Clicking on or off? Lecturers' rationale for using student response systems

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Student response systems, also known as clickers, have been used in lecture theatres with large groups of students to stimulate interest in lecture materials and to provide a means of interaction between lecturer and students or between students and their peers. Whilst the related literature offers practical guidance on using these systems, questions relating to their impact on learning outcomes and best pedagogic practice are in need of further investigation. Discussions with colleagues and a literature review led us to the hypothesis that clickers provide little more than a false dialogue or a cul-de-sac towards the analytical thinking skills required in tertiary education. In order to support or reject this hypothesis, qualitative data collected from interviews with staff members who had used or planned to use clickers was examined alongside quantitative data collected from 177 students on their use. The results from this data support findings from other studies insofar as lecturing staff have adopted this technology in an attempt to stimulate interaction and student motivation in their lectures. The results also suggest it may be possible for lecturers to develop approaches for using clickers that align with both their personalities and discipline-specific contexts.

Keywords: clickers, student response systems, interaction

Introduction

While one gauzy image of a university education is that of a learned scholar holding forth on her or his subject to a rapt audience of students, the reality for many students is more akin to Walt Whitman's poetic depiction in *When I Heard the Learn'd Astronomer* (1892) of boredom, daydreaming, and learning in spite of the professor. Despite the best intentions of academics to avoid that situation, how much can they do when faced with tiered lecture theatres, class sizes of 100-500, and students who may not be entering into the learning environment with an eagerness to learn?

One plausible solution to this challenge is seen to be engaging students through interaction, involvement, and interest. Again, with large classes in restrictive classroom environments, this may seem unlikely. However, evolving technology aimed at creating interactions within these confines has won many instant converts who are willing to try anything. In particular, student response systems, a.k.a. clickers, appear to be a "hot" technology for this purpose.

Clickers resemble minimal (by contemporary standards) remote control "pads" with a series of numbers and/or letters that are typically held by each student or pair of students. The clickers are aligned with a software program that "…has two critical features. First, it gives instructors a wide array of presentation options (e.g., tests, quizzes, classroom participation, random selection of students, and so forth). … The second feature of the program coordinates and records all incoming information with a database of enrolled students" (Hatch, Jensen, and Moore, 2005). Depending on institutional logistics, students either purchase clickers (often bundled with a textbook), collect clickers from a class pool at the beginning of each lecture, or are assigned a clicker for the length of the course. Further, the ability of academics to use clickers as an assessment tool is largely dependent on that logistical arrangement in order to attribute clicker responses to specific students. Clicker usage is often compared to the polling that takes place on the television game show, "Who Wants to Be A Millionaire," whereby audience members participate alongside the contestants in voting for answers. The whole group response is shown to the contestant with the anonymity of being a crowd member intact. At first glance, clicker technology seems to be a reasonable tool for the tasks of instructors of large classes – an anonymous, interactive device that can potentially engage and involve students who otherwise would not perceive lectures as an opportunity to do any of that. However, as with most technology introduced in education, first glances are not enough. Are clickers an interaction saviour or a technological cul-de-sac or a context-dependent tool that is somewhere in between?

Oppenheimer (2003) cautions against educators jumping onto every new technology based on those first glances without critically questioning its pedagogical value. Through his research of how technology is actually used in numerous US schools, he suggests that all too often it is technology for technology's sake and that in a world increasingly saturated with technological gadgetry, educators have become distracted and entranced by the tools. Instead of focusing on how to use the tools in teaching the critical thinking skills especially needed in a technological/media driven culture, the educators' distraction has led students to be "…an increasingly distracted lot. Their ability to reason, to listen, to feel empathy, is quite literally flickering. Computers and their attendant technologies did not cause all these problems, but they are quietly accelerating them". A related message is supported by research in higher education in the United Kingdom. Based on a review of data collected from around eighty thousand students spanning five years Kirkwood and Price (2005) suggest "… teaching and learning in higher education are unlikely to be improved *simply* [sic] by the application of new technology" and conclude that the most important point from their study "…is that the medium itself is not the most important factor in any educational programme – what really matters is how it is creatively exploited and constructively assigned." Emphasis of this point is also made by Draper and Brown (2004) whose experience of using electronic voting equipment with students in lectures over two years was best supported when approaches made use of peer discussion and diagnostic questions.

