



Project Document Cover Sheet

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JISC Final Report

EVAF4ALL: Electronic Voting Analysis and Feedback for All

Final Report

Simon Bates and Keith Brunton

January 2010

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1. Acknowledgements

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University of Aberdeen: Sara Preson, Ian Finlayson, Laraine Milne

University of Edinburgh implementation:

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2. Executive Summary

The use of portable, wireless electronic voting handsets has been widely adopted across a range of different disciplines in Higher Education. Typical uses of them are in large class lectures, where students are posed a variety of questions using them, and can vote to indicate their response to a series of possible answers. The software that accompanies the handset and receiver hardware captures all the data at the point of delivery. Frequently, this data simply collects on the instructor's laptop or lecture theatre PC. This project aimed to develop a software tool that could be used by both staff teaching the course and students on the course, to be able to review the responses to given questions through an online interface that was integrated with institutional authentication and learning management systems. To fully exploit the functionality of the system, it must be possible to keep track of which student has which handset. In some institutions, this is done via a 'loanership' scheme, where handsets are issued to students at the start of a course and the students keep them for its duration. Students accessing the system are able to see *their own responses* together with aggregate responses for the whole class. Staff are able to use the system to review whole cohort performance on questions, which can feed into course development and review.

The project consulted with EVS users active in the UK, seeking partner institutions who would be interested in deploying the software once developed. Fewer institutions than we had anticipated were operating clicker loanership schemes. However, the University of Aberdeen had a similar clicker loan system as exists at the University of Edinburgh and the software was created over two development cycles with deployment at these two institutions being a target for the end of the project. A previously tried-and-tested software development environment was used.

The software was deployed in Edinburgh for the first Semester of the 2009-10 academic session and used extensively in a large first-year course with a track record of consistent

and effective EVS use. The software was configured for deployment at the University of Aberdeen shortly after the end of the project in early 2010.

3. Background

In recent years, electronic voting systems have become very widely adopted through HE, as a tool for interactive engagement and feedback, particularly in large group lectures. The uptake has percolated through a wide range of academic disciplines, and much expertise has been accumulated in how to utilise them effectively, both from a technical point of view and pedagogical considerations. Their efficacy in *engaging* students has been widely investigated and reported [1] In addition, careful studies in certain disciplines have demonstrated that as part of a coherent learning design for a course (often termed 'interactive engagement') they can contribute to impressive learning gains (measured on the basis of pre- and post-teaching delivery of a standard diagnostic test of conceptual understanding). [2] The widespread introduction of EVS technology and pedagogy has reinforced the importance of formative feedback as an essential component of the learning process.

A variety of different hardware (handsets, receivers) and software systems are used to support the use of EVS, all capturing a great deal of data at the point of delivery. Many institutions have central or departmental 'kits' that can be booked out for classes. As uptake grows, some institutions have implemented 'loanership' handset schemes, where students receive handsets for the duration of a course (whole Semester, whole year). To our knowledge, no institutions have *required* students to purchase handsets or bundled them with course texts (a common model in the US).

It is almost certainly the case that the vast majority of the data that is captured during EVS sessions lies unused, despite offering enormous potential for feedback to staff and students alike. Whilst particularly engaged staff may review their own questions, commonly these handsets are used in large classes where several (sometimes, many) staff teach, making an aggregated view of such data additionally cumbersome (e.g. if each staff member uses their own laptop, or data is written to each person's home directory). If staff review of this data is patchy, student review is even more difficult. However, if it could be deployed more effectively, this feedback can become important in the development of independent learning and student autonomy. It is also a potentially a large volume of feedback, since it is not uncommon for courses using EVS extensively to deploy and thus generate data on up to 50 or more EVS questions each presentation.

4. Aims and Objectives

This project aimed to deliver a simple but effective solution to this missed opportunity: to provide a web-based tool that will allow effective aggregation of this data, able to make it visible to students and staff via a common interface. This was achieved by providing solutions to tap in to the 'loanership' schemes thus providing the system with the identities of the students who use the clickers during EVS sessions, uniting student voting data with a particular clicker. The tool will be made freely-available to all interested parties in HE/FE using EVS in their teaching.

At the outset, our aims was to deploy the tool to several institutions who would be interested in adopting it. During the early stages of the project (see 'Methodology' below) it became clear that the use of 'loanership' schemes for handsets was far less widespread than we had anticipated. Being able to pair voting responses to individual students necessitates such a mapping, and without it - although technically within the system it is possible to manually add

student/clicker records - a key feature of the system would be inactive and the tool would offer little added value compared to the (sometimes extensive) profiling of data that can be accomplished with software provided by commercial vendors. As a result of this, it has not been possible to deploy the system to several institutions.

