Implementation of a Teaching Innovation at the Rural Clinical School

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This paper describes a pilot project undertaken to investigate the use of an innovative Information and Communication Technologies (ICT) tool in the case-based learning program at the Rural Clinical School, Burnie. The ICT tool, an electronic voting system, was introduced to address perceived issues in interaction between students and lecturers, with the aim of improving student learning. Taking into account the cultural context of the Rural Clinical School, together with Hannan and Silver's (2002) pre-conditions for successful implementation of ICT innovations, the electronic voting system was trialed over second semester of 2007. The data collection feature of the electronic voting system enabled quantitative measurement of improvement in student knowledge during case-based learning sessions as well as feedback from students regarding the use of the system. Attitudes of teaching staff towards the innovation and its impact on teaching were qualitatively assessed. The degree of success of implementation of the innovation in terms of increasing student-lecturer interaction, and the factors contributing to this are discussed.

Introduction

"The Rural Clinical School provides a dynamic and innovative program delivered by a team of experienced and enthusiastic clinical academic and administrative staff" (Walker, 2007, p. 1). In this statement on the cover page of the year 5 and 6 medical student orientation program document, Professor Judi Walker underlines the fundamental reality that innovation lies at the heart of the very conception of the Rural Clinical School (RCS). The *raison d'etre* of the RCS is to enable medical students to develop the full complement of skills represented in the Bachelor of Medicine and Bachelor of Surgery (MBBS) in a rural context, the aim being to provide a solution to the chronic rural medical workforce shortage. To this end, University of Tasmania (UTAS) medical students are able to complete either or both of the final two years of their degree at the RCS.

Case-based learning (CBL) forms the backbone of the delivery of the year 5 medical curriculum at the RCS (UTAS, 2007b). Independent observation by members of the teaching team responsible for delivering the CBL program, identified that students were reluctant to interact within CBL sessions (R. Moore, personal communication, 2007). Naturally, this caused concern as interaction in the classroom is crucial to the successful execution of the CBL format (Jones, 2006).
Why is it students are so inclined to hold back and refrain from engagement or contribution in these learning situations, which are intended to enable the development of these critical skills? Sarikaya, Civaner, and Kalaca (2006), studying

the anxieties of medical students related to clinical training, conclude that medical students are afraid of making mistakes, and they do not want to look awkward in front of patients or senior doctors. Lack of student interaction also makes it difficult for the lecturer to evaluate their teaching during the sessions. A desire to enhance the learning experience for year 5 medical students led to a search for innovative solutions to enhance student interaction resulting in the trial implementation of an innovative ICT tool at the RCS.

The innovation

An electronic voting system (EVS), otherwise known as an audience response system, is a system that enables live interaction during a lecture with a Power Point presentation. Via a hand-held keypad, each student is able to communicate with the lecturers' computer via radio frequency signal. The software adds a toolbar to the Power Point program from which interactive slides are constructed easily using drop-down template options. These provide a variety of multiple-choice formats to utilise the interactive facility. Examples include: checking prior knowledge; questions with ambiguous answers, or more than one correct option; collaborative learning in teams, and quizzes and comparisons (*Higher education applications*, n. d.).

Interactive engagement is one of the most promising outcomes of using an EVS (Draper & Brown, 2004) as it can promote student interaction in a number of ways. Brezis and Cohen (2004) describe its use in lectures for doctors and medical students as stimulating attention, its anonymity allowing a non-threatening realisation of knowledge gaps. Their evaluation confirmed that most attendees felt the system significantly promoted interest and participation in the lecture. There is emerging research evidence indicating that the use of these systems improves student learning outcomes (Kennedy & Cutts, 2005).

The rationale for adoption of the EVS has grown out of a recognition by the RCS academic team of a need to change the way products are created and delivered (Tidd et al., 1997, cited in Alexander, 2006), and its use would primarily be to help achieve the defined aims of the medical course, and to foster fundamental critical thinking and promote deep engagement with the subject matter (Biggs, 2003). Thus integration of the tool within the case-based learning format would constitute an innovative process change.

