Using active teaching workshops to enhance the lecture experience

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***Abstract**: The ever present challenge of engaging students and encouraging them to participate in active learning requires constant refinement of our teaching practices. This paper presents our experiences over the last year in the use of new hybrid-style workshop classes in the first year general engineering subject, Engineering Systems Design 2, at the University of Melbourne. The workshops were part tutorial and part laboratory and were run in a casual environment in purpose built facilities with students working in small groups over a period of three hours. These classes were run in conjunction with traditional lectures. The role the workshops play in enhancing the material presented in a traditional lecture environment is evaluated using a student feedback questionnaire and the data is presented in this paper.*

Introduction

Educators alike all wish that there was a single perfect solution for teaching - a single classroom and format that would suit all material and all students. Unfortunately students vary as much as the material that can be taught. The traditional format of lectures and tutorials, while long proven capable of producing good results, needs to be reassessed in light of the differences that exist in our student body today (Felder and Brent (2005)).

There are many factors that impact on both the student learning experience and academic results. Firstly there is the material - different topics are better suited to different learning environments. There are the teachers, where balancing experience and staff/student ratios with budget will always be an issue. Then there are the students with their different backgrounds, learning styles and capabilities. Davidovitch et al (2009) look at the impact of having the experienced lecturer teach large tutorials versus having less experienced and cheaper teaching assistants running small classes but conclude that neither system is clearly better. Carmichael (2009) promotes a Team-Based Learning (TBL) structure which combines lectures with small student study groups. While the results published for the TBL structure are better than lectures alone, it can not easily be determined whether the reasons for this are the particular TBL structure or simply the opportunity to complete extra assignments and quizzes. Casteel and Bridges (2007) hand the reins over to students giving them the leadership role in a seminar format resulting in significantly higher student satisfaction, although this is done with students in their later years of study.

Active learning is a popular but somewhat inexact concept. For our purposes, we define active learning to be the process where students have the formal opportunity to impact on their study. The

extent of its advantages is under dispute, although including some active learning is generally considered to be beneficial (Prince 2004). Tied in with the idea of active learning are the ideas of cooperative and collaborative learning; where students work towards a common goal but are assessed individually or collectively, respectively; these types of learning have both their advantages and disadvantages. Hänze and Berger (2007) used a model where groups of students took turns in becoming subject experts and sharing the knowledge with others. What they observed was that while the student experience was better, academic results weren't. Where students are made responsible for learning a particular aspect of the material they did better, but there also seemed to be a tendency to rely on the knowledge of other students in areas that weren't in their area of expertise.

As part of a wide range of educational and curriculum reforms at the University of Melbourne, the School of Engineering now operates a combined first year subject for all students interested in pursuing studies in engineering. The major challenge for academics was to produce a curriculum, teaching structure and environment that incorporates lectures, tutorials and project work that facilitates cooperative learning and encourages students to take a more active role in their education. The key vehicle in delivering such an outcome is the creation of active teaching workshop classes, which provide the main opportunities for active learning. In these classes, students are given time to discuss subject material with both staff and other students, they work in groups on assignments and in-class design projects, and are given hands-on practical projects where possible. This paper will focus on the students' experiences, measured through data collected by a survey, of these new workshop classes and the role that they played in enhancing the lectures.

Background

Core to the first year engineering program are two closely related subjects; *Engineering Systems Design 1* and *2*. Combined, these subjects cover engineering concepts, general problem solving, fluid mechanics, digital circuits, programming, statics and dynamics. *Engineering Systems Design 1* introduces students to "soft skills" such as concept maps, planning designs, decision making and working in groups. *Engineering Systems Design 2* (*ESD2*) is significantly more technical in nature and is more typical of the material associated with traditional engineering subjects. In this paper, we will focus on the use of active teaching workshops to enhance the student's experience in *ESD2*.

To date *ESD2* has run twice, once in the second semester of 2008 (the main semester) in which there were around 700 students, and once in the summer semester of 2009 with approximately 110 students. The subject is divided into four different modules: digital circuits, statics, dynamics and MATLAB (programming). The MATLAB module is meant to support the material taught in digital circuits, statics and dynamics. The format for both instances that the subject has been taught in has been the same, except that in the summer semester the time frame has been halved so that what would normally be covered in two weeks is completed in one. The main semester comprised of three lectures a week, each of which is one hour long, and a single three hour workshop. There were 12 weeks of lectures and 10 weeks of workshops. The subject (lecture/workshop) structure for the summer semester is shown in Fig. 1. The students are expected to attend a 3 hour lecture and a 3 hour workshop on Mondays and Wednesdays for 6 weeks. In most weeks, students will get two hours of circuits/statics/dynamics lectures followed by a MATLAB lecture.