Research on clickers

Hatch et al. (2005) report the origins of this technology which goes "… back at least to 1972, the current infrared versions have been available commercially only since 1999." Judson and Sawada (2002) provide a review and analysis of the use electronic response systems covering a span of thirty-three years. Amongst the earliest reported uses of electronic response systems (ERS) are examples with large science classes where the response system was thought to provide the students with opportunity to make "… immediate response to content questions and to inform the instructor of their level of understanding on specific concepts." This application of ERS in this way are considered alongside stimulus-response and behaviourist theories of learning which were dominant at that time. The conclusion of their study focuses on the instructional approach adopted when considering using an ERS.

As a relatively new technology research on clickers is not particularly illuminating with regard to answering the educational questions about it. Much of the literature appears to have been written by the "innovators" and "early adopters" seeking to create an "early majority" as the technology moves through Everett Rogers' stages of innovation diffusion (1962) and is focused on details about how the author or authors used clickers. Articles such as, "Twelve Tips for Using a Computerised Interactive Audience Response System" (Robertson, 2000), "Using Wireless Keypads in Lecture Classes" (Burnstein and Lederman, 2001), and "Audience Response System in Education: Supporting a 'Lost in the Desert' Learning Scenario" (Banks and Bateman, 2004) place emphasis on the use of clickers. Within these and other articles, several themes emerge that suggest the authors' beliefs in the benefits of clickers.

Participation and active engagement

"The use of keypads dramatically changes the typical one-way interaction between teacher and student in a short time and is a powerful learning tool for the instructor. It has also achieved our goal of greatly increasing the participation of students in the lecture class" (Burnstein & Lederman, 2001, 10).

Anonymity

"One of the best features of an SRS [student response system] is that it allows students to provide input without fear of public humiliation and without having to worry about more vocal students dominating the discussion" (Martyn, 2007, 72).

Frequent or instant feedback and monitoring

"They [clickers] allowed the instructor to assess student knowledge quickly and to monitor student learning. They have the potential to help both students and instructors identify students' misconceptions and deal with them at the time they are recognised" (Hatch, Jensen, and Moore, 2005).

Student learning

A theme that is not present in most of the literature on clickers is the impact on student learning. It might be assumed that increased participation and engagement automatically lead to increased learning, but this

assumption is not explicitly stated by many clicker proponents. Martyn (2007) investigated the link between clicker usage, its effect on participation, and its effect on student learning outcomes by comparing them to a class using discussion instead. Despite concluding that students perceived clickers as beneficial, she found that their learning outcomes (as measured by pre and post tests) were slightly lower than the class using traditional discussion methods.

Similarly, Barnett's (2006) study on students' perceptions of clickers suggests that students value their usage for reasons related to, but not explicitly, learning. In their responses about why they liked clickers, students in Barnett's study stated: receiving feedback on how well they understood the material (36.2%), enjoyed interactivity (22.9%), peer comparison (20.7%), feeling more involved (15.4%), getting exam hints (14.9%), and better learning (11.6%). Again, while "better learning" was the least common response by students, it could be argued that the other responses are necessary building blocks for learning. Barnett goes on to state that, "When it came to pedagogical advantages, students said that their learning was helped in three ways: increased metacognition, better learning, and testing." Unlike many articles about clickers, Barnett does not stop with just their positives. He also found that, "…clickers were perceived by students to have disadvantages. These were pedagogical, technical, and financial. … Pedagogically, the time spent by instructors fiddling around to make the clicker system work, took time away from dealing with course matters. … Another prominent disadvantage was technical. The students reported many technical problems that they had faced. They also noted that the clickers were limited to particular, narrowly circumscribed uses. … Finally, there is a financial disadvantage. Students are required to purchase a clicker and a registration code, whether they were taking one or many clicker based courses, in one or more than one academic term."

