Introducing and Using Electronic Voting Systems in a Large Scale Project With Undergraduate Students: Reflecting on the Challenges and Successes

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Abstract:
Electronic Voting Systems (EVS) have become a popular medium for encouraging student engagement in class-based activities and for managing swift feedback in formative and summative assessments. Since their early days of popularity and introduction some five or more years ago, the author's UK based University has been successful in refining strategies for their use across individual academic Schools and Departments, as previously reported at ECEL (e.g. Lorimer and Hilliard, 2008).

The focus of this paper is a reflection on the introduction of EVS with 300 first year undergraduate students in the School of Computer Science, within the context of a wider 'change' project in teaching and learning affecting the whole institution. The author examines what lessons can be learnt following this rapid scaling up of EVS activity both at a local level and more widely across an HE institution and in reflecting on the successes and challenges of this experience provides key indicators for success and useful support for others considering using EVS.

The paper first considers the landscape of EVS use within the UK and then the specific introduction of EVS at her own institution, before exploring the issues in her own academic School around the latest phase of their introduction as part of an institution–wide project to review measures to support assessment and feedback.

Keywords: electronic voting systems, change management, assessment, feedback, staff training, challenges, successes

1.0 Introduction to EVS at the University of Hertfordshire
The University of Hertfordshire has supported the use of electronic voting systems (EVS) for some years since they originally started appearing as a piece of electronic technology to support teaching and learning around 2003 in the UK. Sometimes known as 'clickers', the technology grew in popularity in the U.S. where EVS had been used in a more routine manner as part of regular classroom activities in HE as well as across the broader education sector. There are a number of competing EVS systems available commercially but they all typically comprise four elements for working effectively; an electronic hand-set per student or group of students, a digital receiver to capture responses from the individual handsets, lecture presentation software into which questions can be embedded, typically based around the use of Powerpoint™ and with the facility to collate and present the responses in a variety of ways, and the associated hardware to present the questions i.e. a computer and digital projector.

In our own early days of piloting them, sets of student handsets were available for lecturers to reserve for classroom use from the central learning support services. This requirement to pre-order the EVS was seen as rather unwieldy since time was required at the start and end of a class to first of all hand out the handsets and then collect them in again afterwards. This was not an insignificant commitment when there might be a class of over 100 students in an hour long lecture. Additionally the software and receiver were also required to be pre-ordered for each class. The developing practice of EVS and the design of questions for their in-class use was initially focussed on a small group of learning and teaching technology 'enthusiasts' (Moore, 1982) working across the different schools of the university. From this early interest in using the EVS for multiple choice questions (MCQ) and in-class quizzes, their use was taken up in local pockets of interest by those who saw an opportunity to

increase interactivity in the classroom,(JISC 2005). This opportunity to engage more closely with student learning and focus the in-class activities around MCQs was particularly developed at the University of Hertfordshire by those teaching in the vocational health related subjects and with smaller class sizes, (Lorimer and Hilliard 2007). At the same time the pedagogy and practice of the use of EVS was being researched and reported from a variety of scenarios across UK based HE institutions (Draper and Brown 2004;Kennedy and Cutts 2005).

Our institution's initial success might therefore be described as having been built up through a successful 'cottage industry', where local EVS champions crafted their expertise with groups of students and developed a series of action research projects in the process. The resulting interest in the pedagogy into the use of EVS and its potential for use in social constructivist approaches to learning was further developed in line with research outputs both from the University of Hertfordshire (Lorimer and Hilliard, 2007; Russell, 2008) and further afield, for example: Nichol (Nichol, 2007) at the University of Strathclyde, and Masikunas (Masikunas, Panayiotidis et al. 2007). All these researchers have indicated an increase in student engagement with the content of their learning when EVS were used regularly. The EVS technology was refined over the past five years and their use was no longer seen as only requiring a series of knowledge-based MCQs, where the expected answers are designed to be purely testing a student's knowledge in terms of Bloom's taxonomy of learning (Bloom 1953).