Planning successful implementation

The UTAS teaching and learning development plan is outlined in the EDGE statement (Hart, 2006). EDGE is an acronym for the four key issues identified as cornerstones for the university to achieve its aims in the development of teaching and learning: Excellence; Growth; Distinctiveness; and Engagement. In expressing and expanding these elements in the context of the teaching and learning development plan, under "growth" it is stated that we must ensure that teaching facilities are supportive of new teaching approaches, and that flexible teaching and learning approaches are essential. Further to this, uptake of emerging ICT tools, which provide flexible approaches to learning is encouraged at UTAS (UTAS, 2006), with the goal of providing the opportunities for students to develop generic graduate attributes. The desirable generic attributes of graduates of UTAS are: knowledge, communication skills, problem solving skills, global perspective, and social responsibility (UTAS, 2007a). EVS tools

are designed to develop specifically the first three of these. Bearing these factors in mind, implementation of the EVS innovation was congruent with UTAS teaching and learning priority issues.

Another consideration was whether the EVS was a suitable innovation. Westera (2004) provides guidelines to educational innovators for the implementation of new technologies in education. These are applicable to this specific innovation. He suggests that devices should be “transparent and interactive” (p. 514), which implies sensory involvement, conceptual understanding of the operation of the device, and operational involvement. He also suggests that the involvement of learners is enhanced by linking the technological product with lifestyle and emotions; he recognises that this insight is superficial but concedes its power. The fact that similar devices are seen often in use on television game-shows is a relevant example of this phenomenon. He states that technology should take education “beyond efficiency” (p. 515), making it “interesting, attractive, entertaining, challenging, pleasing, intriguing”. The hand-held keypads satisfy these criteria, being operated intuitively by a variety of audiences in differing contexts. They are similar in size and design to the numeric keypad of mobile phones, linking the mode of communication of the EVS explicitly with the ways in which participants in contemporary society communicate.

Having confirmed that this innovation is consistent with the stated UTAS teaching and priority issues, and satisfies Westera’s (2004) guidelines for implementation of new technologies in education, the focus turned to the suitability of the local teaching culture within the RCS. This was a critical element of the project as the innovation was to be introduced to the whole program, therefore requiring uptake by a number of teaching staff. Factors in the literature predicting successful implementation were therefore considered.

Alexander (2006) identifies the following issues as crucial to successful dissemination of an innovation: the perception of academics that implementing the innovation would increase the quality of student learning outcomes; the existence of a champion of the innovation (other than the original developer); commercialisation of the innovation process, making it easier for others to adopt the method; enthusiasm of participating teachers, and ease of adaptation of the innovation to the teacher’s own context and values.

The major obstacles identified in the planning phase were that the use of the EVS in practice would depend on individual teachers recognising its value and being prepared to adapt their own style to include it in their teaching; and given a theoretical acceptance of the value of this innovation, the lecturers would also need to be willing to learn the ICT skills necessary to implement it. Previously, there had been no use of an EVS at the RCS nor by any of the lecturers. Another problem was the short time line available. The initial planning took place in July, 2007, and was completed at the close of the academic year in early November, 2007.

Project Methodology

The implementation process

A presentation regarding the educational applications and potential of the EVS was made to the RCS academic team, and received very positively. The head of school agreed to purchase the system. It was clear the staff of the Rural Clinical School had recognised the need to increase student interaction in the CBL component of delivery of the School of Medicine curriculum, and a collegial environment existed within the school, which was essential to develop and nurture the innovation towards eventual successful dissemination.

To foster the successful implementation of an educational innovation, D'Alessandro and Jackson (2006) suggest the formation of a project team encourages the process of interaction between academic and support staff at the various stages of implementation. Accordingly, a group of clinicians and support staff formed a steering committee/ reference group to enhance ownership, uptake, and functionality of the innovation. The group included the medical education advisor, the RCS IT support officer, the office manager, and two senior lecturers in Rural Medicine.