The critical jury is still out

As indicated, Barnett's study of students' perceptions of clicker use stands out among the sweep of literature that leans more to describing instructors' usages rather than critically analysing that usage. While the representative titles cited above and others such as, "Clickers: A Teaching Gimmick that Works" (Wood, 2004) and "Transforming Physics Education" (Wiemann and Perkins, 2005) all focus on usage, it is clear that many educators believe clickers are, at the least, a gimmick that works, and, at the most, have the potential to transform an entire discipline's education. This spectrum of support for clickers is aptly summed up by Hafner (2004), "Although some skeptics dismiss the devices as novelties more suited to a TV game show than a lecture hall, educators who use them say their classrooms come alive as never before. Shy students have no choice but to participate, the instructors say, and the know-it-alls lose their monopoly on the classroom dialogue." The point as to whether shy students having no choice but to participate seems questionable, but the notion of personal experience in their use in classrooms is worthy of pursuit.

As this selected review of clicker research suggests, the questions about their use and perceived effectiveness are somewhere between saviour status and cul-de-sac location. In order to build upon the knowledge base of existing literature and to better understand the potential of this technology for learning and teaching the views of the lecturers who had used and adopted clickers as a classroom tool seemed to offer a significant contribution to ongoing discussion. Details on the context of use, intentions, actions, and review of use provided by lecturing staff using clickers appeared to provide a critical perspective in order to explore the connection between this technology and teaching and student learning outcome.

Towards a viewpoint on clicker use for teaching and learning

Following an on-campus workshop demonstrating the operational aspect of clickers (setting up the software, setting up questions and collecting responses), we asked participating colleagues about the educational value of clickers from their own perspective. The discussion that followed and the viewpoints expressed arose from wide ranging circumstances and from the lecturers' own notions on what makes for good teaching and learning. This discussion prompted us to consider the hypothesis that clickers may offer little more than a false dialogue; the lecturers asking questions and viewing responses from students may think they are developing a personal and developmental dialogue with each student in their lecture, but this may not be the case. The quality of any dialogue of this nature might be too general to lead students to individual reflective practice. In essence, the dialogue generated through clicker use in a large lecture hall may be little more than a cul-de-sac, a dead end, in pursuit of analytical thinking skills required in tertiary education. Having reached this position, we set to finding evidence to support, refute, or perhaps qualify this viewpoint.

Research methodology and instruments

We considered three approaches to data collection for this study in order to provide data of a contrasting nature for subsequent comparison and triangulation (Cohen, Manion and Morrison 2000:112). These approaches included:

- A semi-structured questionnaire for the collection of qualitative data from individual interviews with lecturing staff who had used or were planning to use clickers;
- Quantitative response data from students in order to highlight issues from their experience of using clickers in their classes;
- Observation of students and lecturers using clickers in their sessions.

Lecturing staff attending the aforementioned clicker workshop were contacted and invited to elaborate on the teaching and learning issues relating to clickers already discussed. Seven lecturing staff from five different subject domains agreed to interview, five of which are reported in the following section. Each interview was recorded and transcribed for analysis. Response data from students was collected using the clickers themselves from two large lecture classes in one subject domain. This quantitative data collected was generated from five questions asked at the start of the final lecture of the semester and so formed part of the course evaluation and summary session. Peer observation of use was harder than anticipated due to the teaching schedule. At the time of writing, this approach has yet to generate any data but observations of clicker use with classes has been scheduled for the second semester of the current academic year.

Lecturer response data

The interview duration of the seven staff interviewed varied between thirty and fifty minutes. In general we found that colleagues discussed their educational perspectives on the use of clickers with interest; some were keen to show us the materials they had used or to invite us to observe the use of clickers with their classes. A number of problems on the use of clickers was reported relating to technical or set-up issues, many of which had been experienced during their first use in lecture classes.

