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Computer Aided Assessment, Tablet PCs and "Clickers" in Design Education

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ABSTRACT

Advances in information technology have great potential to improve teaching and learning in design education. “Clickers”, Tablet PCs, and online assessment software threaten to relegate whiteboards, paper feedback sheets and other 20th century teaching techniques to the recycling depot.

Clickers are “remote controls” that allow students to respond to questions in PowerPoint presentations. The system gives an immediate graphical response which can be either projected for the class to see or viewed by the lecturer on a laptop. In a lecture theatre situation, this allows lecturers to gauge and/or assess students’ understanding and use this information to decide whether to move on to the next topic or explain further. So students help regulate the pace of their learning. Students also get immediate feedback on their level of comprehension and lecturers have a record of which topics are easily understood and which are not. The interactive nature improves student participation and engagement.

The use of clickers for assessment in studio courses may provide an engaging and effective alternative to traditional assessment methods. Opinions often differ when assessing studio projects; however clickers allow a panel of staff or students to immediately give a moderated, transparent assessment result. It also enables peer and self assessment allowing for a more “democratic” assessment process. Potentially, administrative tasks are reduced due to the automatic nature of the data collection.

Computer Assisted Assessment offers the possibility of paperless feedback and assessment records delivered directly to the student’s inbox. These systems include functionality such as quick input of standard comments and processing of marks which streamline the assessment and feedback process. Further, existing functionality in Microsoft Office applications can be used to digitally “markup” students’ work. When combined with the intuitive interface of a Tablet PC’s stylus, further efficiencies can be gained: essays and drawings can be marked-up in digital red “ink” analogous to the traditional paper based methods, and whiteboards become redundant when a Tablet PC is linked to a data projector. This paper will review the use of a number of technologies which are being trialed in the industrial design program at the University of South Australia and will make recommendations for implementing them in different fields of design education.

INTRODUCTION

Clickers, Tablet PCs and Computer Aided Assessment are tools that are rapidly gaining acceptance throughout the education sector. This paper investigates how these systems are currently being used and offers some hypotheses on how design education could benefit from them. The first section of the paper focuses on Clickers, the later on Tablet PCs and Computer Aided Assessment.

I. USE OF CLICKERS IN DESIGN EDUCATION

Clickers are known by a variety of names such as Student Response Systems (SRS), Student Feedback System (SFS), Audience Participation System, Classroom Performance System (CPS) Electronic Audience Feedback Systems as well as others. In this paper they are referred to as clickers as this seems to be a common term.

The benefits of this technology when used in a lecture context are well documented. The following quotations are typical:

“Of the respondents surveyed with the system, 75% claimed that the SRS motivated them to attend class” (Auras and Bix 2006)

“Net generation students are very comfortable with this type of technology” (Robinson and Ritzko 2006)

“audience response systems are now mature technology – they have been around in one form or other for the last 20 years” (Pargas and Shah 2006)

“CPS technology received broad, strong support for promoting an active classroom environment, and class attendance was quite high, usually between 80-90%.” (Demetry 2005)

So clickers work well in lectures. But do they have value in courses that are typically taught in different environments such as a design studio? This section of the paper explores that question and reaches the conclusion that there is potential to have benefit on several levels. The main pedagogical benefit is to encourage students’ critical thinking. Other benefits are discussed as well.

A. The Design Studio

How does design education differs from that of other disciplines?

Design education typically consists of a combination of both lecture based knowledge-intensive technical courses and the Design Studio which addresses the more skills –based aspects of the discipline. The benefits of a design studio based approach for teaching design are well accepted within the design education sector. Design Studios are typically laid out in a way that allows free movement of people (and ideas) between work areas. Skills are gained through a process of completing projects by following predetermined methodologies and gaining feedback from both peers and lecturers/tutors. One of the key pedagogical benefits of a studio approach is that students do not work in isolation and therefore have the opportunity learn from each other and become critically aware of each others work.