The experience correlated well with Hannan and Silver's observations (2002) regarding the qualities of institutions which nurture successful innovation:

- innovator feeling secure within an understanding community,
- recognition of the need for change,
- encouragement from the head of department, and
- financial resources available from the department.

The time between initial planning and the decision to acquire the EVS was three weeks. It took a further three weeks to obtain the system, as various commercially available systems were considered. It was decided that the most suitable system was the "Turning Point" system. It was chosen as it had already been used in higher education applications in Australia (Williams, n. d.), and had a well designed web-based training program. The system was introduced into the CBL component of the course without warning the students, in order to avoid any preconception bias in student feedback.

Research questions

The overarching theme of the project was to enhance student learning through improved student-teacher interaction. The initial research question guiding the implementation process was "does demonstrating improved student performance during a teaching session positively influence teachers to implement the technology?" Implicit within this question is "how well do students engage with the technology?", and "does the increased student-lecturer interaction inherent in the application of EVS enhance student learning?" Subsequent questions, dependent on successful implementation, include "what factors about the technology influence uptake by staff?" or "do staff perceive that the system has the potential for improvement in student learning?"

Evaluation

To answer the first research question, “does demonstrating improved student performance during a teaching session positively influence teachers to implement the technology?” the initial design of the project structured the use of the EVS around administering a set of multi-choice questions, drawn from the core subject material to be covered in the specific CBL, both before and after a CBL, without giving the answers initially.

EVS responses during a teaching session therefore provide a rich source of data for subsequent analysis. The data collection feature of the EVS enabled simple quantitative measurement of improvement in the number of correct responses by the students. The results gained from three CBLs were reproduced graphically or in tables, providing descriptive statistics for comparative purposes. No formal statistical analysis has been attempted, due to low numbers (13 students).

Qualitative student feedback, regarding their experience using the EVS, was able to be collated easily by using the EVS. This was used to address the second and third research questions: “how well do students engage with the technology?”, and “does the increased student-lecturer interaction inherent in the application of EVS enhance student learning?” Qualitative feedback from teaching staff using the system was obtained during the trial by informal discussion recorded by the researcher and, at times, in-class observation of their integration of the system.

As successful implementation of the EVS was essential to answer the subsequent research questions “what factors about the technology influence uptake by staff?” or “do staff perceive that the system has the potential for improvement in student learning?” to limit the use of the EVS to the pre-post CBL question format would have placed an artificial limitation on the project. Indeed, once staff had successfully used the system, they each expressed a wish to integrate it into their teaching in different ways, rather than being limited to the pre-post CBL question format. Thus in the interests of successful implementation and broader benefit to teaching, the collection of data in the pre-post format was limited to only three CBL sessions. Ultimately the most clearly defined measurable endpoint regarding successful implementation would be the RCS teaching team’s decision regarding whether to further expand the use of the system in the RCS program next year.

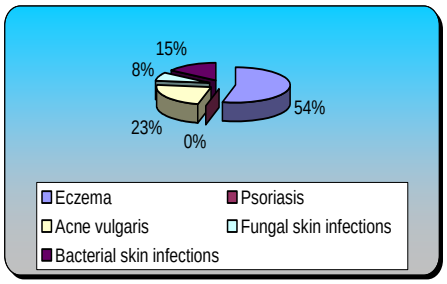
Results and discussion

Quantitative feedback

“Turning point” saves the data collected in Excel format. Each of the questions posed pre-post CBL were recorded in this way to allow comparisons. Two examples of answers to a multi-choice question posed pre- and post-CBL are reproduced in figure 1. This is an example of a question that all students answered correctly after the CBL. Not all questions were answered correctly by more students at the end of the lecture; an example of this is detailed in figure 2.