One colleague interviewed first experienced clicker use at a European conference presentation. With this awareness and interest, he researched a number of articles on their use and educational benefits, finding that clickers:

> … increased student learning quite substantially, also they increased student enjoyment of lectures, people didn't fall asleep and even they increased student attendance, so students, you know, present were getting 50-75% of enrolments to a lecture particularly and I think the prediction was to go up to 80% who used clickers … I thought I would try them out.

He used clickers with his first and second year undergraduate groups of 250 and 40 students respectively. Of the six lectures where clickers had been used with his second year students, three failed due to technical reasons and to the short set-up period at the start of the lecture (10 minutes). He adapted his course materials to incorporate clickers into his class in the following way:

> …typically [I put] four clickers slides into each lecture and I find it takes two or three minutes each so those four slides…they are dispersed across the lecture. They take about ten minutes in total … I have one which looks back to the previous lecture to see if they have retained anything… then typically two during the lecture where there are key points. I want to see if they have understood the key points, so just after explaining some slightly more difficult topic I will ask a question to see if it really sank in.

The questions used were multiple-choice usually with just one right response. He reported "…looking for about 75% correct to be confident that they've really got the point and usually that was the case." Where the correct response to a question was less than 75%, the lecturer said he was unsure about what to do - whether to go back and to review material or to carry on - but that such a situation had not yet arisen. A number of the questions required students to use prior knowledge and reason before making their responses. Whilst the options available offered one correct response, other options were partially correct. It was this kind of question that the lecturer thought would help develop students' conceptual understanding. In this class, students were each provided with their own clicker but the lecturer also encouraged group discussion when selecting a response.

The second interviewee chose to use clickers as a means of enhancing communication with groups of over 200 students in his classes. He became aware of clickers from information available on websites, but it was a local demonstration of their use which gained his attention. Clicker use in these sessions was seen to be an extension of his use of flash cards to collect student responses:

> …clickers [were] another way … to do something on an individual basis. It's not ideal because you don't get true feedback, you only get a sort of a representation of what people are doing. At least they are engaging, so it's sort of a step back in a way [but it's] probably more engaging than a lecture where you just stand up, and there's no engagement.

After using clickers in his classes for over two years, he found that students soon became accustomed to them. He reported that using clickers has little effect on the way he prepares his sessions; the inclusion of questions are an addition but he saw these as adding a level of interactivity to the class, an aspect which he identifies as increasing student motivation and enjoyment. In terms of teaching style with clickers he reported:

> … I think that you've got to be fairly relaxed with your teaching. You throw a question out and then the lecture theatre becomes very noisy. That's because they are stimulated, they're talking about it, you know and then the same happens, you give the results, you show them how everybody's responded and then suddenly the noise escalates again, so you've really got to at that point stand back and just realise that's a good thing, they're engaging.

From a broader perspective he described technology as a useful tool for teaching which may not be appropriate for every class because of class size and other factors.

Our next interviewee was introduced to clickers by a departmental colleague. Our interviewee tried them in one of her first year undergraduate classes with approximately 280 students. Technical problems with computer equipment in the lecture resulted in set backs in their use. The short turnaround time between one class ending and her own starting, usually with students wishing to ask her questions, was identified as problematic. When the clicker system was operational, the tutor reported some success with the students. She commented on her expectations when using the clickers:

> I thought the clickers gave them a chance to try out their ideas or their answers, and then we could discuss them, like what do you think is true… so it's not like non-threatening but it gives them a chance to test, to make them think.

In her class, students worked in small groups each making decisions on and thinking about the issues in the questions presented though the lecturer thought this approach "… was not as good as the individual". This lecturer had also used clickers with a postgraduate group of 20 students coupled with the use of a computer blog. The responses provided were reported to allow the students to assist the lecturer in steering the direction of the lecture. The anonymous response provided by the clickers was found to have a degree of success with material that might be of a personal or emotive nature, such as asking about personal experiences related to the class content of child psychology.