Why should students be critically aware? The importance of critical thinking is widely recognised. “To evaluate and interpret someone’s work (as well as one’s own), are indispensable attributes.” (Dutton 1987). Becoming critically aware is one of the important stages of intellectual development. (Felder and Brent 2004). Students should be encouraged to “undergo a developmental progression in which they gradually relinquish their belief in the certainty of knowledge and the omniscience of authorities and take increasing responsibility for their own learning (Felder and Brent 2004). This is probably important for all disciplines but certainly so for Industrial Design. Industrial Design deals with many aspects of products that are uncertain and subjective. Assessing the worth of these subjective components requires critical analysis.

Aesthetics is one of the subjective attributes that requires critical analysis. “Although the subject of beauty has been

studied for centuries, there is still no unanimous consensus on what is beautiful" (Crilly, Moultrie et al. 2004) However it is possible to have a meaningful discussion on what is beautiful. For example it is possible to say the following statements with certainty.

- "I find this thing more attractive than that"
- "most people find this more attractive than that"
- "according to theory of Semantic Interpretation (Crilly, Moultrie et al. 2004) this is more attractive than that"

However it is very difficult to prove the statement "this IS more attractive than that"

When it comes to assessment, there will always be a degree of variability of marker assessment. "Assessing subjective areas of product design, large variations occur between multiple assessors irrespective of whether they are lecturers or peers" (Pritchard and Albon 2003). This can be problematic when there is only one assessor. It can be argued that by having multiple assessors (ideally the entire class) and then averaging the scores will reduce the variability and ultimately give a more realistic and fair assessment.

Peer assessments not only encourage critical thinking and improve student engagement but also are seen as more democratic and fair by "leveling out" the variability of subjective assessment.

B. The Studio Critique

Students' work is put on display in a way in which the entire class can see it and a discussion takes place about the relative merits of each piece of work. This assessment can be summative (contributing to student grades) or formative (as a learning experience without grades) Regardless of whether it is summative or formative, the ideal scenario is where all students put forward their views and the lecturer acts as a moderator. The students should be "encouraged to take on the primary responsibility to critique one another " (Dutton 1987).

However in practice getting students to meaningfully critique their own and other's work is not always very successful. Students are often reluctant to put forward their views for fear of being "wrong". There is also a reluctance to put forward negative views about another student's work for fear of insulting that student or for fear of retribution. These problems may well be caused by various aspects of the theory of the hidden curriculum. The hidden curriculum in its simplified form refers to "those unstated values, attitudes and norms which stem tacitly from the social relations of the school as well as the content of the course" (Dutton 1987) The studio environment is an effective incubator of the hidden curriculum. Another hurdle is that of available time. Even when the inhibitions are overcome it is only possible at best to get the opinion of a couple of students without the session becoming overly time consuming. This means that getting a representative cross-section of student views is unlikely. So typically the studio critique becomes more like a lecture with the lecturer doing most of the talking and the class passively observing. From this it would seem that the only way to get an effective student-student critique is to provide an environment where students' opinions are both completely anonymous and all students get the opportunity to put forward their views. This could be done by the use of a questionnaire that is collected and collated and then discussed at a later date. Aside for the obvious workload issues involved in this approach, it suffers from a lack of immediacy that is essential. Clickers may well solve these problems.

I believe the use clickers as a tool for students to assess and critique the work of their peers has the potential to improve the educational value and quality of the design studio critique. The next step will be to test this hypothesis in a design studio context. The method I plan to use is as follows: At the initial stage of a project, a discussion takes place about the expected outcomes. As a group, a list of criteria is discussed and a rubric created where descriptions for successful, unsuccessful and exceptional outcomes are placed next to each criteria. This means students are fully aware of how the project will be assessed from the outset. At the completion of the project, the students' work will be displayed and the lecturer acts as a facilitator asking students to register their opinions to various criteria for each piece of work. Students' responses can be immediately displayed and automatically averaged and collated. The clickers will mainly provide summative assessment although the use of the rubric will also provide a degree of formative assessment as well..

