response time.

The clickers were used in three broad ways – to manage student's early expectations about the subject, to allow students to learn more about their peers and to provide feedback on technical questions.

The first lecture is an introduction to the subject that provides basic subject information to the students while also giving them familiarity with the clickers through a couple of response exercises. The data obtained is useful for students to understand a little more about their cohort and how their perceptions about various topics sit with respect to the rest of the class – as well as being equally useful to teaching staff to observe trends in first year students. One question, which surveys access to computers for the purpose of study, is shown in Figure 2. The results are presented clearly over the top of the various alternatives so as to be visible to the class.

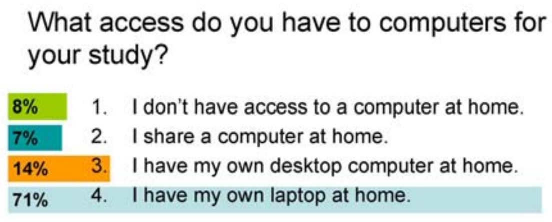

Figure 2: Computer access question

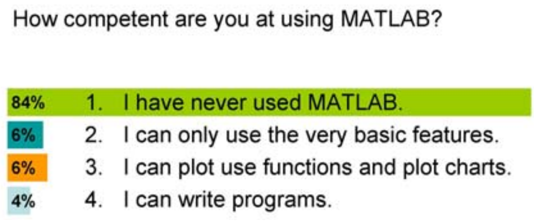

Figure 3: MATLAB experience question

A big hurdle for students to overcome in *ESD* 1 is learning to use MATLAB, a numerical programming environment and programming language. As the subject is multi-disciplinary in nature, students come from varying backgrounds with varying degrees of experience and competency. Some may feel isolated and unaware of what skills their fellow class members may have. An important use of the clickers in the first lecture is to reassure students that they are not alone in learning MATLAB as shown by the question posed in Figure 3.

As mentioned earlier, *ESD 1* develops generic engineering skills throughout the semester. For students in their first semester at university, the importance of these skills may not seem clear when the teaching of more technical topics from mathematics, chemistry or physics might appear more appropriate. Therefore, managing the expectations of the students at the beginning of the course is vital. In the second lecture, the class is asked to respond by listing what they think are the three top responses to an industry survey asking which skills are important in an engineering graduate as shown in Figure 4.

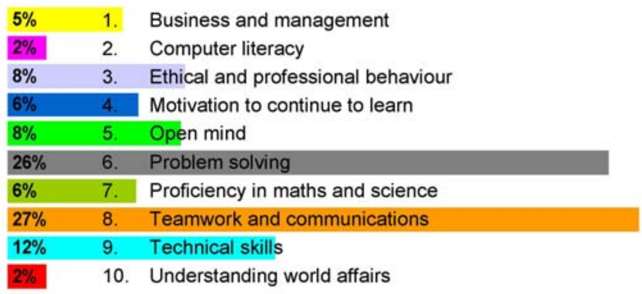

Figure 4 : Industry survey of important engineering skills

The results of the votes on the ten skills are then presented and compared with how the students voted. Based on experience, it is likely that students on the whole will correctly identify the top 3 skills although perhaps not in the correct ordering. It is then explained that the course teaches topics that help build skills primarily in the top three areas. Displaying these results to the class is useful as it confirms to the majority that their expectations of the course are in line with what will be taught while for others it results in them readjusting their expectations.

Several small quizzes were spread throughout the lectures to act as a mental circuit breaker and give feedback to students on their knowledge and standing with respect to the rest of the class. This process acts as motivation for their learning as they receive this feedback instantly and it is not used for assessment purposes. Importantly, it also provides staff with feedback as to the common misconceptions that students have so that they can be addressed either immediately or in following lectures.

At the end of the period of clicker usage, a survey was performed to gauge the effectiveness of the clickers with the combined result for the subject (approximately 600 students) being presented in Table 3.

Statement	Strongly Agree	Agree	Neither	Disagree	Strongly Disagree
I found the clickers useful as I was able to get immediate feedback in class	67%	13%	8%	2%	10%

Table 3 : Usefulness of the response clickers

Reflection and recommendations

The results from the student surveys have indicated that students prefer the workshop environment, feel as though their understanding of the subject material is increased more in an active learning setting and largely agree that the clickers are useful to obtain immediate feedback in class. Although this was only a limited trial, taking these points into consideration, it is planned to move to a full-scale implementation of incorporating clicker activities into most lectures to increase student engagement for *ESD 1* in semester 2, 2010 with approximately 100 students enrolled. Activities will include more multi-choice conceptual quizzes, preference of review topics, choice of lecture examples and end of lecture reflection about what was perceived as the major learning objectives of the class.