Our next interviewee had not yet used clickers with his classes but had expressed an interest in doing so. His interest arose from materials he had read in a publication relating to his own subject domain reporting that clickers had improved student's understanding of concepts in large lecture classes. This led the lecturer to consider that the use of clickers with a large lecture group was one of the "… the easiest things that we can do to increase our student learning in our lecture classes". The lecturer reported on his observations of student reticence to respond to questions in classes:

> … Only about one third of the students ever hold up their hand because they don't want to feel that they've made a mistake and held up their hand to a stupid answer, so the clickers allow the students to be anonymous [and] allow them to interact, and that's important in their learning that it's not a passive process, it's an interactive process.

The lecturer explained how clickers could be used to try to identify conceptual misunderstandings at the time they may be occurring. This provided a means of feedback to establish how well he was teaching. If faced with a correct response rate of about 60%, the decision to review the material with the whole class was in doubt.

Our final interviewee was also yet to use clickers with a class. He became interested in their use as a result of increases in class size. The teaching approach he had previously favored was to develop dialogue with each class member based on issues and questions posted via the online learning management system. With a projected class size of over 100 students, he considered the use of technology to support student-lecturer dialogue and clickers seemed an appropriate technology to use. He described how Socratic dialogue was used between class members where students are asked to consider responses made by other students in the group:

> I've gotten to the point where I hate the lecture, so what I do is [I] put my assignments up on the web and the students download them… I walk in the class and I say, "Frank what did you get for number question one, Susie, do you agree with Frank? You know, Harry, what do you think about that, question number two, you know, Jane what did you get?" And so that's how I do my class.

Though students are reported to not like this approach to begin with, the interviewee reported that they would soon change their views with many students eventually providing positive responses on class evaluations. The lecturer reported that this worked well for class sizes up to 50 or 60 but with more than that something further was needed. By providing students with their own clickers and by noting the reference number for each the response made by each student can be recorded from an ongoing tally of correct or incorrect responses to questions asked in class. Recording the students' responses was seen to add a degree of social accountability. Related issues on the quality of dialogue that could be developed through clicker use with a group of over 100 students in class were also yet to be explored. This approach raised further issues for the lecturer in terms of the cost and access to the clickers for each class. He was currently exploring the possibility for students to purchase their own clickers for his classes. Cultural issues were also identified as a possible challenge to developing dialogue; what worked in one country may not work the same way in a different country.

Student response data

One of the lecturers interviewed provided us with access to two of the lecture classes in which he had used clickers throughout the semester. Each class was a first year undergraduate class studying topic related materials. In collaboration with the lecturer, six questions were constructed and presented to the students at the start of the final class of the semester. Student responses were collected using the clickers. Each question was presented to the group for one to two minutes. On completion of the questions the response summaries were presented to the groups and we were invited to add any comments to the students or ask any further questions. The questions used and a summary of responses are presented in table 1.

Discussion

Due to our collection of data across a variety of disciplines and with an equally varied group of colleagues, it is initially challenging to arrive at general understandings or lessons about clicker usage at our university. Despite the labeling of these instructors' efforts as a "pilot project," their routes to using clickers did not depart from the same place as many of them had serendipitously come across clickers at the same time the university was seeking to trial them. Thus, when the opportunity to use clickers was presented, these participants appeared to come into the experience at the same time when, in fact, each of them had already researched or trialed them independently.

However, amidst this variability of contexts, the literature offers a number of points of comparison for lecturers' reasons for and methods of using the clickers. In agreement with other studies reported in the literature, the rationale for using clickers reported by our own colleagues is based on these three intentions: 1) to increase participation and active engagement in class, 2) to address the need for students to remain anonymous in order to participate in large classes, and 3) to provide frequent feedback.. In relation to the literature with regard to connecting clicker usage to improved student learning, none of our colleagues, save one, explicitly made that claim. Consequently, it appears that the lecturers interviewed in our study chose to use a new technology in their teaching with the overall assumption that it would positively impact student learning and with the view that participation, engagement, anonymity, and feedback were tangible benefits of clicker use. Interestingly, though, they did not seek to pin that final hope of improved learning on clicker usage. In our view, this sober estimation of clickers by the instructors is sensible in that they have not fallen sway to seeing this, or any technology for that matter, as the "silver bullet" to solve all teaching and learning challenges. Indeed, Oppenheimer (2003) would be