Before CBL

1.) Which of the following is the commonest skin presentation to the GP?	Responses	
Eczema	7	53.85%
Psoriasis	0	0%
Acne vulgaris	*3*	*23.08%*
Fungal skin infections	1	7.69%
Bacterial skin infections	2	15.38%
Totals	**13**	**100%**



After CBL

9.) Which of the following is the commonest skin presentation to the GP?	Responses	
Eczema	0	0%
Psoriasis	0	0%
Acne vulgaris	*13*	*100%*
Fungal skin infections	0	0%
Bacterial skin infections	0	0%
Totals	**13**	**100%**

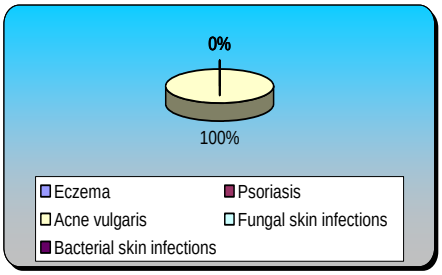
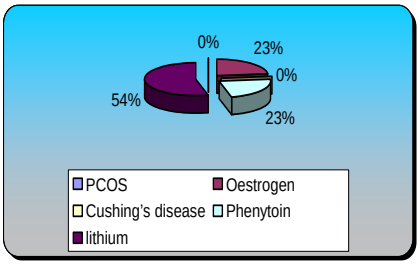


Figure 1: Example of results of an multi-choice question, administered before and after a CBL. Note. Correct answers are in italics

Before CBL

2.) Which of the following is not associated with causing acne?	Responses	
PCOS	0	0%
Oestrogen	*3*	*23.08%*
Cushing's disease	0	0%
Phenytoin	3	23.08%
lithium	7	53.85%
Totals	**13**	**100%**



After CBL

10.) Which of the following is not associated with causing acne?	Responses	
PCOS	0	0%
Oestrogen	*3*	*23.08%*
Cushing's disease	0	0%
Phenytoin	6	46.15%
lithium	4	30.77%
Totals	**13**	**100%**

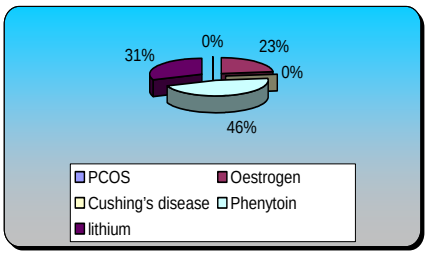


Figure 2. Example of results of a multi-choice question, administered before and after a CBL. Note. Correct answers are in italics

Table 1 indicates the number of students (out of a total N of 13) answering each question correctly in each of three CBL sessions related to dermatology, rheumatoid arthritis, and obesity. The number of students answering correctly increased reliably after each CBL. Of note is that the difference is less marked for the obesity CBL. Unlike the other two, the questions in that CBL were randomly drawn from a monograph, and had not been designed specifically to test the core knowledge being taught during that session. The questions for the other two CBLs had been written specifically by the lecturer to relate to the desired learning outcomes for that CBL session. It should be noted that the three CBLs in which these data were gathered were taken by different academics.

Table 1.
Number of Students Choosing the Correct Response Before and After the Dermatology, Obesity and Rheumatoid Arthritis CBLs

	Dermatology		Obesity		Rheumatoid Arthritis	
Question	Before CBL	After CBL	Before CBL	After CBL	Before CBL	After CBL
1	3	13	11	9	3	10
2	3	3	11	12	4	10
3	4	12	9	13	6	7
4	9	10	12	13	2	9

