The Classroom Performance System – the introduction of a pedagogical innovation in the teaching of an engineering course.

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***Abstract**: In 2006, 47 students of the University of New South Wales at the Australian Defence Force Academy took part in the trial of a novel pedagogical tool – the Classroom Performance System (CPS). The students were undertaking an Aircraft Systems course as part of the third year of Bachelor of Aeronautical Engineering or Bachelor of Technology (Aeronautical Engineering) programs. CPS allows the student to answer multi-choice type questions via an electronic keypad. The collective class responses are immediately displayed to the class and to the instructor. The resulting evaluation of the correct and incorrect answers is designed to evoke class discussion and interaction. An end-of-year questionnaire solicited student evaluation of the system. Student response was mixed with 60% of the class not wanting this pedagogical innovation to continue.*

Introduction

The purpose of this paper is to report on the introduction of a new teaching and learning tool into my teaching practice at the University of New South Wales at the Australian Defence force Academy, (UNSW@ADFA). The rationale behind the introduction of the innovative teaching and learning tool is to foster student engagement and interaction during teaching. The level of classroom engagement of the students undertaking an aeronautical engineering degree at the Australian Defence Force Academy, (ADFA) will be discussed along with some of the pedagogical issues, theories and methodologies which support or do not support the use of electronic response pads in the lecture theatre or classroom.

In their paper concerning the concepts that affect the learning behaviour of most people, Paskusz, and Stice (1987) constructed psychological building blocks for learning. They maintain that important building blocks include the concepts of active learning and feedback to the learner.

As a lecturer in aviation-related engineering courses (the material of which can be highly technical in nature) I endeavour to engage my students in active teaching methods; especially those methods which involve a feedback mechanism. As military officers-in-training my students are, at times, stretched to the limit of their physical and mental resources. Their daily routine may include a two-hour physical training session on a cold and unyielding parade-ground followed by a two-hour lecture in a cosy and comfortable lecture theatre. There have been times when I felt that I should perform back-flips and handstands in order to keep my students awake and engaged.

Biggs (1982) maintains that questioning and quizzes are useful in lower order factual knowledge acquisition and early relational knowledge. University lecturers generally take care to devise courses that develop students' analytical and research skills. However, a large amount of aviation-related courses, as in most engineering courses, relies on the student successfully acquiring substantial amounts of lower-order factual knowledge.

I have experimented with in-class quizzes, group discussion, student presentations to the class and other such pedagogical methods of active student engagement. I am happy to report some success with these methods however, in late 2004, I decided to be more innovative in my teaching method.

The innovation involved a student-owned electronic response keypad which required the student to actively engage in class quizzes and which provided almost instantaneous feedback to the student. As well as instantaneous feedback to the student, the readout on the receiving computer provided instantaneous feedback to the lecturer as to the effectiveness of his or her teaching.

Rationale for the Pedagogical Innovation

According to Paskusz and Stice (1987) in order to learn, a student should be actively involved in the material.

> "It is not enough that he may hear material or see it; he must also think and talk about it, or do homework on the topic" (Paskusz and Stice, 1987 p 91)

In other words, he or she must pay attention to the course material and therefore, any procedure or aid that helps to direct the student's attention to the material will aid her or his learning.

As well as active learning, Paskusz and Stice (1987) maintain that another facet to successful learning is the feedback to the learner. Feedback is the provision of information about whether or not the student has achieved the intended objective. Learning can occur without any overt feedback but its direction is not predictable and operates under little control. With feedback, the learner can establish whether he or she is learning the correct material and whether he or she is employing the correct methodology. The more immediate the feedback, the more efficient is the learning, Paskusz and Stice (1987).

> "…the learner is positively reinforced for the things he has learned correctly and adequately and errors may be corrected before it becomes necessary to unlearn any misconceptions or before these misconceptions cause further errors. The more feedback is delayed the less effective it is in motivating the learner and in controlling the learning process", (Paskusz and Stice, 1987 p 91).

