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# USING EVS AND RESPONSEWARE TO ENHANCE STUDENT LEARNING AND LEARNING EXPERIENCE

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## ABSTRACT

*A significant body of literature has made the case that Electronic Voting Systems (EVS) have a positive effect upon students' learning and their learning experiences. After a successful pilot study in a final year unit at the University of Bath, in which we used EVS systems to promote deep learning, we expanded upon the use of such systems and applied this technology to other units within our undergraduate Computer Science degree programme. This expansion enabled us to adopt a range of techniques and approaches to our teaching with a view to enhancing our students' educational experience. Examples of this development include the application of EVS systems to revision lectures for a first year unit and asking final year students to reflect upon their learning and use this reflection to develop EVS questions as a component of their coursework. We also used such systems as an alternative mechanism to obtain unit student evaluation. It was in this context, in the absence of support for free form answers, that we considered the use of web-based ResponseWare systems with a view to enhancing and complementing the work that we had undertaken in adopting EVS systems. This paper reports on our and our students' experiences using both of these technologies.*

## Keywords

*EVS, ResponseWare, Improving student learning and experience*

## 1. INTRODUCTION

In any learning environment that guides students to take control of their own learning, motivation and feedback play crucial roles. A successful learning environment is one that provides both encouragement and motivation complemented with feed-forward and feedback formative assessment strategies that enable the students to evaluate their performance, reflect upon, monitor and take responsibility for their own learning. Although students might seem to be mainly interested in their summative marks, numbers on their own provide little on which to reflect and even less to improve upon. On the other hand, providing feedback that students are willing to take on board is essential for helping students to actively take control of their learning (Race 1994)

Electronic Voting Systems (EVS) are increasingly being adopted in learning and teaching strategies with a view to facilitating the students' active engagement in their learning. Such systems also provide the lecturer with a means through which students can be given instant anonymised feedback within a classroom context. Students are given a device, often called a 'clicker', with a number of buttons and are asked a series of multiple-choice questions (MCQs). For each question, the students select an answer and press the associated button on the 'clicker'. The system collects all the student responses which can be displayed to the class thus a student can ascertain the holistic response of the class to each question but no student can identify the response given by another student. Consequently, in a safe and anonymised environment, a student not only receives feedback on where he/she is in engaging with the material, he/she can also benchmark their performance against the class cohort. A significant body of literature (Crouch & Mazur, 2001; Russell, 2008; Draper, 2009) is present detailing the benefits of such a technology to the student learning experience. Studies both in programming (Cutts and Kennedy, 2005; d'Inverno *et al.*, 2003) and non-programming CS units (Stuart, *et al.*, 2004; Davenport *et al.*, 2009) indicate that EVS (also referred to as ARS - audience response systems) increases student interactivity, enriches the lecture environment and can be used to facilitate learning in small group teaching sessions and the students' self-study environments.

This paper draws upon our experience gained in the use of such systems within the Department of Computer Science. Initially, EVS systems were used to promote student engagement with the taught material and we

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developed revision exercises as a way of providing interactive formative feedback beyond the simply factual (Davenport, *et al.*, 2009). We did so with a view to providing instant formative feedback, facilitating peer interaction, enhancing student motivation and triggering deep learning. We have extended this and now also use it to deliver summative assessment (of EVS questions the students *themselves* set). EVS sessions then allow students feedback from their peers on the questions that they submitted. We also use sessions to obtain feedback to us from students who have studied the unit. Apart from reporting on the use on EVS in a variety of classroom situations we also report on the use of ResponseWare, a web-based voting system with the possibility of asking open-ended question. In particular, feedback can be given by tutors on students' code snippets supplied via an anonymous free text facility, as a pedagogic adaptation of agile coders dojos (a flexible mechanism to engage a large group in to writing a piece of software interactively - Sato *et al.* 2008). We report on a questionnaire used to determine the students' voice in the effectiveness of this development.