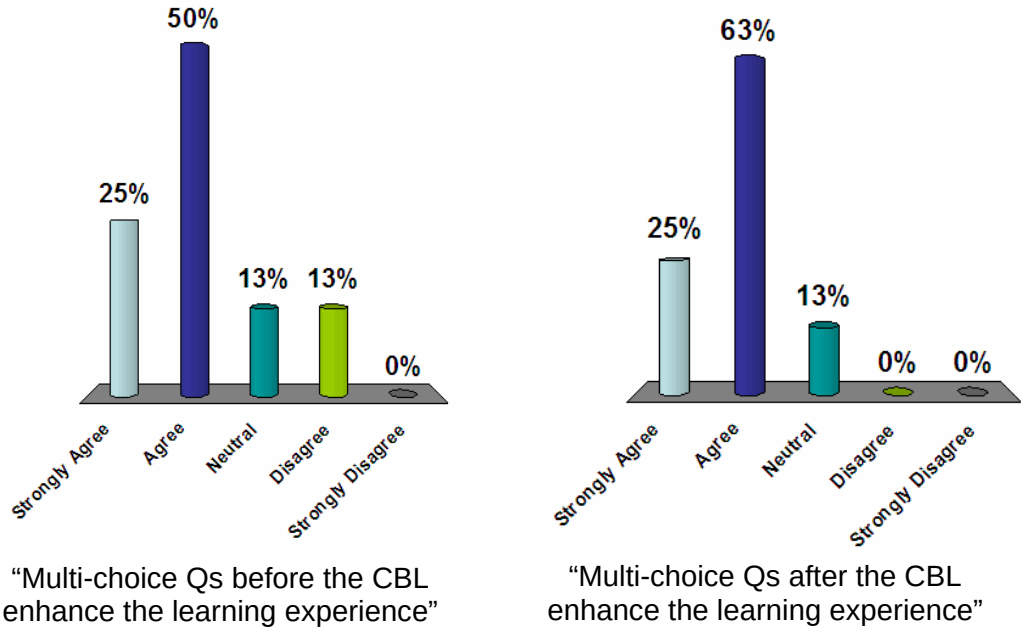
5 6	6	11	1 3	0 11	6	9
Average	5	9.8	9.8	11.6	4.2	9

Note. Total number of students in each class was 13.

On average, 6.2 students answered questions correctly before CBL, whereas 10.1 answered correctly following the CBL class. Therefore the results provide strong evidence that the EVS has measured learning that took place during the session. Furthermore, excluding the obesity questions yields an average of 4.6 students anwsering correctly before CBL, compared to 9.4 answering correctly after CBL, which demonstrates the greater average improvement in sessions with purpose designed questions. It must be emphasised that while improvement was able to be *demonstrated* by the EVS this improvement is not being *attributed* to the EVS. The project was not designed to quantitatively estimate the component of improvement, which may be attributed to the utilisation of the electronic voting system.

Qualitative student feedback

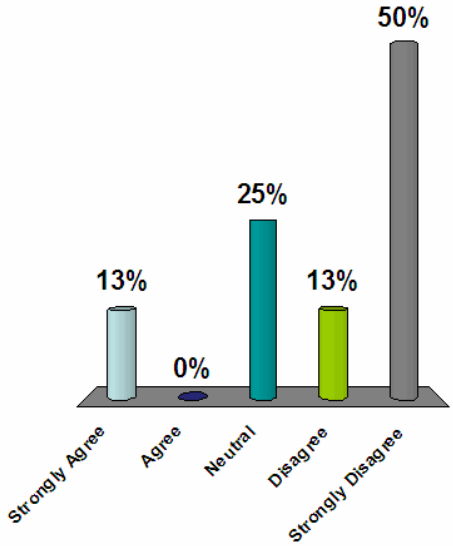
The spread of opinions regarding the pre- and post-CBL multi-choice question format, reproduced in Figures 3 and 4 below, raise some interesting observations. Some students did not "enjoy" the experience of being "forced" at the beginning of a session to answer a question when they were uncertain of the answer, without being given the answer immediately. These students became more vocal in their criticism of the use of EVS in this format as the weeks passed. It is worth noting that using the EVS in this way does negate the potential benefit it can offer of giving immediate feedback to students.