Percival and Gibbs (1994) maintain that in the absence of frequent personal feedback from tutors through face-to-face contact or marked assignments, students need other forms of feedback on their progress. Percival and Gibbs (1994) espouse that an economical method to provide feedback is to use the computer-marked multiple-choice question test. Percival and Gibbs (1994) suggest that it is possible to set questions which test high-level educational goals such as understanding, synthesis and problem solving and yet still be able to mark answers mechanically.

At the University of New South Wales, the administering of multi-choice-type quizzes and tests, which may be mechanically marked, can be facilitated using WebCT. WebCT is an online computer program where students and lecturers may interact with postings of course material, bulletin boards, discussion forums and various types of assessments and quizzes. I have used WebCT a great deal and I have found it ideal to post course lecture notes; provide students with links to required course reading that is available in digitized form and to provide guides and references. While the quiz function provides immediacy of feedback of the correct answer, this function does not necessarily provide the student with the rationale behind the correct answer.

Thus, as previously mentioned, I chose to adopt another approach to provide, not only student engagement but immediate feedback and discussion of in-class quizzes. This approach involved the use of the Classroom Performance System (CPS).

The Innovation – The Classroom Performance System.

The Classroom Performance System (CPS) is comprised of a student-owned keypad which resembles the remote-control handset of a television set; a receiving module which is linked to the lecturer's personal laptop computer and the computer program and codes which enables the handset to communicate with the lecturer's laptop and the central data-base which, for my purposes, was located in the United States of America. A brochure which describes the form and function of CPS is included as figure 1.