In 2008 the University's School of Life Sciences piloted the use of EVS with a complete cohort of undergraduates who were given a personal handset and retained it for use across their undergraduate careers until they graduated. As a result of this scheme there was a further increase in the training of academics and a necessary development of study materials to promote interactivity and engagement. This in turn led to an archive of local material and expertise which demonstrated some of the wide variety of ways in which EVS were being used creatively in the classroom by academics across the curriculum. The following examples indicate situations where EVS use became commonplace within the wider Faculty; group discussion and decision-making; ethical debates with a 'before' and 'after' poll; conditional branching, where students follow through the logical consequences of their initial answer to a question to its conclusion in a case study, (Lorimer and Hilliard 2009) as well as revision quizzes to test previously taught material.

In response to this increased enthusiasm among academics and students in Life Sciences where the use of EVS had grown over six years to become a regular feature of the student classroom, a cross-university project was drawn up to introduce the use of EVS across a much broader group of the university's campus-based students from September 2010. The aim of this ambitious project was to promote a culture change in the use of learning technologies by providing an impetus for the use of *inter alia* EVS by an extended set of academic schools and to increase student engagement in line with the University's own stated agenda for improving the student experience.

The project was designed and grounded in line with much of the previous work of the University's Learning and Teaching Institute in the principles for good assessment practice and feedback (Nichol and Macfarlane-Dick, 2006) and underpinned by the seven principles of 'Good Teaching and Learning' (Chickering and Gamson, 1999).The use of EVS had already become widespread in other institutions, (see above e.g. Draper and Brown 2004, Kennedy and Cutts 2005) but their take-up was not always valued beyond the increased student engagement in classes nor did EVS necessarily lead to an overall reduction in costs for the host School. Student satisfaction and their enjoyment of EVS had been identified as a useful marker of success, (Lorimer and Hilliard, 2008); however, the broader aims of this project wanted to delve into the nature of student engagement with EVS and see if their use could lead to measurable savings overall. These savings were envisaged as being primarily time savings through a reduction in the assessment burden for staff, reducing their marking load or replacing an examination with regular EVS tests. For some programmes engaged in the wider project there was an expectation of higher student retention rates (Nichol, 2007).

Following an invitation to individual Schools from across the university to bid for funding, the project proceeded with the provision of personal EVS handsets to nearly 4,000 students across nine academic departments for use throughout the second semester of the academic year for a minimum period of at least 6 months. Many Schools intended at this stage that undergraduate students should expect to retain their handsets throughout their university career. In practical terms this ambitious project required that a number of the academics in participating Schools would have to both undergo training in the use of EVS and to reflect personally on any necessary pedagogical changes to their practice to be made, once students were provided with a personal EVS handset. The overall project also required a necessary commitment to the scaling up of teaching and learning support, to solve the practicalities of organising the handset distribution to individual students, as well as considering the provision that needed to be made for the increased number of disabled students, who were now participants in the project.

2.0 The local situation: introducing EVS across a wider user group of academics
The situation in the School of Computer Science with regard to the use of EVS essentially mirrored practice across the wider university. There was a small group of enthusiasts who had been reviewing their pedagogy and developing their own practice continually since the original opportunity for the provision of handsets. During the previous year a small-scale 'change management' project, called 'Piloting Innovative Practice' (PIP) was developed in the School in line with Change Academy principles (Anderson et al, 2008; Doolan, 2010; Saward and Anderson, 2010). One mini-PIP project explored the potential of EVS in a non-traditional use for peer assessment and feedback for student presentations, as a new way of managing student engagement in class. This PIP was extremely successful in terms of engaging students and cutting staff time in administration of mark allocation and collection. It was subsequently demonstrated to other academics in the School, with the intention of gaining greater buy-in for the School's participation in the wider EVS project planned for Autumn 2010. The scene was now set for developing the use of EVS more widely across the School in the next academic year.

