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Promoting the use of clickers across a whole engineering faculty: how, why and is it worth it?

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Abstract: The use of electronic response systems (ERS) in lectures is well publicised and the benefits are well known. However, this technology is rarely used in day to day lecturing because the logistical obstacles such as booking response devices, distribution and collection during lectures and software availability in standard lecture theatres, outweigh the benefits for all but exceptional circumstances. Consequently, the faculty of engineering at Sheffield undertook a project with the main aim of removing these obstacles and thus obtain the advantages of ERS across the whole curriculum. This paper will consider several linked aspects and offers differing insights from authors covering different departments and roles. First, how to ensure that all students have a clicker, or response device, with them during lectures. Second, how to support staff so that they can use the technology with the minimum of preparation or forward planning; this includes issues such as availability of software and hardware receivers. Finally, it will evaluate the project in terms of its impact on the student experience, student learning and staff perceptions.

1. Introduction

Many authors have talked about the potential benefits of Electronic Response Systems (ERS) or 'clickers' within a lecture environment (Cranston and Lock 2010, Draper and Brown 2004, Kay and Le Sage 2009, Thorton and Groefsema 2006, Laws 2007, Russell 2008, Ramachandran and Haas 2010). Consequently, there is little debate that these can be a useful tool for some scenarios, improving student engagement and hopefully therefore, learning. Certainly there is strong evidence that students who actively attempt the questions posed use an ERS system, engage with the correct answer when it is revealed and thus either confirm their own understanding or lack of understanding, both of which provide useful feedback.

Given these observations and the well publicised issues with 'feedback' scores in the national student survey, it is reasonable for Universities to consider to what extent ERS could be a contributory factor to improving student feedback. Within the authors' institution, the equipment was available to academic staff and indeed the second author had used it several times with students enjoying the experience. However, the logistical obstacles to regular use were significant:

- The software was not readily available for staff to prepare slides in advance. Infrequent usage meant that preparation was neither efficient nor easy. The final quiz had to be sent to the centre for testing and final delivery.
- The clickers had to be booked in advance from a central section.
- Clickers were large and could not be delivered to the lecture theatre by a single person – at least not for classes of over 100.
- Time had to be made at the beginning and end of the lecture for distribution and collection – again not an inconsequential task with large classes and a 50min slot.

For these reasons, the devices were used by the 2nd author mainly for end of semester quizzes to help students assess their progress and preparation for the upcoming exams.

It was clear therefore that the University was not getting the most out of the ERS. The first author was

given a remit by the faculty to consider how one could improve feedback to students, without increasing staff loading and one possible target was to improve the use of ERS. However, for this to happen, it was necessary to overcome many of the existing logistical obstacles.

This paper looks at different aspects of the project that followed. Section 2 will look at the proposal, that is what methodology will enable effective and efficient usage of an ERS system by staff across the whole faculty and many modules; this include some discussion of how to convince senior staff to back the project. Section 3 looks at staff experiences of adopting the technology and assesses how successful it has been in increasing staff participation. Section 4 looks at the student experience and in particular, what is new here from existing papers, is the relatively broad and consistent usage of ERS across the curriculum. The paper will finish with conclusions, especially giving some thought to the differences between faculties and what might explain these.

2 Implementing the project: convincing and enabling senior and teaching staff to engage

2.1 Enabling factors and good practice

The authors' institution already had an example of good practice to follow in terms of making regular and effective use of ERS, that is the medical school. Medical students are loaned clickers for the non-clinical years of their degree and must bring them to all formal sessions. In addition to engaging them in their learning, they are also used for attendance monitoring and to monitor individual student performance on in-class questions as each clicker (and therefore associated response) has a personalised ID. The main enabling factor behind the efficacy within the medical school is that students had to carry a personalised clicker at all times.

A second enabling factor is linked to staff resource, training and dissemination. It is not uncommon for good practice to spread amongst academics more by chance than design because all the teaching staff are active in research and other duties. While training courses and awareness courses exist on new technologies and ideas, attendance is usually poor. Consequently, good practice often spreads when there is a champion in the department who can enthuse their colleagues (the champion must command respect) and provide some support and training to get colleagues started. Given these observations, the engineering faculty at Sheffield decided to use some its budget to create a two year teaching support post with the main remit of assisting academics in establishing new assessment and feedback practices, with an underlying goal of improving student experience and learning while not increasing academic loads. This Teaching Assistant (TA) had a relatively free role, to identify where there is most potential for benefit and to support staff either individually or in groups as appropriate.

One project the TA identified as having significant potential was to increase the use of ERS within the faculty.