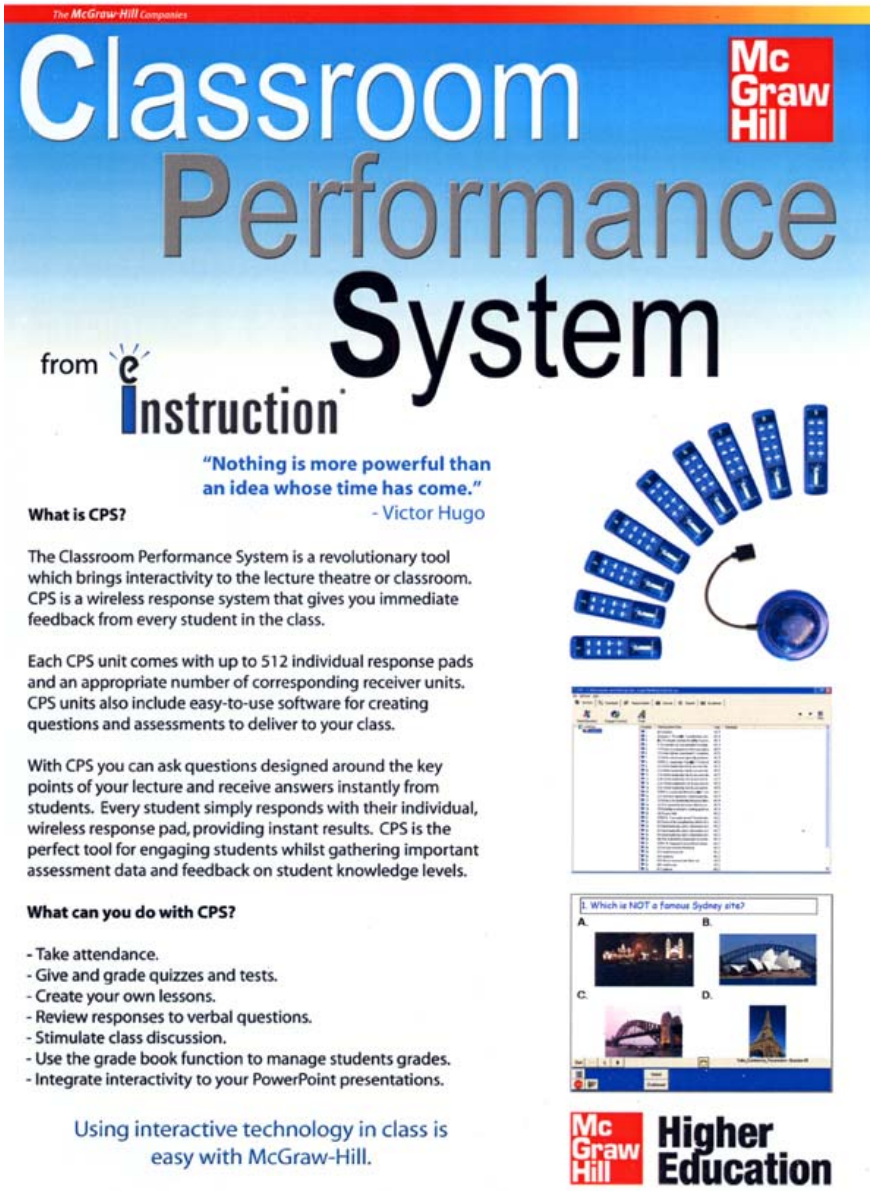

Figure 1: Classroom Performance System

On the student keypad there are six buttons labelled A through to F. When the lecturer uses his or her laptop computer to generate a PowerPoint slide on which there is written a question and several alternative answers, the student may respond by pressing the button corresponding to what they believe is the correct answer. On the screen of the lecturer's laptop and the projected PowerPoint slide a graphical interface lets everyone know when all students have responded. Then, when the period of time allowed for the students to respond has elapsed, the graphical interface changes to a histogram of the various student responses. It is possible for the lecturer to obtain the result of an individual student response. However, this is best achieved by uploading the responses to the central data-base where separate scores may be shown and also collated for the individual student. By using the central data-base the CPS may be used as a form of recorded assessment.

The Classroom Performance System is linked to the publishing company – McGraw-Hill. Supply of the software and receiving module, (at no cost to the lecturer), is contingent on the lecturer setting as a course text the relevant McGraw-Hill publication. The student must buy the prescribed text as well as the response handset and enabling code. In 2005, the additional cost of the handset was $8.75 and the additional cost of the code (which was provided in a sealed envelope in the text) was $15.

Shorrock, (2002) surveyed students from several universities and reported that according to students an effective academic understood "the financial pressures placed on students" (p 61). I include this quote because, in fact, I responded to my students' complaints and ensured that the additional financial impost was well within the Defence-funded book allowance.

After purchasing the text, handset and code, the student is required to go on-line in order to access the central data base. The student enters the class code, handset serial number and the access code of the sealed envelope in order to register as a member of the class and to enable the handset.

It is germane to mention that it has been observed by my academic colleagues that there is a perceived reluctance of students to engage in any task or activity that carries little or no assessment. This may be due to the demands placed upon the student by their military masters or perhaps is indicative of the modern generation of tertiary students. There are pedagogical issues associated with always attaching assessment to any required student tasks, the main one being the observation that students tend to become strategic in their studies. They deliberately neglect those components that they perceive to be dispensable, (Gibbs and Habeshaw, 1989).

Gibbs and Habeshaw, (1989) maintain that selective negligence is a fact of life for a lecturer. When I first introduced the CPS as an innovative learning and teaching tool, my students exhibited a marked reluctance to become involved in the relatively new technology.

Were my students threatened by the technology? I would be surprised if this were the case as these students were aiming to become pilots or engineers on highly sophisticated machines equipped with myriad electronic devices. Perhaps it was the student perception that this innovation was "Mickey Mouse" or puerile and not worthy of their attention. Perhaps the students' reluctance to become involved in the relatively new technology was a function of the additional cost involved in the mandatory acquisition of a prescribed text and the additional cost of the CPS equipment?

In her analysis of teaching media, Laurillard, (1993) makes the point that print is still the most important educational medium, in terms of proportion of teaching delivered that way, in both distance teaching and campus universities. However, the growing trend towards supplying students with copies of the lecturer's notes, readers, access to digitized extracts from books and journals has meant that students have become reluctant to acquire their own professional library of books.

In order to ensure that my teaching and learning innovation would be adopted by every member of a course that I was teaching in 2006, I decided to use the CPS as a form of student assessment. I designed into my course – Aircraft Systems - a 15% component of the overall course assessment based on the results of some in-class tests using the CPS.