## 2. EVS AND RESPONSEWARE

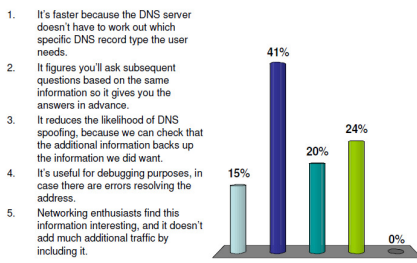


Figure 1: A clicker

At the beginning of the 2008/2009 academic year, the University of Bath, purchased 200 TurningPoint RF ResponseCards (or 'clickers'), with 200 added later. Operating on a radio frequency, thereby not requiring line of sight between the clicker and USB RF receiver, and with the relevant software installed by default on lecture room computers, the technology was relatively straightforward to set-up in a teaching space prior to a lecture. Interactive question slides can be created within Microsoft PowerPoint using the TurningPoint 2008 toolbar and *easily* dropped into an existing presentation. The day to day administration of the TurningPoint EVS is managed by the Audio Visual team, supplemented by pedagogical and technical support by the e-Learning team (one-to-one meetings and group workshops), and in-class support.

ResponseWare enables students to respond to presented questions in real-time using a Wi-Fi or data connection on a mobile phone or laptop. Importantly, the software can be used seamlessly in mixed environments alongside traditional clickers, with results collated by the TurningPoint 2008 software. While TurningPoint EVS allows students to respond to multiple choice, alphanumeric and multiple response type questions using a clicker, ResponseWare Web allows students to respond to open questions with free text.

I: When a user performs a DNS query, they often get back more information than they asked for. Why?



G: When a user performs a DNS query, they often get back more information than they asked for. Why?

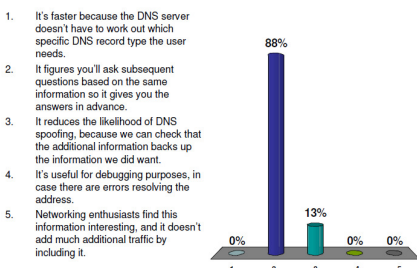


Figure 2: Individual then group vote

Each group was allocated a topic, typically a part-chapter from the course text, by selecting from a set of sealed envelopes. The general rubric read as follows: "This question should *not* have an obvious answer, and should demand some thinking and discussion". Each group submitted its question and answer slides to the lecturer,

## 3. EDUCATIONAL CONTEXT

### 3.1 Networking

This is a final year unit, compulsory on most Computer Science programmes at the University of Bath. Due to the cohort size (58 in 2009/10) and highly factual nature of the material, the lecturer, who has taught this course for several years, has always struggled to engage the students. Problems classes have ended up being another form of lecture. Hence the suggestion of EVS seemed like a plausible technique. In 2008/9 we tried fairly conventional use of EVS: the major distinguishing feature, described in Davenport *et al.* (2009) was the use of questions with "no right answer", to promote engagement with the deeper levels of the material. This proved relatively successful, so in 2009/10 we also required the students themselves to set such questions. The process went as follows: two sessions of questions were set by the lecturer, which the students answered individually. As well as their direct pedagogic benefit, these introduced the students to the technology and the style of question expected. The students were divided into fourteen groups of approximately four. They were introduced to Bloom's taxonomy (see Williams (2006) for more details) and a public resource (Appendix C of Carneson *et al.*, 1996) describing its interaction with MCQs. Each

who vetted them for factual correctness and pedagogic appropriateness. At this stage, one group was told to go and rethink, and two more had the answer slides enhanced. Each question was asked twice to the entire class in an adaption to the Mazur sequence (as described by Nicol & Boyle (2003)): (1) Ask the question, students vote individually. (2) When all have answered, but before the answers are shown, ask the groups to confer. (3) Part-way through this, show the individual answers. (4) Tell the students to press the group clicker, according to the group consensus. Marks (10% of the unit total) were allocated based on the correctness and difficulty of the question, and the extent to which it made the group think (assessed by observation and considering group and individual vote patterns). Figure 2 shows one such question, with first the individual, then the group, responses.

Unit evaluation responses suggest that some students perceive the unit as merely requiring the memorisation of large amounts of facts. In addition students enter the compulsory unit with very different levels of interest and prior experience of the subject. It was hoped that working in groups to discuss and answer questions, explore an area of the subject in depth and design a question which highlights a misconception of their peers would challenge assumptions about how to study the subject. It was expected that promoting peer interaction and introducing a competitive facet would raise levels of motivation and, through use of imposed ("Imposed" groups is in fact departmental policy for summative assessment, to ensure mixing of ethnic groups and prevent *de facto* segregation) rather than peer-selected groups, sharing of prior experience and knowledge.