2.2 Convincing senior staff

In order for ERS to be used more widely it was assumed that students would need to have their own clickers as any other mechanism would introduce substantial logistical hurdles. If it is not easy staff will stop using the ERS regularly if at all, even where they think learning could be helped.

Given the importance of improving student feedback and engagement within a learning scenario that will remain lecture dominated in the medium term, it was also a relatively easy conclusion that ERS was a logical and tested method for improving the lecture experience and thus would have a sizeable impact on most students learning. Given the current financial climate it was felt that the only realistic means of getting each student to carry a clicker was by the faculty purchasing these and loaning them to the students.

It is well recognised that senior staff, who ultimately fund projects, require relatively straightforward data to support their decision making [e.g. Rossiter 2008]. For example provide:

1. Good evidence of efficacy, such as usage in similar institutions, student evaluations, reputable articles, etc.

2. Give a well thought out proposal for how the project would impact on student learning and, specifically, how this would benefit the faculty and University. If some cash benefits can be described, even better.

3. Demonstrate that you have thought the more important logistical and implementation details

4. Give a detailed costing.

The TA, supported by faculty officers in L&T, presented this data to senior faculty managers who were then happy to put substantial sums into a pilot project for the 2011-12 session whereby clickers would be purchased for every incoming first year student and all staff engaged with year 1 would be supported in active and regular use of the clickers.

2.3 Administrative issues and convincing teaching staff

Staff involved in teaching will realise that the availability of technology is not enough for it to be used, for example many colleagues still use an OHP or whiteboard in preference to a computer, smart screen and data projector and relatively few record lectures (Nortcliffe and Middleton 2008) There is a need to convince staff that the technology will:

1. Improve their teaching (or facilitation of student learning).

2. Not increase their loading or preparation time in the medium term (they might accept a small transient increase).

3. Be popular with students because it is effective.

In the authors' view the 2nd of these is critical and thus a key enabling factor for any new practice is that staff perceive it to be easy to use. Without this, most staff may not even consider the potential benefits.

So, a critical task for the TA was to ensure that the software and hardware required by staff to use ERS was:

1. Readily available on staff desktops.

2. Readily available in ALL lecture theatres.

3. Question preparation was perceived by lecturing staff to be technically easy with effort focussed on constructing effective questions; that is in line with normal lecture preparation duties.

The TA chose TURNINGPOINT because of existing expertise of this software within the University and the reasons for the original choice remained pertinent (use with powerpoint and general ease of use). Many staff already have their lectures in powerpoint and thus the generation of questions for use in class is equivalent to putting one extra slide into your lecture slides and coding this feels just like entering a list into a normal slide. While some thought is required into designing these questions, the authors would argue the associated workload is no different from normal lecture planning and that is certainly the 2nd/3rd authors' experience (see Table 3.3). There was a need to persuade central computer services to provide the software on the University managed desktop (and thus on all lecture PCs) in relatively short lead time – much shorter than they normally require; this is where senior management backing can be a real help (Rossiter 2008). The TA provided individual staff with the software for upload onto their desktops and the final enabling factor was that lecturers needed to carry the dongle (which receives the clickers responses) to lectures and this is about the size of a memory stick so not onerous. Individual or group training and support documentation was made available to staff who needed it to get started.

Finally, what might seem a minor point but is nevertheless is critical: how were the clickers distributed to the students? The faculty wanted to retain ownership to ensure students respected the clickers and also wanted to keep a record of the electronic signature of each clicker so they could be used to identify individuals (for example for personalised feedback). Thus some tasks were required that were managed by the TA.

1. Collect student registration details during intro week.

2. Assign clickers to students' registration details and label all clickers with students' names and their registration number (names are not necessarily unique). Organise a distribution session where students 'sign' a document or conditions for the loan and then collect their individualised clicker.

It should be noted that for 900 students in the faculty, this is not an insignificant task and thus not all departments had the clickers for the start of term.

3 Staff engagement and evaluation

Usage of the clickers across the faculty was variable and this section aims to summarise how the clickers were used and by whom alongside some understanding of whether there were some clear patterns which explained this usage.

3.1 Usage in the Authors' department

In the case of the 2nd author's department, the chair of the Learning and Teaching Committee was proactive in getting all first year teaching staff involved in the project (Rossiter and Gray 2012) so there was consistent usage across all modules. There are five twenty credit modules provided by the department and clickers were used to some extent on all of these, as summarised in Table 3.1. It is clear that the majority of staff used the clickers regularly, even if not in every lecture. Exceptions are predominantly where the lecturer was from a different department (service teaching) and in one case where the internal staff member (near retirement) who did not use powerpoint and was initially resistant to change. The type of usage was also varied as listed in Table 3.2 and some comment on staff workload and quotes are given in Tables 3.3, 3.4.