The University of Hertfordshire operates on a semester based system and throughout the first semester 2010-2011 between October and December 2010, there was much planning required for the introduction of EVS to a cohort in excess of 4,000 students. The School of Computer Science planned to introduce EVS with first year undergraduate students on the BSc Computer Science and Information Technology programmes, having previously worked with Masters students and final year undergraduates. Each student registered on the programme would be given a handset, which it was intended they would be able to use through the rest of their undergraduate programme. The importance of the anonymity of the handset user has been widely discussed in the literature, (e.g. Banks, 2006) but it was also important to know which handset belonged to which student so that they could be used regularly in summative testing. The process therefore required each student to have their handset registered to them and a central database was designed and linked to the managed learning environment (MLE) to accommodate this instead of individual schools keeping their own records. This also facilitated the movement of students between schools where their studies overlapped from one to another, for example students who majored in Business might also be studying Computer Science but should only receive a single handset from the university.

Academics teaching on the programme who were typically very experienced with teaching first year undergraduates were offered training and additional support for re-designing their materials as necessary, as part of their participation in the project. The central university project team offered seminars and developed online 'how to' videos of, for example, downloading student lists and how to register student handsets. The chosen provider of the EVS technology at the University of Hertfordshire was Turningpoint™; this was based on the prior experience of handsets and software used by the School of Life Sciences and the Radiography Department and from the comparison of user experiences recorded since the early days of using locally bought sets of EVS at the university.

The various reporting facilities of the software allowed student scores to be gathered (as they were linked to their personal handset) and thus the use of EVS for summative testing as well as for formative work.

2.1 A methodology for capturing the staff and student responses to the EVS

The author's role within the School was to both lead the project and to provide support for colleagues on a day-by-day basis as they incorporated more EVS-type activities into their teaching. The methodology for assessing and evaluating the introduction of the EVS to the cohort has used both qualitative and quantitative methods and some of the work in assessing the student experience is still ongoing at the time of writing. In addition the author provides her own reflections on the process and the outcomes of the project in the conclusion below.

A set of student-focussed questions with a Likert scale for answers was used by Computer Science to enquire into the student experience. The questions were incorporated into a presentation and used by staff at the end of a lecture to gather student opinions about using EVS (n= 50). Additionally, because the case for EVS use with students has been discussed widely in the literature the author was interested in the challenges that their introduction might bring to established teachers and so individual face to face interviews were held with a cross-section of colleagues in the School, those with prior experience of using EVS and those with none. Their comments are reported below.

3.0 Successes from the EVS project in the School of Computer Science

In this section the author considers four areas where the introduction of EVS could be judged a success, in terms of student and staff engagement with both the process and the outcomes and the way in which the outputs from the project have informed ongoing enquiry into assessment and feedback approaches.

3.1 Student engagement

It has been widely reported by *inter alia* Lorimer and Hilliard, (2008, 2009), Nichol (2007) that increasing interactivity in the classroom promotes a greater student engagement with their learning. The outcome from the student side of the use of EVS has been positive. As technically-literate students they rather predictably found the EVS 'easy to learn' and 'easy to use'. They particularly liked the immediacy of the feedback when EVS were used in class (80%) and would recommend their use for students studying the same module the following year and in other modules. They also widely agreed (74%) that 'using EVS helped my understanding of the module'. They did not all agree (54%) that the use of 'Weekly EVS questions were the only reason for attending lectures', but this could be attributed to the variety of styles of use by academics across modules. A larger group responding to the same questions in the Business School (n=200) had similar responses in terms of student use of EVS. This can be deemed a success for the local use of EVS. although the results could have been predicted from the many other national studies.

3.2 Staff engagement

Five undergraduate module teams committed to using EVS for some of their teaching from February to April 2011. Prior experience of their use was limited but some academics embraced the new technology with great enthusiasm, fired up by the examples and opportunities shown through the training sessions.

"Seeing different examples of experienced colleagues' use of the EVS inspired me to try other ways to use them myself." (Module tutor)

Other colleagues who had previously used EVS were keen to experiment with their use in large groups and seminars particularly now when the handsets were permanently linked to individuals and

they did not need handing out at the start of a class and their ownership recorded for that assessment.