### 3.2 Programming

EVS was also used in Programming, a compulsory double unit for all first year computer science students. The intention was to create a more interactive environment. In previous years, revision quizzes were organised in the lecture by means of pen and paper and via the e-learning platform Moodle. In this unit two programming languages are taught: Python and Java. The Python revision lecture was a traditional quiz, students provided questions from which the lecturer would selected the most appropriate ones to compose a quiz. For the Java revision lecture, an EVS quiz was offered but without the competition element.

After the first programming exam students were given the opportunity to attend remedial lab classes if they wished to recap some key ideas at a speed determined by those present. ResponseWare was used by the tutors to ask a mixture of MCQs and questions inviting a free text response enabling less able or less confident students to anonymously put forward their own ideas without risk of embarrassment. As these were remedial classes tutors were asked to ensure they did not move on until *all* students were ready. We used a ResponseWare adaptation of a coders dojo (Sato *et al.*, 2008), an agile programming mechanism to allow participants to improve their (coding) skills. In one of its traditional forms, the randori<sup>1</sup>, two people start the exercise. After five minutes one of them leaves the pair to be replaced by one of the other participants. The rotation continues until the problem is solved. The approach improves participants' skills by doing and by seeing other people doing. For the remedial classes we adapted this version by using the software as a sounding board for suggestions allowing students to participate without having to step in the spotlight. ResponseWare also allowed students to let the tutors know whether they were ready to move on. Figure 3 gives a screenshot of one the sessions.

Please enter your response...

PUBLIC INTE...	2	PUBLIC DOUB...	1
INT DOUBLE(I...	1	PUBLIC DOUB...	1
PROTECTED I...	1	PUBLIC INT (N...	1
PUBLIC DOUB...	1	PUBLIC INT D...	1
PUBLIC DOUB...	1	OTHER	5

Figure 3: ResponseWare slide with answers

representatives can then pass this information on to their peers. Unfortunately this is a timely process. This year we decided to run in parallel an EVS evaluation session for the Programming unit. With the EVS questionnaire we wanted to create an environment of immediate feedback and encourage an environment of discussion between students and between students and the lecturer.

### 3.3 Unit Feedback

Feedback is not a one-way mechanism from staff to students. Feedback from students allows staff to reflect and improve the unit for following years. At Bath, students are surveyed regarding the effectiveness of each unit via paper-based questionnaires or via the web. Summary results are presented at the Staff Student Liaison Committee. Student

<sup>1</sup> See <http://codingdojo.org/> and <http://me.andering.com/2008/10/21/as-a-programmer-i-want-to-go-to-a-coders-dojo-so-that-i-can-improve-my-skills/> for more information.

## 4. EVALUATION

### 4.1 Networking

A group of 23 students responded to the evaluation questions, of these 83% agreed or strongly agreed it was good to be more interactive in lectures. Students were asked to consider various aspects of the group work. 65% felt that answering as a group was more educational. 60% of respondents found working in groups to *answer* questions to be beneficial or very beneficial, however, as might be expected with imposed group work, 17% felt it was a sad necessity and 4% found the experience disastrous. Respondents were more divided in their opinions on *designing* questions as a group, while 43% did find this experience to be beneficial and 17% were unconcerned by the experience. 29% felt that the group work was a sad necessity and a further 13% found the experience disastrous! Despite these opinions on group question design, when asked to consider whether that involvement in designing a question had improved their understanding of the subject 45% *strongly agreed* that it had with a further 23% agreeing and 14% neutral. Hence a small majority responded positively towards all aspects of group work *except* the experience (rather than the outcome) of designing questions in groups: the questions were marked and this may have contributed to this response. The lecturer felt the questions produced by the students were generally good, and could be reused in future deliveries. Some questions proved difficult for other students to answer which suggests that they adequately highlighted areas of misconception. The lecturer also noted that this cohort was far more active than previous years in discussing revision topics among themselves, and trying to "see the wood for the trees".