ACS123 (Mathematics)	Used actively in semester 1 but not in semester 2 as lecturer from different department and uses solely the whiteboard.
ACS124 (Analysis + control)	Used in both semester 1 and 2 in most lectures.
ACS125 (Systems modelling)	Used in both semesters on a regular basis.
ACS126 (Computing)	Used occasionally (more by one member of staff than another)
ACS108 (Laboratory)	Very few lectures but used occasionally in these.
EEE150 (Electrical)	Delivered by a separate department – not used.

Table 3.1 Summary of whether and where clickers were used in a module in the authors' department

ACS123 and ACS124	1. Simple competency questions (can you solve problem A or not) – can indicate individual errors or sometimes when the whole cohort is struggling or even they can all do this (hurray!). 2. Competency questions with distracters to illustrate common misunderstanding or a simple error. 3. Test class progress and revision a few weeks after a topic was first done.
ACS125	1. After each theme to gain student feedback on where focus is needed – i.e. please spend more time on A and less on B. 2. Assess student progress so far. 3. Plan future lectures around responses.
ACS126 (Computing)	Predominantly in early part of course to gain student engagement. At end of course for all purposes listed in above two rows.
ACS108 (Laboratory)	Occasional use with some similarities to ACS125.

Table 3.2 Summary of learning usages in the authors' department

ACS123 and	A few minutes before each lecture to add in question slides as appropriate. Best done at the time so can take account of student progress so far in

ACS124	lectures and atmosphere. Question slides can be reused in future years.
ACS125	About 5 minutes before each lecture to prepare question slides and 15 minutes after lecture to provide extra resources and feedback if appropriate.
ACS126 (Computing)	Existing slides were extended with question slides to assess student understanding
ACS108 (Laboratory)	A few minutes before each lecture to add in question slides as appropriate.

Table 3.3 Summary of staff workload associated to clicker usage

- *A large number of students seem to be bringing them to lectures – perhaps encouraged by regular staff usage.*
- *Having to carry the receiver is somewhat irritating as I keep leaving it in the lecture theatre and then having to go back for it.*
- *You need to get software put on your computer to prepare questions.*
- *For the most part the questions have been effective in getting student interaction and engagement during lectures.*
- *They have also provided good feedback to the lecturer on issues where students are confused, or indeed most students are competent.*
- *There is a limit to the potential uses, for example questions with simple yes or no answers.*
- *I have not tried more advanced usages, partially due to time pressures and hence stuck with the tried and trusted slide of choose 1 from n options.*
- *Quite good for an end of term formative exam to test understanding of class as a whole.*
- *This was easy to do, took little time and improved student engagement with the lecture.*

Table 3.4. Staff comments on their experiences.

3.2 Usage in the other departments

Usage has been variable in the eight Engineering departments. In common with many Universities, teaching innovations are promoted from the bottom-up rather than the top-down. By that, we mean that while departmental teaching representatives decided to invest in clickers and support is offered to staff in their usage, it remains the individual's choice as to whether they embrace such an innovation.

The TA offered demonstrations of clicker usage in teaching to all departments and most took up this offer. Sessions focussed on the pedagogy. Multiple choice questions were used in different ways, including questions for peer discussion and simple testing. Sessions also showed how to create questions and further features of the software. Help documentation had also been prepared so staff were left with instructions for local usage. Follow up group sessions were also offered and one-one sessions in an individuals own office when the TA could also install the software thereby eliminating any reluctance with the software. The help documentation, software and examples of use was also shared with any staff requesting it, in recognition that some staff would prefer to work through things themselves and not attend training.

Departmental use currently varies from one department where there has been no use, a second department where one staff member used them once to the remaining six where there has been patchy use up to the second author's department, where usage has been most extensive.

The department where there has been most use received one group training session only. This is the second author's department and he had previous experience of using the clickers in teaching and acted as a local advocate. However other departments also had local advocates and they proved less effective. What seems distinctive about achieving high departmental staff usage is that in addition to a local advocate, the department also has a strong first year teaching team who both regularly discuss approaches to teaching and support one another in employing new initiatives.