The benefits are:

- Students are required to think critically about each piece of work.
- Students individual responses are anonymous allowing for true reflection.
- Assessment is interactive and students become involved in and gain "ownership" of the process.
- All assessments now have a formative component.
- In the case of summative assessment, the results are immediately collated and the student gets immediate feedback about their grade for that assignment.
- The lecturer's workload is reduced allowing for more frequent assessment points.

Clickers have undoubtedly established themselves as an invaluable teaching tool for many knowledge based courses. In a Design studio context they are yet to make an impression. The next step will be to trial this hypothesis in context.

II. TABLET PCS AND ELECTRONIC FEEDBACK

Tablet PCs are highly portable notebook computers typically equipped with wireless communications and a screen that can be written on with a "digital pen" called a stylus. This combination of features enables users to sketch, take hand-written notes, surf the internet, mark-up files and documents, and read email almost anywhere. Innovative new software applications are emerging rapidly as users dream about what might be possible and software developers race to be the first to satisfy these dreams. When placed in an educational environment this technology is enabling more efficient and effective work practices, particularly in regard to collaboration and communication. In the context of design

education the Tablet PC enables students and educators to digitally sketch. Wireless communication allows them to disseminate ideas in sketch format instantly to their audience for feedback and discussion. There are many reasons to utilise this powerful new design and communication tool but unfortunately financing and implementing these systems can be difficult.

C. Tablet PCs for Teachers

Tablet PCs facilitate communication, especially in the classroom. Kenrick Mock (2004) has used a Tablet PC to teach a computer science course at the University of Alaska Anchorage. He reports the following advantages of a Tablet PC connected to a data projector over the traditional blackboard;

- The lecture can be conducted entirely by drawing in digital ink without preparing material in advance, as is necessary with PowerPoint. Alternately, material can be prepared in advance and annotated during the lecture.
- The instructor can easily re-display previously covered material that would normally have been erased on a blackboard.
- Convenient access to multiple pens in different colors, widths, and styles
- Easy to switch to other applications (e.g. telnet, web browser, IDE)
- Digital ink can be saved and viewed later through a web browser.
- By standing off to the side, the instructor never occludes the screen and can maintain eye contact with the audience while lecturing.
- No messy chalk or nasty fumes from dry erase markers.

This has also been Freney's experience when teaching studio and CAD courses in the Industrial Design Program in the Louis Laybourne Smith School of Architecture & Design. Freney has also found that by using his own Tablet PC he can easily find particular files, shortcuts and links to favourite websites. Having quick access to these resources helps to respond to questions from students before they loose concentration and makes a lecture more dynamic rather than a predetermined set of PowerPoint slides.

D. Tablet PCs for Students

In the hands of students, interesting new possibilities are emerging as demonstrated by undergraduate students at Massachusetts Institute of Technology (MIT) competing in the 2002 International Design Competition. The Microsoft Customer Solution Case Study (Microsoft Corp., 2002) reports on a project in which 40 Tablet PCs were given to MIT students who were undertaking a collaborative design project which focused on a robot design;

"The Tablet PC was found to be uniquely suited to meet MIT students' needs. It enabled improved drawing and annotation of mechanical designs, which increases creative brainstorming. The Tablet PC also fostered collaboration and communication by means of MIT's extensive wireless network and easily handled data-intensive mathematical applications. These capabilities have led MIT to explore even more ways to use the Tablet PC on campus to benefit the learning experiences of both faculty and students."

In a report by Catherine Chambers, Professor Loukas Kalisperis of Penn State University Department of Architecture reports that having the tablet PC available has also increased the number of designs produced by the students. Kalisperis explains that not only are the designs "more thoughtful, more refined, and better tested," there are more of them, which creates an unexpected challenge for Kalisperis and the students. Before the Tablet PC project, students turned in three to four project boards each week, which were presented and reviewed with the instructor and peers. "Now, students are able to produce more drawings than they can possibly present in their fifteen minute time slot!" says Kalisperis.