Date	Hour 1	Hour 2	Hour 3	Workshop
Week 1 Monday	Introduction	Circuits	Circuits	No workshop
Week 1 Wednesday	Circuits	Circuits	Circuits	Circuits
Week 2 Monday	Circuits	Circuits	Matlab	Circuits
Week 2 Wednesday	Circuits	Circuits	Matlab	Circuits
Week 3 Monday	Statics	Statics	Matlab	Circuits
Week 3 Wednesday	Statics	Statics	Matlab	Statics
Week 4 Monday	No Lectures or Workshops			
Week 4 Wednesday	Statics	Statics	Matlab	Statics
Week 5 Monday	Statics	Statics	Matlab	Statics
Week 5 Wednesday	Dynamics	Dynamics	Matlab	Statics
Week 6 Monday	Dynamics	Dynamics	Matlab	Dynamics
Week 6 Wednesday	Matlab	Matlab	Conclusion	Dynamics

Figure 1: ESD2 Subject timetable (summer semester)

The purpose of the new format workshops is to encourage both active learning and to facilitate students to develop teamwork and leadership skills. Each workshop class contains up to 60 students in around 20 groups of 3 with 2 members of the teaching staff. There are 10 tables in the workshop, each table has two computers and two student groups (see Fig. 2). Each student group has access to one computer. The workshops are conducted over three hours, with the class being split into two parts, the first part (Part A) is similar to a traditional tutorial although students work on questions in their groups, while the second part (Part B) involves the students being guided through a practical design problem which typically involves them interacting with a piece of equipment.

Figure 2 : Workshop environment

Method

The study on the effectiveness of the new active teaching workshops in enhancing the lecture experience was conducted in the Melbourne School of Engineering at the end of the Summer Semester (Jan/Feb) 2009. In order to assess the effectiveness of these classes, an anonymous two-page pen-and-paper questionnaire was distributed to students in their final workshop class and returned to the teaching staff at the end of the class. The questionnaire had a combination of multiple choice questions and space for additional comments.

The surveys were distributed to all students in the subject; this spanned several workshop classes, totalling just over 100 participants. The aim of the questionnaire was to measure the students' perception of the effectiveness of the various learning components of the subject. These responses would then be used to further refine the material and format of the workshop according to the desired outcomes.

The survey was divided into several main sections with the following goals:

1. to gauge (according to students' perceptions) which sources or activities had the largest contribution to
    a. the learning of the course material;
    b. to the understanding of the material;
    c. and how effective online assessment, provided by online quizzes, was in the subject;
2. to assess the preference of a workshop-style or lecture-style environment;
3. to measure how much the tutorial exercises and practical exercises contributed to the students' perceived learning.

The scale for the multiple choice responses was a five-level Likert scale (see Babbie (2005)).

Results and Discussion

Learning and understanding sources

The first section of the questionnaire asked students to measure how effective certain sources were with respect to both their learning and their understanding in the subject. The response scale used had the following choices

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

Table 1 gives the results to the two questions posed to assess the effectiveness of sources in learning and understanding. Some interesting points can be noted from this data. Firstly, it appears that students make a clear differentiation as to what the terms "learning" and "understanding" mean. Lecturers are rated (by a very small margin) as the biggest contributor to learning in the subject with tutors and friends close behind. When asked about which activity contributed to their understanding of the subject material, attending lectures rated lower than attending the workshops classes, which was clearly rated as being more significant. From this it seems as though students associate learning with seeing material for the first time (as in the lectures) and actually further their understanding through active participation in the workshop classes. Secondly, the contribution of notes and references to learning are rated as the least significant. This supports the notion that active forms of teaching are making the most impact on the students in terms of their learning and understanding of the subject material.

Table 1 : Learning sources and activities

Question	Source / Activity	Mean score
How much have the following sources contributed to your learning in the subject?	Lecturers	**3.63**
	Tutors	3.59
	Workshop group members	3.51
	Friends	3.58
	Notes / Reference books	**2.48**
How much have the following activities contributed to your understanding of the subject material?	Attending lectures	3.56
	Attending workshops	**3.91**
	Completing written assignments	3.58
	Completing online quizzes	3.02

The positive contribution of the workshop classes to further students' understanding of subject material adds weight to the argument that they form an integral role in the learning of the subject material. A major concern of the lecturers is having students leaving lectures with little retention of the subject matter that was presented. To overcome this concern, several of the projects that were completed in workshop classes were also discussed and further analysis was conducted in lectures. Also, the workshop classes were used to actively reinforce key concepts soon after the lecture through related project work and enhanced the lecture experience. The data also shows that the workshops helped lectures move on more quickly with students having a strengthened understanding of the material presented in lectures.

