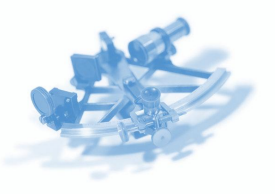

The use of electronic voting systems to engage students in outreach activities

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Abstract
This paper discusses the use of electronic voting systems specifically in a range of outreach contexts. The Department of Chemistry at the University of Reading and the School of Chemistry at the University of Southampton are actively involved in delivering outreach activities at primary and secondary school level with a view to inspiring a new generation of budding chemists. Voting systems are successful in engaging students across all age groups as demonstrated by our experiences with youngsters aged 4 to 18. They are especially effective at breaking down the barriers of non communication thrown up by students when faced with a difficult question and encouraging the participation of even the most reticent teenager.

Introduction
There are numerous brands of electronic voting systems (EVS) now available on the market,[1] and they are finding use in a range of educational contexts.[2] While a number of innovators have extolled the virtues of such technology in supporting physical science teaching at HE level over recent years,[3] the establishment of EVS as an integral component of our teaching, particularly in chemistry,[4] has yet to become embedded.

It is now widely recognised by all stakeholders that outreach activities may play a significant role in the sustained viability of our disciplines and our departments.[5,6] Outreach may involve students of all ages, and can include visits by university personnel to schools as well as visits by pupils to universities. Although a number of factors are involved, it seems unlikely that the expansion of outreach activities across the country has not played some part in the increase in numbers seen in a number of chemistry departments in recent times. Perhaps more evidence is needed to convince the sceptical scientists among us, but anecdotally at least, it seems fair to say outreach activities are beneficial to all involved.

Our positions in chemistry at Southampton and Reading, supported by funding from the RSC's 'Chemistry For Our Future' programme,[7] allow us to champion new approaches to teaching and have afforded us the opportunity to experiment with EVS both in undergraduate teaching and in schools outreach activities. The latter of these is the focus of this article, although it should be noted that we do make youngsters aware that these 'zappers' are actually used in our undergraduate teaching,[8] and this is perhaps part of their attraction to the participants. One might ask the questions 'How can EVS be used to enhance outreach activities?' and 'Why is this beneficial to HE?'. We hope these questions will be addressed in the following discussion of a number of case studies taken from our repertoire of outreach activities.

Case studies
Classroom activities
Although there has been some focus on the use of undergraduate teaching space for in-house outreach activities, there will always be a place for HE staff in the classroom. The portability and versatility of EVS makes them an invaluable tool for enhancing communication with youngsters across the age range. At Southampton, EVS have been taken to schools and used to support the delivery of an activity on biofuels to pupils at Key Stages 3, 4 (GCSE) and 5 (A-level). Questions asked range from those intended to spark debate to those that test knowledge and understanding either before or after the main body of the activity.

Many students, even at 6th form level, are reluctant to answer questions and share their views, particularly when they find a stranger at the front of their classroom. The use of EVS acts initially as an ice-breaker, with all pupils able to express an anonymous opinion *via* their handset. With results being displayed in the form of a bar or pie chart, many

pupils suddenly find their tongues, enquiring 'Who thought that?!' of any unexpected answers. Suddenly the seed of the discussion has been sown, and pupils are engaged in the activity.

The introduction of 'How Science Works' as a core component of QCA specifications[9] for the teaching of science at all levels of secondary education means that all students need to develop an understanding of 'the thinking behind the science'. By taking a snapshot of the youngsters' thoughts and immediately discussing the outcomes with them, we are able to tackle a particular issue head-on and add a useful educational dimension to our outreach activities.

The Great Science debate

The use of EVS is ideal for gauging the opinion of a large group in support of or against a particular argument relating to a given topic. At Reading, EVS have been used in a popular science debating activity with pupils of a range of ages and abilities, from Year 7 to Year 13. The activity is intended to engage young people in scientific topics relevant to everyday life, such as nuclear power, biofuels and GM foods, in addition to developing their skills in investigating and producing evidence to back up their opinions. These are key areas identified in the science curricula from Key Stages 2 to 4.

We have run several of these debate events, both in school and on campus, in which pupils research and formulate arguments within teams and then compete to convince the audience in a discussion of the issues. The audience opinion is polled using EVS both before and after the debate and the winning team is decided on the swing of votes in their favour.

As discussed earlier, the anonymity of the system ensures that all pupils feel able to express an opinion, even if the topic is particularly controversial. The speed at which this data can be assimilated and displayed is also a great benefit, allowing both the audience and the debating team to gauge the general feeling in the room. Since many of these events involve large numbers of pupils, the audience for a particular debate is essentially made up of teams who are debating other topics. Using EVS before the debate helps to engage these pupils in listening and actively thinking about the issues presented, rather than just sitting and waiting for their turn. The competitive aspect is also enhanced, as teams can see the scale of the task ahead of them. Witnessing the eloquence and passion that pupils exhibit about scientific concepts they may previously have regarded as boring is a joy to see.