E. Computer Aided Assessment

In the hands of design educators Tablet PCs offer new possibilities for providing feedback and assessment of design projects. Short turn-around time and higher quality feedback have been identified as being essential for students to learn (Hounsell 1997b), yet this can be difficult to achieve especially in the studio environment where submissions are often pinned to the wall or exist in three dimensional format. Tablet PCs coupled with suitable Computer Aided Assessment (CAA) software offer some useful solutions.

Freney has developed a CAA software application that enables the assessor to rapidly enter comments and allocate marks against assessment criteria (Freney and Wood 2006). When a CAA application is coupled with a Tablet PC the assessor is free to roam the classroom making assessments and providing feedback on work pinned to the wall. By use of a microphone it is also possible to record audio feedback and embed it into a "Feedback Sheet" using Freney's system. Then using wireless communications the Feedback Sheet can be emailed to students or to a colleague for review and moderation – all without leaving the classroom. This method of feedback and assessment in studio, and other courses taught in the industrial design program, is seen by students as being "fair" and easy to understand. It also provides many other benefits such as keeping digital copy of assessment and feedback information which can be consulted in the event of a complaint regarding a final grade. Denton (2003) has found that his CAA application, "Electronic Feedback" has enabled assessors to provide better quality feedback in a shorter amount of time.

In relation to the use of clickers in studio critiques it is conceivable that the results from the clicker responses could immediately (or automatically) be entered into a CAA application. The combination of an audio recording of the critique, peer assessment via the clickers, and swift online documentation and calculation of grades using CAA provides feedback and assessment in a variety of formats thereby catering to a diverse range of student learning modes.

Another possibility that has proven to be successful is a method for providing feedback on digitally submitted design projects such as PowerPoint presentations. By use of the Ink Annotation functionality that is a part of the Windows XP Tablet Edition operating system the assessor can digitally mark-up any Microsoft Office document (Word, Excel, etc.). PDF files can be marked-up using Drawing Markup Tools

functionality of Adobe Acrobat. Figure 1 shows a student's design for a hand held stab-mixer in an industrial design studio course in the Louis Laybourne Smith School of Architecture & Design. The outline of a hand has been "marked-up" and a hand written annotation accompanies it as feedback to the student clearly explaining how they could improve the design communication of the image. In response to the statement "I have received feedback that is constructive and helpful" 11 out of the 12 respondents in the design studio agreed or strongly agreed.

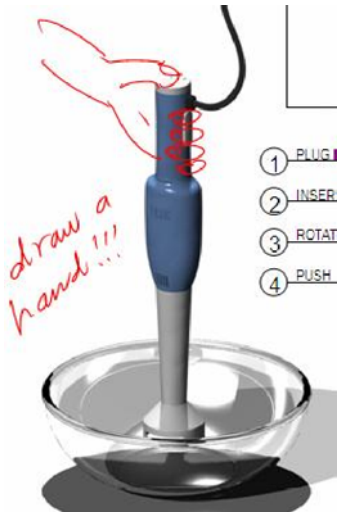

Fig. 1 Excerpt from student's PowerPoint presentation illustrating use of Ink Annotation functionality.

Despite the many advantages of Tablet PCs there are some significant disadvantages. They are far more expensive that a comparable desktop computer (although it hardly seems logical to compare them given the differences in functionality) and given their portability they are prone to theft and damage. White et al (2006) assert that support from Head of School, Executive Management and IT support staff are essential. "Institutional issues… are the most challenging and require a sustained and persistent effort on the part of those considering an innovation."

Given the growing body of evidence in the literature supporting the technologies discussed in this paper large scale investment in these systems may offer significant benefits for students, teachers and the bottom line, especially in design schools.

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