3.3 Summary of staff usage and perception

There was not 100% take up of clickers by staff, even in the authors' department where their usage was promoted enthusiastically. However, the younger staff all adopted the clickers and even one member only a single year from retirement engaged, even though it would just a single year's delivery in his case. Staff who did not engage enthusiastically were largely chalk and talk in their approach to lecturing and thus it would have required a more substantial effort and change in teaching style to make use of clickers.

Staff in the authors' department were all very positive about the benefits the clickers brought to the lecture and would like the Faculty to continue its policy of providing these to students. The workload repercussions were considered largely inconsequential and absorbed easily into normal lecture planning.

More generally in the Faculty, it is recognised that we are still early into the lifetime of the project. While training of a nature determined by the department and their staff is important, it is clearly not the only factor. Anecdotal evidence would indicate that one positive experience of actual usage of the clickers is incredibly powerful. This need only be an observation of a colleagues teaching but it is observing the reaction of the students to interactive teaching which is the powerful bit. In the Faculty of Medicine where students were also bought individual clickers, staff usage increased steadily over time and over a number of years as opposed to a surge in use when they were first supplied. This reflects change models where "Innovators" and "Early Adopters" are followed by more widespread adoption. Many staff need to know that colleagues have successfully used a teaching innovation before they are prepared to experiment; they need to feel "safe".

4 Student perceptions and evaluation

The most fundamental question is to what extent did the usage of the clickers improve the student learning experience, engagement, feedback and of course, learning. Unfortunately without some form of control group, one cannot give particularly definitive conclusions on this and to form a control group would have huge ethical implications, and hence cannot be done. Indeed anecdotal feedback already suggests significant disquiet from the cohorts who had to wait longest to receive their clickers. However, on the positive side, there is strong anecdotal evidence that students were reliable in bringing their clickers to lectures which ironically could partially explain the dissatisfaction for those having to wait longest.

Consequently the evaluation is based primarily on student perception, although of course they will have had the experience of some lecturers not using these so can compare experiences across modules. An early evaluation on a module taken by Automatic control, Bioengineering and Aerospace (over 200 students) gave the following data in Table 4.1 Interestingly, despite being overwhelming positive about the use of clickers in lectures and wanting this to continue, the students were much less positive about the suggestion that they might purchase these themselves , the 'value' in cash, or indeed, that they should treat them with respect as belonging to the University. A simple summary is: "We want to use them but we also think the University should provide them."

Question	**Agree or strongly agree**	**Disagree or strongly disagree**
Using clickers in lectures is a good idea and helps my learning.	79%	5%
I find it useful to see how other students in the class have answered.	82%	6%
It forces me to engage with a question before seeing the answer.	68%	13%
Gives me immediate feedback on my progress	79%	5%
It is useful to help me see when I am making a common error, or have misunderstood a key point.	72%	12%

I would like to see the use of clickers carried on into my second year?	75%	8%

Table 4.1. Student evaluations from Semester 1 of ACS124.

In the end of semester module evaluations where students answered “Please tell us what you think about clickers in your lectures”, the responses were categorised into positive, ambivalent and negative. Throughout the faculty (excluding one department), 202 students responded and 82% of comments were positive, 9% ambivalent and 8% negative. In departments where clicker usage was higher, positive responses increased to 88% (the second author’s department). In departments of lesser use and even in the department where clickers were used only once, students were still able to see the benefit to learning.

The excluded department was the one where clickers weren’t used at all in the teaching. In this case, 42 students responded and only 33% of comments were positive.

In the comments themselves, the students identified the following benefits of the clickers to their learning:

- Engaging
- Interactive and involves all students
- Helps retain attention
- Identifies where they stand relative to their classmates
- Encourages competitiveness between students
- A fun way to solve problems
- Identifies understanding of material and any areas of weakness
- Reinforcement of learning
- Instant feedback
- Anonymity in responses important
- Method for directing future teaching

It does therefore appear that given an opportunity to use the clickers (however limited), students are largely very positive about their use. Where they aren’t used at all, but have been issued, they are not surprisingly, not at all positive.