Table 1: Student reponses to clicker use in sessions

		Overall n=177	As %
The most beneficial outcome of using the clickers in this class was to:			
1	Explore our understanding of concept and idea	84	47.5
2	Explore our understanding of demonstrations	12	6.8
3	Help you and the lecturer interact	56	31.6
4	None of the above - they were of no benefit to this class	48	27.1
What role did clickers have in the learning environment in this class?			
1	Irrelevant	26	14.7
2	Interesting	94	53.1
3	Useful	71	40.1
4	Essential	9	5.1
Were the clicker questions:			
1	Too trivial	7	4.0
2	Suitable for assessing understanding	77	43.5
3	Too hard to be useful	11	6.2
4	A mixture of the above	88	49.7
5	Not relevant to my learning	18	10.2
Did clickers:			
1	Increase your understanding	54	30.5
2	Increase you interest about the subject	14	7.9
3	Neither of the above	66	37.3
4	Both of the above	26	14.7
5	Other	40	22.6
How would you describe your interactions using the clickers?			
1	Minimal - I used them without really engaging with the questions	44	24.9
2	Limited - I used them but there are technological limits	24	13.6
3	Developmental - I used them and began to think about concepts and ideas	118	66.7
4	Fundamental - I used them and now see them as necessary for this class	13	7.3
If you had a choice of physics courses that all have the same content, which would you chose?			
1	Courses in which clickers are frequently used	60	33.9
2	Courses in which clickers are occasionally used	95	53.7
3	Courses in which clickers are not used but other technologies is	19	10.7
4	Courses in which neither the clickers nor other technology is used	26	14.7

pleased that they were not distracted by this technology and instead saw it as one of many tools that can be used to intentionally address some specific hurdles in their classrooms.

Additional comments were made by students in both groups. These included:

- Clickers were a waste of time; multi-choice questions don't make you think;
- Responses were useful to the lecturer to see what's going on;
- They were useful because they got you to talk to other students;
- They were good for revision, to test you understanding of a topic;
- They were useful for some subjects like physics, but not for others;
- The lecturer needs to allow the students time to think about the questions

In addition to finding complementary aspects of our research in the existing literature on clicker usage, we also sought to use the challenge of our variety of contexts as an opportunity to create classifications or descriptions in terms of approaches to teaching and learning with clickers. The number of classifications arrived at exceeded the number of approaches we had initially expected and we recognise that new classifications could be created through conversations with more colleagues. For the purposes of presenting these to our colleagues considering using clickers in their classes, we made use of a series of vehicle and driving analogies detailed in table 2.

In providing these analogies and descriptions we should point out that we do not see this list as comprehensive, nor are these analogies exclusive to different teaching and learning approaches. As a means of presenting concepts to our colleagues alongside technical aspects of the use of clickers, we found them useful in generating group discussion and for lecturer reflection on the pedagogical aspects surrounding the use of this particular technology.

Table 2: Analogies of clicker use based on interview data collected

Analogy	Description
Speed bump	questions and responses are used to slow down the delivery of the class content providing pauses where student and staff can review and reflect on what has been presented. This approach adopts between 4 and 10 questions prepared in advance and used at appropriate intervals throughout the lecture.
On ramp	questions and responses used to add interest and perhaps motivation, introducing activities to the presentation of material which may otherwise be dry or monotonous. This approach makes use of questions and responses in the same was as the previous analogy;
Thelma and Louise	based on the ending of the film of the same name by Ridley Scott, this is an all-or-nothing approach to using clicker and generating responses to further dialogue between lecturer and student. This approach represents a higher risk to use than other approaches and relies on the technology working effectively and students offering responses throughout each of the classes for the course;
Empty car park	students responses generated guide the content and style of the lecture. This name for this analogy follows from the marked out parking bays in an empty car park; despite the road marking and driving convention the driver moves in any direction of their choice.
Long distance trucker	this view looks at the course as a whole and considers the most appropriate route for the journey from start to finish. There may be periods where the driving is continuous (which we associated with content delivery) as well as stops and detours (which we associate with clicker use and responses)
Reduced visibility driving	the lecturer is guided by an intrinsic belief that clicker use is adding something to their sessions, but what this may be is unclear
Driving by the instruments	This analogy represents those lecturers who are looking for additional means of feedback to gage their teaching and how their students' understanding of the materials presented.