"Being able to automatically link each handset with the student's personal ID really reduced the time taken for inputting and checking marks." (Module tutor)

Particularly popular were the use of 'surprise quizzes', dropped in randomly to the teaching sessions but with a small summative assessment element, to ensure regular attendance and high engagement. These were used by one module team with great success as the gathering in of marks was immediate and removed much of the burden of previous testing with MCQ style questions, marked by hand.

"*The 'drop- quizzes' proved to be a successful method for encouraging regular student attendance and engagement throughout the module.*" (Module leader)

Other teams explored the use of student discussion with EVS, before a group was required to give their joint answer, as a means of encouraging the students to articulate their understanding and to explain the solution to a problem to others.

3.3 Developing the User database

Much of the success of the EVS project and its embedding into the culture of the teaching of this cohort of first year undergraduates could not have been achieved without the initial design of the user database and its subsequent use for generating separate attendance lists of students registered for each module. The process of registering each handset to its student owner once and for all removed the time-consuming handing out and collection of handsets on a per class basis. Each handset has a unique barcode identifier and when the handsets were issued a barcode reader was used to register first the handset and then the student's ID card number. This was recorded on the university's MLE and provided an entry which could be searched either by student ID or by handset ID. In the case of a lost handset being retrieved, any lecturer in the university could access the database and arrange to notify the student of the return of the handset. Furthermore if students had their handsets piled onto a table during a discussion, it was easy to identify which handset belonged to which student. The student registration lists were downloadable from the central MLE and customisable for each module.

3.4 Building on previous work

The success of the project at a local level was also due to the leadership of the project at an institutional level. This had built on the success of the introduction of the university's MLE (Jefferies and Oliver, 2003) and its Blended Learning Unit (Bullen et al, 2009) which between 2005 and 2010 had encouraged broader use of technologies to enhance learning and teaching practice across the university and to develop associated pedagogies, to enhance the student experience. Accordingly, lessons learnt from prior use of EVS across the university were shared, with the more experienced users from the School of Life Sciences and the Department of Radiography exploring in seminars and workshops how they had developed their own 'best practice' guidelines in the use of EVS to build constructive formative assessments which served to encourage interactivity in class and greater student engagement with their learning materials. This enthusiasm was infectious and encouraged colleagues to take up the challenge.

4.0 Challenges of the EVS project

While some of the immediate successes of the project have been outlined above, it is however worth noting the challenges which were faced during the swift introduction of EVS across the nine participating Schools and in Computer Science in particular. These have been categorised in terms of the hardware and software issues, and staff time and ongoing training.

4.1 Hardware and Software Updating

Introducing new IT can traditionally be a challenging time for both project managers and IT users. The challenges might include the human factors issues faced by the users who are asked to incorporate new ways of working with IT and in this case to design new ways to present their teaching materials. Alternatively, issues may arise as a consequence of the timing of the upgrading of the IT hardware and software and the availability of technical support in a large organisation, where major tasks and associated planning of their staffing might be scheduled on a three to six month or annual advance planning basis. In relation to this project the technical challenges related firstly to the timescales of the EVS introduction and to a previously unanticipated need to install new EVS receivers on some of the classroom hardware, and secondly to software issues where there was an incompatibility issue with a previous version of the software, already installed on certain classroom based PCs. An upgrade of the software from the previous academic year when the Computer Science CABLE project took place meant that new software had to be downloaded by the academics. This was not in itself a problem as this was a simple web download onto staff machines, but the problem arose as a new digital receiver was required and the earlier versions of the software which were already loaded onto some classroom and staff machines were then found to be incompatible with this new receiver. The complexity of the project's roll out of EVS to academic staff was compounded with the nine Schools being based across two separate but linked campuses, which had different provision for software support.