"Multi-choice Qs before the CBL enhance the learning experience"

"Multi-choice Qs after the CBL enhance the learning experience"

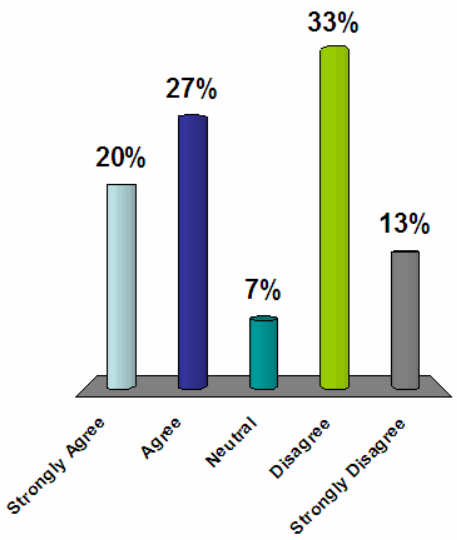
Figure 3. Students' opinions regarding completing multi-choice questions before CBL (left panel) and after CBL (right panel).



"I object to doing the same multi-choice Qs before and after CBL"

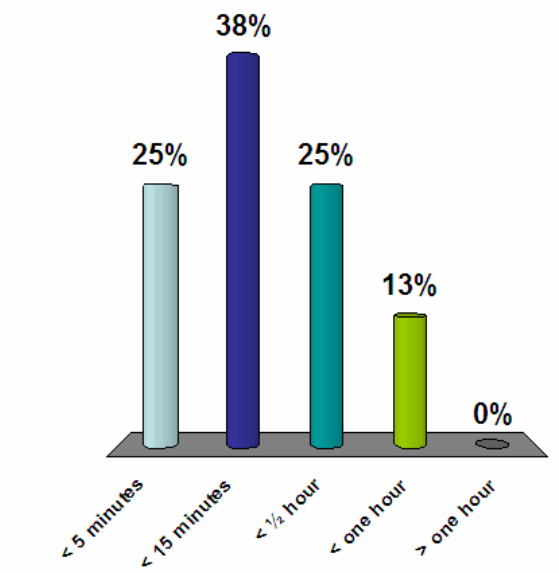
Figure 4. Students' opinions regarding completing the same multi-choice questions before and after a CBL

An observer in the class hearing the chorus of vocal criticism of the pre- and post-question format may have concluded that the majority of students disliked the system; however the results above (see Figure 3) confirm that the "silent majority" experienced a personal learning benefit from the use of the system this way. This echoes findings in the literature that suggest a specific benefit of EVS is its anonymity encouraging interaction and engagement (Simpson & Oliver, 2007; Brezis & Cohen, 2004); see Figure 5 below: This would seem to confirm that the anonymity for responders that the system offers is a significant benefit for a high proportion of students. It is interesting to compare this feedback from Figure 5 to the answers given to the regarding time spent pre-reading, as shown in Figure 6.



"The anonymity of electronic voting increases my involvement in the classroom"

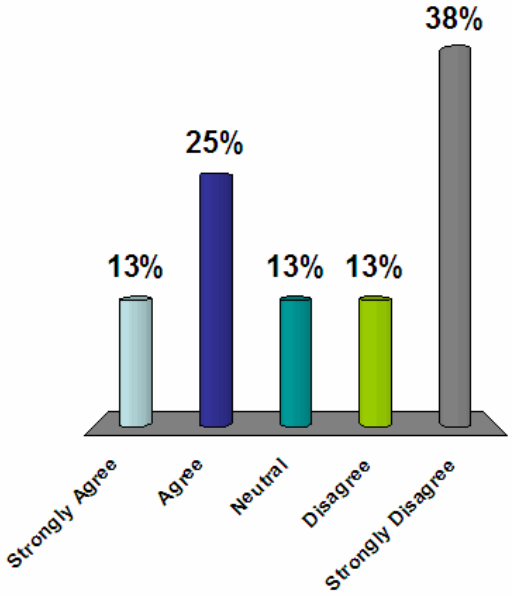
Figure 5. Anonymity impacting on involvement



"The *average* amount of time I spend in pre-reading for a CBL is:"

Figure 6. How long do you spend pre-reading for a CBL?