Conclusion

Through these conversations and subsequent analysis of the data, we have found our colleagues to be engaging with clicker technology in different ways but with the same general purposes, namely the improvement of their teaching and students' learning in large lecture classes. As noted, they are adopting this technology with a good degree of intentionality and rationale and do not appear to be entranced by technology for technology's sake. However, all that being said, we caution against an institutional adoption of this or any technology without regard to individual contexts. To do so could lead to a furthering of the vehicle metaphor - that of driving while distracted as suggested by Oppenheimer's vision of educators and students distracted by technology. With respect to our false dialogue hypothesis the responses from lecturing staff and from the student data lead us to consider further study into the contextual use of clickers and the activities students engage in surrounding use. The student data in particular suggests clicker use leads to increased understanding (see table 2) but these results reflect one subject domain and one context only. Based on this it seems likely that some movement from our hypothesis as stated previously is necessary, but further data from students in other classes is needed in order to determine the scale of such movement.

References

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

Banks, D. & Bateman, S. (2004). Audience response system in education: Supporting a 'lost in the desert' scenario. *International Conference on Computers in Education*.

Barnett, J. (2006). Implementation of personal response units in very large lecture classes: Student perceptions. *Australasian Journal of Educational Technology*, 22 (4), 474-494.

Burnstein, R. & Lederman, L. (2001). Using wireless keypads in lecture classes. *The Physics Teacher*, 39, 8-11.

Cohen, L., Manion, L. and Morrison, K (2000) Research methods in education. 5th Edition. Routledge Farmer, London and New York.

Hafner, K. (2004, April 29). In class, the audience weighs in. *New York Times*. Retrieved August 16, 2007, from http://www.nytimes.com

Hatch, J., Jensen, M., & Moore, R. (2005). Manna from Heaven or "clickers" from Hell: Experiences with an electronic response system. *Journal of College Science Teaching*, 34 (7), 36-39.

Judson, E. & Sawada, D. (2002). Learning from past and present: Electronic response systems in college lecture halls. Journal of Computers in Mathematics and Science Teaching, 21(2), 167-181.
Martyn, M. (2007). Clickers in the classroom: An active learning approach. *Educause Quarterly*, 2, 71-74.
Kirkwood, A. & Price, L. (2005). Learners and learning in the twenty first century: What do we know about students' attitudes towards and experiences of information and communication technologies that will help us design courses? Studies in Higher Education, 30(3), 257-274.
Oppenheimer, T. (2003). The flickering mind: The false promise of technology in the classroom, and how learning can be saved. New York: Random House.
Robertson, L. (2000). Twelve tips for using a computerised interactive audience response system. *Medical Teacher*, 22 (3), 237-239.
Rogers, E. (1962). Diffusion of innovations. New York: The Free Press.
Wiemann, C. & Perkins, K. (2005). Transforming physics education. *Physics Today*, November 2005, 36-41.
Whitman, W. (1892). When I Heard the Learn'd Astronomer, retrieved 12 October 2007 from http://www.ac.wwu.edu/~stephan/webstuff/poetry/Whitman-WhenIHeardth.html
Wood, W. (2004). Clickers: A teaching gimmick that works. *Developmental Cell*, 7, 796-798.

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Please cite as: O'Donoghue, M. & O'Steen, B. (2007). Clicking on or off? Lecturers' rationale for using student response systems. In *ICT: Providing choices for learners and learning. Proceedings ascilite Singapore 2007*. http://www.ascilite.org.au/conferences/singapore07/procs/odonoghue.pdf