The newer campus commissioned and opened originally in 2003 had an integrated software upgrade system whereby selected software products could be upgraded centrally for each classroom on the campus overnight. The older campus whose IT systems were historically supported at faculty level did not at the time offer a centralised software upgrade facility and the necessary upgrading of the Turningpoint™ software along with the installation of tamper proof hardware receivers had to be undertaken on a per room basis. The scheduling of this significant task was soon realised to be too great to be undertaken during the normal teaching timetable throughout the semester when rooms were rarely out of use for more than an hour at a time. The temporary solution for the Computer Science academics based on this campus was to use a dedicated laptop on which was installed the recent software upgrade which was compatible with the new receivers purchased and to take this along to their classes with the portable receiver. This then required rather more 'kit' to be taken to classrooms instead of the preferred option of using a memory stick with their ready prepared materials installed. This challenge will have been removed by September 2011 because a schedule of hardware and software revision and upgrading has been put into place for the summer months when the classrooms are less heavily scheduled, in preparation for the new academic year.

4.2 Staff time

Academic staff readily took part where possible in the training sessions offered prior to the start of the semester. Some of those newer to the lecturing environment willingly and enthusiastically prepared their teaching materials taking the opportunity to incorporate regular EVS sessions throughout the semester.

For those with a particularly heavy teaching load which included the cohort of 300 students, through February to April, there was much less time and inclination to change tried and tested ways of delivering familiar material to incorporate the newer technology and introduce greater interactivity than they were already. In some cases it was the smaller tutorial sessions where the use of EVS proved most successful and where students shared the opportunity to discuss their answers collectively before giving a group response.

This challenge will be approached by offering more local support for reconsidering the pedagogical issues related to social constructivist approaches of using EVS and associated course re-design during the quieter non-teaching periods of the summer. The module teams will thus be encouraged to

plan their regular use of EVS with greater elapsed time for planning than was available in the 2010 - 2011 academic year. Further training opportunities are being offered at both entry and advanced levels to promote the maintenance of the necessary skills.

5.0 The way forward: plans for 2011-2012
The old proverb states that 'Rome was not built in a day', neither can such a major change as introducing EVS across 4,000 students with the resultant impact on pedagogical approaches be fully achieved within a single academic semester. The lessons learnt in the School of Computer Science from introducing 300 students and lecturing staff to using EVS include those issues which arose internally and those which arose through external decision-making.

The enthusiasm of the core staff who have been using EVS regularly has been matched by the student engagement and enthusiasm for using the handsets. Plans have now been made to offer ongoing training so that this enthusiasm will encourage others to re-design and remodel their module delivery. It has become clear that local support is vital for the ongoing success of using EVS otherwise the use of this or any other newly introduced technology is likely to subside over time until the users include only those keen and already committed users. Building on the lessons learnt since the introduction of our university's MLE from 2001 (Thornton et al,2004), it is therefore planned to have a network of local EVS champions to support academic colleagues with technical issues and through the pedagogical redesign of course delivery. Over the next year this will help to embed a changing culture in the School which will encourage the increased use of EVS, after which each succeeding cohort of undergraduate students will be offered their own free handset on entry to the university. There has been a programme of continuing classroom support via our Equalities Unit for those students whose disabilities mean they do not have the fast reaction motor skills for using EVS in tests.

6.0 Reflections and Conclusions
The university's project to make EVS available to a far wider group of staff and students than previously envisaged has already (June 2011) had some notable successes. Students have expressed their enthusiasm as users of the EVS, where this has been measured across the university. Students appreciate knowing their results and receiving feedback immediately through the use of EVS, with the opportunity to learn from their mistakes and have the correct answers explained instantly. This outcome has been in line with past research into student experiences of their introduction and use. Further savings are foreseen at this institution in terms of redesigning summative assessments for the forthcoming academic year so that EVS can be used to save more academic time currently taken up with repetitive marking of scripts. At the time of writing not all results are available but a significant increase in first year retention rates seems likely.

As far as the pedagogy of using EVS is concerned this has been shifting for some time away from a culture where the traditional lecture dominates as a teaching medium and towards a more socially constructivist view of gaining knowledge. This process can not happen overnight nor even in a single academic year but the introduction of the EVS has offered further evidence of greater student engagement in their learning and of a changing academic culture that embraces this.

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