In the United States, the technology of the Classroom Performance System is mature. For instance, at Duke University, first-year students are equipped with handsets and I Pods which they keep and maintain for the duration of their undergraduate degree. Lecture theatres and tutorial rooms are hard-wired to receive the handset signals. In a recent television program medical students demonstrated that the acquisition of "lower-order" factual knowledge was monitored by the lecturer, providing ready and instant feedback to multi-choice-type question, (Smart University, 2004).

In 2005 and 2006, at UNSW@ADFA, I was the only lecturer trying to implement the Classroom Performance System. There were difficulties in the introduction of the CPS as an innovative pedagogical technology. Many of the difficulties stemmed from the fact that my software and hardware support team were distant and often not accessible. 'Glitches' during lectures were embarrassing and difficult to fix. However, as the semester progressed, the Classroom Performance System (CPS) gained student acceptance as both student and lecturer became more familiar with the technology. Discussion of the incorrect responses to the multi-choice type questions created a level of interaction which was not typical of the military student.

The construction of the multi-choice questions became a demanding task. As previously mentioned, the students had reported a perception that I was introducing a "Mickey Mouse" technology. When alternative answers to multi-choice questions provoked active mental processes in order to understand, for instance, the workings of an aircraft hydraulic system, then student perception of CPS changed. The feedback was visual – the student could see what proportion of the class had answered incorrectly.

If that proportion was high, I believe that the student felt empowered to question the lecture material and to contribute to class discussion and interaction. As the course progressed the Classroom Performance System gained a measure of acceptance. In order to obtain a measure of the effectiveness or otherwise of the CPS, I included a questionnaire as part of the routine course evaluation process. A copy of this questionnaire follows:

Questionnaire Evaluating the Classroom Performance System.

Classroom Performance System

As part of our continual process of improving learning and teaching methods at UNSW@ADFA, we ask you to take a few minutes to complete the following survey on the Classroom performance System.

SA = Strongly Agree; A= Agree;

D = Disagree; SD= Strongly Disagree

Please circle your response.

1. I found the handsets easy to use.

SA A D SD

2. Answering a class question and achieving immediate feedback helped me to measure my level of understanding of the topic.

SA A D SD

3. If my answer was incorrect, I felt too intimidated to question the lecturer.

SA A D SD

4. If my answer was incorrect, I wanted to resolve the discrepancy during class discussion.

SA A D SD

5. I would like to see the Classroom Performance System continue as a learning and teaching technology at ADFA.

SA A D SD

44 of the 47 students responded to the questionnaire. Grouping the "strongly agree" and "agree" responses into one category (and likewise for the "disagree" and "strongly disagree") I found that 80% of the students reported that the handsets were easy to use.

70% of the respondents replied positively ("agree") to the question concerning immediate feedback. This result supported the notion espoused by Paskusz and Stice (1987) that feedback delivered without delay aids in motivating the learner and facilitating the learning process.

The third and fourth question was written in such a way as to provide a measure of validation. A "disagree" response to the question regarding intimidation linked to an incorrect answer was countered by an "agree" response to the question regarding class discussion linked to an incorrect answer.

50% of the respondents disagreed with the notion that an incorrect answer inhibited further questioning of the subject material compared to 75% of the respondents who agreed with the notion of resolving incorrect answers during class discussion. I believe that these responses indicate that the CPS was a positive influence in enabling class interaction and student involvement in the subject material. As a pedagogical innovation in higher education, I believe that the CPS accords well with Paskusz and Stice (1987) in that any procedure or aid that helps to direct the student's attention to the course material will aid her or his learning.

Disappointingly, 60% of the respondents did not want to see the CPS continue at the Australian Defence Force Academy. I believe that this perception may be influenced by the fact that the class on which I conducted my trial was almost at the end of their program of studies. As a pedagogical

innovation in higher education, the positive influence of CPS in enabling class interaction and student involvement indicates that it is a worthwhile addition to the toolkit of learning and teaching. If introduced from day one at first-year level and used campus-wide in many courses, it is conceivable that most engineering students may more readily accept this pedagogical innovation in higher education. Further work is indicated where the subject students are undertaking first-year engineering courses.

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