On moving to a more widespread use of the response clicker in *ESD 1* for semester 2, 2010, several technical matters need to be considered. The main logistical issues of how to distribute, manage, and collect the clickers need to be addressed. Clickers will be distributed by demonstrators in the first workshop class (around 50 students per class). A simple handheld bar code scanner will be utilised to scan in student ID cards and the corresponding clicker that they have been allocated. Clickers will be collected in the last week of workshop classes, or may be returned in the week leading up to the final exam. As a byproduct of this clicker allocation, lecture attendance rates can be monitored based on the number of people responding during lectures and compared with the anecdotal evidence of around 60% attendance.

While alternative voting schemes to the response clickers do exist such as the mobile phone voting response system Votapedia (Maier, 2009), it is felt that employing a dedicated system with each student receiving a clicker is more efficient, less error-prone due to poor signal reception, fairer to students who do not have a mobile phone and would thus have a higher level of student participation

Conclusion

The results of the student surveys on learning sources, learning activities and preferred learning environment make it clear that there is a large difference in student experience between attending a lecture to attending a workshop class. The fact that students feel that a more active environment is a bigger contributor to their learning and understanding implies that engagement is the key factor; this should come as no surprise given the direct link between engagement factors and learning outcomes identified in the Survey of Student Engagement (Australian Council for Educational Research, 2009). Through the trial use of electronic voting response systems in a first year engineering subject, it has been shown that the students feel as though the system was useful to obtain immediate feedback and will thus be useful in promoting engagement in a lecture environment. The lessons learned in this trial will now be used in a move to a full-scale deployment of the clicker system in semester 2, 2010.

References

Australian Council for Educational Research. (2009). *Australasian Survey of Student Engagement*.

Babbie, E. R. (2005). *The Basics of Social Research.* Belmont, CA: Thomson Wadsworth.

Buskes, G., Evans, J., Ooi, A., & Shen, B. (2009). *Using active teaching workshops to enhance the lecture experience*. Paper presented at the 20th Annual Conference for the Australasian Association for Engineering Education.

Caldwell, J. (2007). Clickers in the large classroom: Current research and best-practice tips. *Life Sciences Education, 6*(1), 9-20.

Draper, S. W., & Brown, M. (2004). Increasing interactivity in lectures using an electronic voting system. *Journal of Computer Assisted Learning, 20*(2), 81-94.

Felce, A. (2007). A critical analysis of the use of electronic voting systems: ask the audience. *Emirates Journal for Engineering Research, 12*(1), 11-26.

Fies, C., & Marshall, J. (2006). Classroom response systems: A review of the literature. *Journal of Science Education and Technology, 15*(1), 101-109.

Fies, C., & Marshall, J. (2008). The C3 framework: evaluating classroom response system interactions in University classrooms. *Journal of Science Education and Technology, 17*(5), 483-499.

Hmelo-Silver, C. E. (2004). Problem-Based Learning: What and How Do Students Learn? . *Educational Psychology Review, 16*(3), 235-266.

Kay, R. H., & LeSage, A. (2009). Examining the benefits and challenges of using audience response systems: A review of the literature. *Computers & Education, 53*, 819-827.

Maier, H. R. (2009). *Student participation in lectures using mobile phones*. Paper presented at the 20th Annual Conference for the Australasian Association for Engineering Education.

Prince, M. (2004). Does Active Learning Work? A Review. *Journal of Engineering Education, 93*(3), 223-231.

Siau, K., Sheng, H., & Nah, F. F. (2006). Use of a classroom response system to enhance classroom interactivity. *IEEE Transactions on Education, 49*(3), 398-403.

van Dijk, L. A., van den Berg, G. C., & van Keulen, H. (2001). Interactive lectures in engineering education. *European Journal of Engineering Education, 26*(1), 15-28.

Wankat, P. C. (2002). *The effective, efficient professor : teaching, scholarship, and service*. Boston: Allyn and Bacon.

Copyright statement