### 4.2 Programming

At the conclusion of the second quiz 76% agreed that it was good to be interactive in lectures, 44% liked the EVS quiz, 28% the paper quiz with 24% liking both. When students from programming 1 were later asked for their views on the quizzes 59% agreed that EVS quizzes are more effective as they allow comparison with the rest of the class. Those who in hindsight regarded quizzes positively still favoured the EVS quiz however, 42% agreed that they would prefer not to have quizzes with only a third agreeing that EVS was useful for receiving feedback from lecturers. This contrast between views in the quiz and respondents to later questions might suggest students absent themselves from quiz classes if they don't believe them to be effective or that, in hindsight, they were unsure of the expected outcomes of the activity or how to use the feedback. Another interpretation is that stand alone quiz *classes* seemed less effective as the same group reacted positively to the suggested model of regular short quizzes used to inform the provision of lab exercises aimed at resolving uncovered misconceptions. This idea was put forward by the two lab tutors and we note such a model forms the basis for Cutts and Kennedy's (2005) connected learning environment. There was little consensus whether student written questions or lecturer written questions motivate them to improve. Some students found them equally useful while others showed (sometimes strong) preferences for one or the other. From a lecturer's perspective, the EVS presentation resulted in more discussion than the pen and paper variant despite the fact that in the latter students wrote their own questions and hence competed. While the lecturer had to write the EVS questions, this guaranteed the coverage of the entire syllabus and a range of difficulties.

### 4.3 ResponseWare

Students who attended the three remedial labs agreed that using ResponseWare enabled them to receive effective feedback (93%, 76%, 100%) and to influence the direction of the class (87%, 39%, 71%). In 2 classes they were asked whether the system should be used in usual exercise labs and this idea was very positively received (80%, 83%). In a subsequent survey 69% agreed that using ResponseWare to suggest the next step in "live code" classes would be an effective way to check their understanding and requests for "live code" classes are a frequent occurrence on unit evaluation forms.

The tutors found ResponseWare allowed them to monitor the understanding of *all* individuals in the group but that it was challenging to prepare sessions if responses completely controlled the direction of the class. While open responses allowed students to put forward their ideas the real time display of this input was very inefficient for the tutor and incomplete for the students. Despite this tutors noted that discussions in terms of student ideas rather than tutor generated examples were more realistic. The tutors agreed that, in theory, ResponseWare allowed mining for problem areas rather than relying on serendipitous discovery. However, they did not feel that ResponseWare could be used in standard exercise classes as students' perceive these as individual programming time on pre-determined tasks. They suggested that separate labs, like the remedial

classes, bringing together concepts from lectures with "live code" in the manner of a coding dojo could use ResponseWare if the inefficiencies and overheads of using the system for free responses could be overcome. A student suggested that a technology such as GoogleWave might be useful.

#### 4.4 Unit Feedback

Students were engaged and felt more involved in the live survey which resulted in a lot of discussion. When later asked whether they agreed it was more effective 63% of respondents felt that it was with 78% agreeing that clickers were useful for giving feedback to lecturers. The outcomes of both the EVS and the traditional unit evaluation surveys correspond. The students participating mentioned that they would prefer the lecturer to give their expectation of the results in between the voting and the announcement of the results. The downside of using the EVS as a unit feedback mechanism is the lack of free-form comments and suggestions. In the web-based version details on the aspects of the unit they liked and disliked and suggestions for improvement can be entered. For this reason, we are considering using ResponseWare, for this type of activity. From a lecturer's perspective, asking for unit evaluation in class with immediate and public feedback can be rather daunting. Students can see the lecturer's reaction and there is no escape from possible negative votes. It does however open a door to more interaction between staff and students and gives students some proof that their comments are considered and not just gathered and placed in a drawer.

### 5. CONCLUSIONS

The final year cohort, despite not appreciating all aspects of the imposed group work seemed to agree that involvement in writing and answering questions improved their learning. The first year cohort had more mixed views and may benefit from a clearer educational rationale or a more integrated use of EVS. The first year students appreciated providing unit evaluation using EVS and the lecturer found this a useful activity. Programming students frequently ask for "live code" classes and our first uses of ResponseWare suggest that students view this as an effective way to learn however we feel that a more natural solution and efficient solution to the display and use of the responses would be required for more serious use.

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