Quiz challenge

Youngsters in all age groups quickly make the link between an activity using EVS and the popular TV quiz *'Who Wants to be a Millionaire?*', and the technology presents the opportunity to run quizzes in a number of different styles. Undoubtedly there is an element of fun in such activities, but the importance of fun in any outreach activity should not be underestimated, as evidenced by the high levels of engagement observed. Traditional quizzes, typically involving some sort of written activity, can quickly alienate some participants and lead to a dilution of the message the outreach activity is intending to convey.

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The questions used in quizzes may be designed to cover aspects of the science that was incorporated into the outreach activity to reinforce learning and identify strengths/weaknesses in the delivery of the event. By including questions on science in the media and famous scientists, we can add weight to our 'sales pitch' that science is important in all of our lives and that scientists have a major role to play.

Paperless surveys and feedback

Anybody engaging in outreach work will be familiar with the requirement to evaluate the impact of the activities, which usually results in a pile of forms which are time-consuming to fill in and analyse, the whole process being demotivating for participants and facilitators alike. EVS can be used to poll answers to evaluatory questions posed to the entire cohort in a short timeframe. By asking questions about the effectiveness/enjoyment of different components of the event, the user can ascertain what works and what doesn't in order to assist planning for future events in an expedient manner. One may choose not to review bar charts of data during the polling session, with the software normally allowing the collection of data in a 'review only' format for later inspection.

The process of compiling the data into easily interpreted graphical reports with statistical summaries is in most cases almost a 'one-click' procedure, with the use of spreadsheets allowing the user to discern the subtleties hidden in the data. For instance, one can find out about the future plans of the participants by asking the question 'Before today, how likely were you to do a chemistry degree?' before gauging the impact of the outreach activity by asking 'How much more likely are you to do a chemistry degree after today's event?'. It is then very easy to identify how effective your activity has

been at selling chemistry to those with different levels of interest prior to the event, without having to dig through written evaluations for the appropriate evidence.

Conclusions

Discerning the true impact of EVS as a tool in delivering outreach activities is a difficult task, but we can identify clear benefits, many of which have been discussed above. Key features are the enhanced level of engagement of all students in a deeper level of thinking, and the ability for the facilitator to give immediate feedback based on student responses. The participants in the outreach activity leave with a clearer understanding and recall of the message they were intended to receive. Whether that message is one with a scientific basis, or a sales pitch regarding the value of studying science at a higher level, it appears that EVS can play a significant role in enhancing the impact of any outreach activity.

References/Notes

1. For a review of the pros and cons of a range of different brands of EVS, see: Barber, M. and Njus, D. (2007) *Clicker Evolution: Seeking Intelligent Design*, CBE – Life Sciences Education, **6**, 1-8.
2. Duncan, D. (2005) *Clickers in the Classroom*, San Francisco; Pearson.
3. For examples, see: (Physics/Biology) Bates, S. P. and Howie, K. (2006) *The use of electronic voting systems in large group lectures: challenges and opportunities*, New Directions in the Teaching of Physical Sciences, **2**, 1-8.; (Life sciences) Caldwell, J. E. (2007) *Clickers in the Large Classroom: Current Research and Best-Practice Tips*, CBE – Life Sciences Education, **6**, 9-20.; (Maths/ Engineering) d'Inverno, R., Davis, H. and White, S. (2003) *Using a Personal Response System for Promoting Student Interaction*, Teaching Mathematics and its Applications, **22**, (4), 163-169.
4. For a comprehensive review, see: MacArthur, J. R. and Jones, L. L. (2008) *A review of literature reports of clickers applicable to college chemistry classrooms*, Chemical Education, Research and Practice, **9**, 187-195.
5. MacDonald, A. (2004) *Outreach: A guide to working with schools and colleges*, Higher Education Academy Physical Sciences Centre, Institute of Physics and Royal Society of Chemistry.
6. The importance of outreach in chemistry is reflected by the fact that many departments are actively involved, often with support from the Royal Society of Chemistry, industrial partners or other outreach providers. For a discussion of the benefits of primary outreach to a chemistry department, see: Harrison, T. G. and Shallcross, D., (2007) *Why Bother Taking University Led Chemistry Outreach into Primary Schools? Bristol ChemLabS Experience*, New Directions in the Teaching of Physical Sciences, **3**, 41-44.
7. Both authors were appointed after the award of funding to each department as part of Strand 3.1 of the Royal Society of Chemistry/HEFCE 'Chemistry for our Future' programme, with dual aims: i) play an active role in the delivery of schools outreach activities and ii) develop means of support for chemistry students in making the transition from school-to-university.
8. Niyadurupola, D. G. and Read, D., *Assessing the Impact of EVS in the Undergraduate Teaching of Chemistry,* manuscript in preparation.
9. To find out more about the QCA guidelines for How Science Works, see: <www.qca.org.uk/qca_9437.aspx> (accessed on 16/07/08).

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