As a side note, completion of written assignments ranked higher than completing online quizzes. This could be a result of the online quiz being marked automatically, whereas tutors mark and provide annotations on written assignments. In this way, it could be seen as contributing more to understanding due to a higher level of feedback being provided.

Teaching environment

The second section posed one question on the general preference of the teaching environment; comparing the lecture-style environment (over one-hundred students in a lecture) to the workshop-style environment (around sixty students in an active teaching workshop with two tutors). The results are provided in Table 2, noting that the scale used was

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

Table 2 : Preferred environment

Question	Mean score
Do you prefer a workshop-style environment or a lecture-style environment?	**3.45**

The results show that students prefer a workshop-style environment. When read in conjunction with the results from the previous section (see Table 1), it could be surmised that while lectures provide an essential path for the learning in the subject, students prefer the workshop-style environment and feel that they further their understanding most in the workshop classes. This may indicate that they prefer collaboration and feel more engaged in this sort of environment; the high level of interaction between students and tutors in the workshop classes is likely to positively influence the preference for the workshop-style environment.

Practical and theoretical split of workshops

As mentioned in the Background section, the workshop classes are usually split into a theoretical part relying on collaboratively solving small tutorial-style questions with the tutors providing guidance (Part A) and a practical part that reinforces the theory covered in the tutorial-style questions (Part B) through experiments. A question was posed that asked students to gauge how much each part contributed to their learning in the subject. The following scale was used for responses to these questions

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

Table 3 : Tutorial and practical activities in workshops

Question	Activity	Mean score
In workshop classes, how much do you feel you learn from the following activities?	Part A (Tutorial)	**3.72**
	Part B (Practical projects)	3.29

From Table 3, it is clear that while both sections of workshop classes are seen as contributing more than a moderate amount to learning, it is the tutorial-style section that is deemed to contribute more to student learning. This could be due to a combination of both the resemblance of the tutorial-style questions to what one would expect on an end of semester exam and the inherent open-endedness in the practical projects teaching more generic concepts as problem solving and design.

Discussion

The results obtained in the previous sub-sections are encouraging for the use of the active teaching workshops in supporting the lectures in *ESD2*. However, the small sample size of students (approximately 100) is a limitation to this study, as is the fact that it was run over the condensed timeframe of the summer semester. It is hoped that a similar study will be performed in semester 2, 2009 on a larger sample of around 700 students. Results from this study will be presented at the conference.

One way in which the study could be expanded is by putting a "workshop contribution" question on the questionnaire. This would be a question that gets the student to rate how much they believed they participated in their group in the workshop classes. Comparing the responses of this question to the

first two questions on learning and understanding (see Table 1) could yield an insight into how engaged the students are in their workshop classes and explain the apparent difference in understanding gained from the workshop classes to the lectures. Another idea is to run the questionnaire online followed by an online quiz that simulates a mini-exam and compare the two results. This could assess which students, in terms of academic performance, are the ones who prefer a workshop-style or lecture-style environment, or which students find that the workshop classes are contributing most to their understanding of the subject material.

Conclusion

The results gathered from the student questionnaires show that active teaching workshop classes are having a positive effect on the lecture experience for students in the subject *ESD2* in the Melbourne School of Engineering at the University of Melbourne. While students felt that lecturers had the most influence on their learning of the subject material, they also felt that attending workshop classes was the highest contributor to their understanding of the subject material. This has allowed the lecturers to proceed through the lectures more confidently knowing that the tight integration of the lectures and workshops has symbiotically reinforced students' knowledge; lectures can be more progressively built upon without having to laboriously recap key points. The workshop environment was also preferred to a lecture-style environment by students, highlighting their prefererence for collaboration and being actively engaged in the course material. As this is only a preliminary investigation, further modifications to the original survey are planned to highlight aspects of the course which could improve – especially in terms of lecture/workshop integration. The subject is still under minor development and it is hoped that with such questionnaires and assessment of student feedback the workshop classes can be further developed to enhance the lecture experience.

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