- *Useful. Gives an insight into what the rest of the class think to a particular point or question. Allows you to see 'where you stand'.*
- *It is very good way to vote for addition of extra material that more students find difficult. It also gives you confidence in case of correctly answering a question or tells you what you need to work on in case you did something wrong.*
- *Very convenience and able the students to know their abilities in understanding the subjects.*
- *To take the view as we well as for evaluation of the subject.*
- *Allows us to see if everyone else makes the same mistakes so can be reassuring, sometimes.*
- *It doesn't make much of a difference, perhaps better if we got question we had to work out on paper.*
- *Lots of lectures don't actually involve them however when used for answering questions or giving feedback to lecturers I think they are very useful*
- *The use of clickers in questions during the lectures helped me gauge how well I understand the material so far and which areas I am weak in.*
- *In ***, we were able to anonymously vote on what additional material the lecturer could give us to help us - this was good as I tend to feel embarrased to directly ask for help and its a little comforting to know I am not the only one who struggles with the topic material.*
- *great way to answer questions confidentially from other students*
- *They allowed us (the students) to give feedback on where we were most struggling, and so enabled the lecturer to know which topics he needed to concentrate a little more on.*
- *They encourage students to be competitive. Clickers make it easy for students to give feedback.*
- *Helpful.*
- *It is really a fun way to solve the problem. We would do the working and use the clicker for the right answer which sounds fun for me*

• *They provide really useful feedback on what I have picked up in lectures and what I need to practice more. They also show how good I am doing compared to other students which is a important criteria for me.* • *They are great as they provide instant feedback and overview of your classmates.* • *Unnecessary as after the lecture the answers are not posted on mole* • *It's a great idea*

Table 4.2. Student quotes from semester 1

5 CONCLUSIONS AND THE FUTURE

Finally, is it worth the money and was the project effective? It is recognised that we are still very early into the Faculty of Engineering clicker project and it would be premature to make a full evaluation of its success at the moment. However, we can make some early conclusions.

The removal of obstacles was paramount prior to promoting staff usage. Issuing students with their own clicker removed any need for giving out clickers within the teaching session itself. Using software that was largely familiar (because it worked with powerpoint) and making it readily available to staff were also critical.

Getting staff to then use clickers in their teaching appears to be related to three factors: appropriate training, a departmental advocate and an active and supportive teaching team. The training both showcased teaching ideas and also demonstrated “how to”. The departmental advocate disseminates both formally and informally successful experiences and relates student opinion. However the third factor of a close teaching team who have a co-ordinated approach to teaching and readily support one another in change, seems in our case to have been the catalyst for mainstreaming the usage.

While the latter point about teaching teams appears to have achieved the most widespread use to date, it is not expected that at the University of Sheffield, that will be a common approach. A variety of teaching methods are currently commonplace and such variety both reflects the academics individuality and is considered beneficial to the students. A co-ordinated teaching team approach is unlikely to be replicated throughout the Faculty. Instead, it is hoped that as staff observe the use of clickers in teaching and acquire knowledge of their success on the students learning then this will motivate significant numbers of staff to appropriately use the clickers in their teaching. Furthermore as we continue to develop use, our own expertise will grow. An example of this is a recent formative test undertaken with the clickers, where the individual students results were recorded. The students were subsequently emailed their individual (and the cohort) test performance. Such new examples of use, particularly when it ties into the widespread need for efficient and timely student feedback, will promote use and harvest new academics prepared to adopt usage.

6 REFERENCES

Value Based Management .net. Rogers model for the adoption and diffusion of Innovations. http://www.valuebasedmanagement.net/methods_rogers_innovation_adoption_curve.html [Accessed 04/04/2012]

Cranston, G. and Lock, G. (2010), Who wants to be an aerospace engineer? Use of an audience response system to stimulate student learning in engineering lectures, Engineering Education, Vol . 5, No. 1, pp23-29

Draper,S.W. & Brown,M.I. (2004) ‘Increasing interactivity in lectures using an electronic voting system’, Journal of Computer Assisted Learning Vol 20, pp. 8194

Kay, R. H. and LeSage, A. (2009) Examining the benefits and challenges of using audience response systems: a review of the literature. Computers & Education, 53 (3), 819-827.

Laws, E., (2007), Motivating students using in-class question sessions, International conference on engineering education (Coimbra)

Nortcliffe, A. L. and Middleton, A. (2008) Blending the Engineer's Learning Environment through the use of Audio. Engineering Education 2008 Conference

Ramachandran, J. and Haas, O.C.L. (2010) Improving the learning experience for the first year engineering students using technology enabled activity led learning, Engineering Education Conference

Rossiter, J.A., (2008), Barriers and enablers to implementing mathematics and statistics support, MSOR Connections, Vol 8, No. 2,pp33-37

Rossiter, J.A. and Gray, L. (2012), Using teamwork to engage students and manage transition, Engineering Education Journal, to appear

Russell, M (2008) Using an electronic voting system to enhance learning and teaching. Engineering Education: Journal of the Higher Education Academy Engineering Subject Centre, 3 (2), 58-65.

Thorton, H. and Groefsema, M., (2006), Students perceptions on the use of an electronic voting system, HEA Annual Conference

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