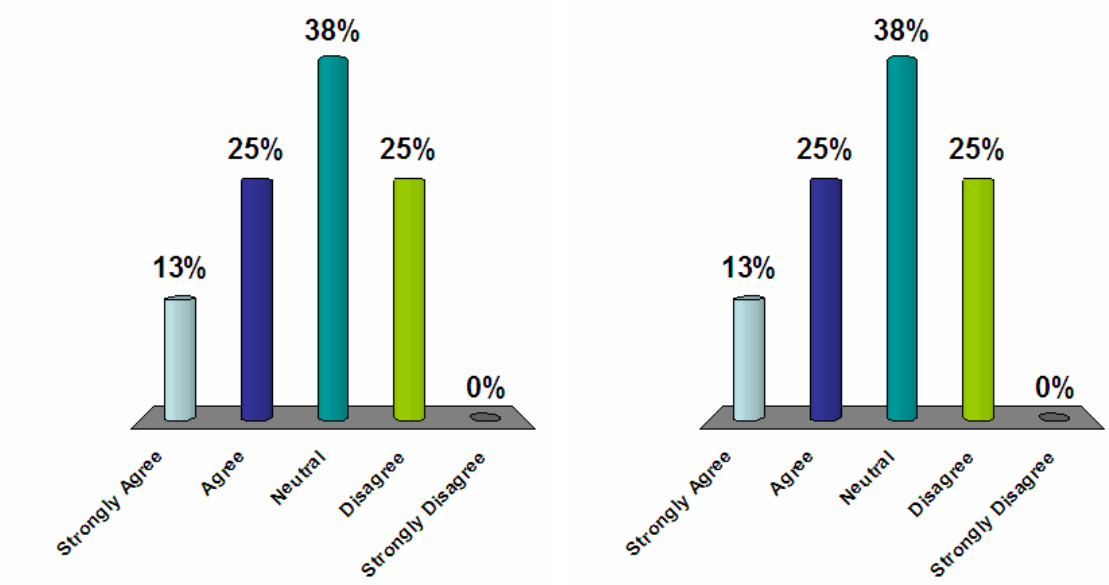
If the feature of the software linking responses to participants had been utilised, it would have enabled precise correlation between time spent pre-reading, and likelihood of being in favour of answering questions on the subject material before a CBL session. However, it can be hypothesised that answers regarding pre-reading may not have been as likely to be honest (see Figure 7):



"Linking individual keypad responses to participants would not bother me"

Figure 7. Opinions regarding participant list

The student group was surveyed twice regarding their impression of the impact of the system on their learning experience; see Figure 8 below. Of interest is that the results are *identical.* This spread of results is consistent with Simpson & Oliver's observations (2007) that students perceive both advantages and disadvantages of using the technology.



"Interactive voting (keypad multi-choice Qs can improve my learning"

Student responses mid-way through project

"Using electronic voting (keypad) multi-choice Qs enhanced my learning"

Student responses at conclusion of project

Figure 8. Students' learning experiences - data obtained mid-way through the project (left panel) and at the completion of the project (right panel).

A member of the project team reported informal negative feedback from students regarding the RCS budget priorities, listing the EVS among "frivolous" expenses. It is possible that a presentation to the students regarding its pedagogical underpinnings prior to EVS implementation may have altered this impression.

Qualitative staff feedback

The core teaching team at the RCS consists of five academics with fractional appointments; four come from a general practice background, and the fifth from emergency medicine. This team takes the CBL program. In addition, there are four specialists with fractional appointments overseeing (and doing) the bulk of teaching within their specialities. As the author is teaching in the CBL program, and it was from within that core teaching team that the observation regarding the need to increase interactivity arose, the proposal to introduce the EVS began in the CBL program. Each member of the core team has a different teaching style; and some are

more familiar and comfortable with PowerPoint presentations than others. Formal class teaching is in tutorial format. Initially, the entire team responded very positively to the EVS concept, but differed in their individual thoughts regarding how it would be best utilised.

Primary advantages of the system that were identified by teaching staff included the anonymity of responses encouraging student contributions, the likelihood that deeper engagement with the subject will be fostered as students are forced to confront their own level of knowledge and make a decision regarding an issue, and the benefits of immediate feedback that the system offers. This correlates well with the pedagogical principles that can be enhanced by EVS: that content transmission is not the most effective way of learning; that students' active engagement with ideas and actions supports learning; and that quality feedback should be provided to students (Simpson & Oliver, 2007).

Some initial skepticism was voiced regarding the use of the system in CBLs, expressing that the lecture-style question/answer format the system encouraged would be better suited to tutorials. However as mentioned above, once three staff members had used the system, the level of interest increased further, with individual determination to use the system in broader applications.

Staff observed once they had seen the system working, that the adaptation of their thinking and teaching style required in the construction of multi-choice questions to test the subject to be taught in a session forced them to take a deeper view of the subject. From their perspective, teaching was improved.

I note here that without the motivating factor of the graduate certificate in teaching and learning unit requirement to develop a university learning and teaching development project, this project would not have occurred. Similarly, the unit's requirement that a presentation be made reporting progress represented a significant watershed in the project's development. Many staff attended the presentation and the lively discussion continued for some time afterwards. One staff member came to me afterwards requesting a tutorial in the use of the system, having been inspired by the presentation.

Of note, after I was away for a week the next two CBLs did not employ the EVS; significant momentum in terms of ongoing use of the system had been lost. This is in line with Alexander's observation (2006) that the existence of a champion of an innovation, other than the original developer, is crucial for successful dissemination of an innovation.

The system is yet to be used in a specialist tutorial. Each of the four specialists mentioned above have expressed interest to varying degrees; one has visited my office twice for two training sessions in constructing interactive PowerPoint slides. "It's stunningly easy to use…experience shows that if someone can't use a piece of technology in the first five minutes, they tend to give up" ("Go back to school with interactive voting", 2006). Despite this, our experience confirms that the main barrier to having people work independently with the system remains the technical issue of familiarisation.

This aside, to date, the overall experience has been very positive with ongoing plans to deploy the system more broadly. A multiple-choice question paper is a major component of summative assessment in the fifth year medicine course. One RCS academic suggested using the system to run a trial multiple choice exam in the classroom. This was quite successful and represents an excellent opportunity to use EVS to align teaching with assessment.

Finally the decision was made November, 2007 by the core teaching team to purchase more handsets, which will enable us to use the system for combined 5th and 6th year lectures, or in other larger audience situations. A system that enables textual response, which will further broaden the system's teaching possibilities, is currently being investigated.

Conclusions

Qualitative staff feedback received and behaviour observed confirmed the observation that EVS can improve teaching, by increasing student contribution and engagement and providing immediate feedback. However the experience confirmed that a successful ICT implementation needs to be well planned, and must not rely on the expertise of an individual.

The majority of students felt the system impacted positively on the teaching environment. Some expressed annoyance at perceived unnecessary technical gadgetry. Of interest for future teaching planning was the finding regarding minimal student pre-reading, given the centrality of the CBL program to the year 5 medicine course.

Data indicated that a significant proportion of students valued the anonymity the EVS provides, positively linking it with likelihood of interaction and enhanced learning experience. It may be that the quieter students, who are less inclined to speak out or contribute openly in lectures, are experiencing the greatest benefit from the technology. To answer this intriguing question, further research using EVS with matched participants and increased sample size could attempt to correlate individual student-teacher interaction with student responses. The fact that the RCS team intends to invest in an expanded EVS indicates that the implementation of the innovation has been successful.

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