5. Methodology

Our methodology for the project took the form of initial engagement with the EVS user community (via online questionnaire to gauge interest in the project, followed up with a face-to-face workshop) and subsequent requirements gathering and evaluation before setting out to develop the software. The EVAF software was authored by one of the project applicants (KB), an e-learning developer with several years experience of undertaking major software development projects in the School of Physics and Astronomy at the University of Edinburgh. The back end technology will be based on SQL, with Ruby/Rails being used for the front-end web interface. These choices were based on previous experience and their use having been tried and tested in previous software development projects, most notably a class signup tool that is used to allocate more than 1000 students across many different courses, to timetabled tutorial / laboratory groups within academic units at Edinburgh. It was also necessary to use a familiar development environment to enable the software to undergo two cycles of development with the space of a one-year project. Use was made of open source and freely-available tools in the development, such as the Google chart APIs for graphical display of voting data and relevant web standards considered in the software's design and implementation.

Development was undertaken in two separate iterations, with user feedback obtained after the initial development allowing for modifications or refinements to be made as part of the second development cycles. Site visits were made to the deployment partner institution at the University of Aberdeen, initially to give an overview of the system's capability and integration into courses at Edinburgh, but latterly focussing on development and deployment issues.

6. Implementation

At the commencement of the project, we undertook a survey of EVS practitioners via the JISC Mail list, to identify a snapshot of EVS use amongst current adopters and to gauge interest in hosting a deployment of the software later in the project for use in their own institutions. The survey was administered electronically using SurveyMonkey [3] in December 2008 / January 2009. The survey, together with selected and anonymised responses from EVS users is included as Appendix 1.

Following up on the responses from the survey, we invited all interested parties to attend a one-day meeting in Edinburgh in February 2009, to find out more about what the project was aiming to deliver and to show early screenshots of what we envisaged the interface would look like. Representatives from 7 other institutions attended, together with a JISC Regional Centre representative. Following this meeting, we attempted to capture institutional system information from these EVS users, to ascertain the requirements for the EVAF software that could be factored into the software development process. The matrix of institutional systems that are relevant to the EVAF software is included as Appendix 2.

At this point in the project, it became clear that institutional loan systems were less commonplace than we had anticipated that they would be, and the added value of the EVAF software for institutions who did not operate such schemes was extremely limited: there

would be little that the system could deliver that commercial EVS software did not do. One institution that did operate such a loanership scheme for handsets was visited to present a more detailed overview of the project to a wider cross-section of interested parties, and the development work began with deployments at Edinburgh and Aberdeen being the goal for the project. A detailed technical design description is included as Appendix 3 of this document.

Initial development was undertaken during the spring / summer of 2009 with a prototype tool suitable for local deployment in Edinburgh in time for the start of the 2009-10 academic session. The second iteration of development ran into some delays in the autumn of 2009 for a variety of reasons. In some cases, these were relatively minor modifications that needed to be made to facilitate deployment to another institution but actually turned out to be rather time consuming to implement. An example of this followed the discovery that many VLEs (Moodle, Blackboard) currently do not provide access to class information outside of their own user interfaces. As a result of this, the software was re-designed to allow this previously non-optional component to be optional- at the expense of some accuracy in statistical output. Despite these delays, the EVAF software was deployed at Aberdeen in Jan / Feb 2010. The project concluded with the production of the documentation (user, installation, development) for the software and the evaluation of its use in Edinburgh in the first Semester of the 2009-10 academic session.

7. Outputs and Results

7.1. Main outputs

The main agreed output of the project was the EVAF software and documentation - in line with the items outlined in the project proposal. There are three aspects of the software that has been developed - a web front end that staff and students; a set of 'connector' code that allows EVAF to communicate with important systems - such as the loan system of the institution; and deployment/configuration options to allow EVAF to be installed at a local institution.

As a front-end web-based application, EVAF provides students and staff with a means to continually review votes that were cast during lectures using EVS (clicker) technologies. The front-end application provides numerous features to allow both staff and students to analyse and reflect on question design (staff) and responses to questions (students). 'Connector' code has been developed to allow EVAF to integrate with the institution's clicker-loan system to ensure that students are allowed direct access to their votes and their votes only. EVAF can integrate with WebCT to continually synchronise class rosters to provide more accurate statistical information on voting population. EVAF can be deployed to any institution that employs a clicker-loan system to manage the distribution of clickers to students. A number of configuration options allow for the modification of front-end aspects (logo, institution name, etc), loan system connector, VLE connector (where appropriate) and authentication mechanism among other things. More information can be found in Appendix 3 of this document.

EVAF has been successfully deployed in the 'Physics 1A:Foundations' course at the University of Edinburgh in the first Semester of the 2009-10 academic session Appendix 4 presents a more detailed description of how it was used and an evaluation of its uptake and effectiveness.

7.2. Additional Outputs

During the course of the project, a number of additional evaluation outputs has been produced. These evaluations and documents had direct impact on the priorities of the project and so are included in the Appendix section. They are also available from the project website.

- EVAF4All Partner Questionnaire - see Appendix A
- Matrix of Institutional Systems - see Appendix B

8. Outcomes

The initial consultation exercise for this project (evaluation questionnaire and meetings) created a somewhat unexpected outcome of providing insight into the status and extent of EVS use in HE in the UK at the time. The main outcome of the project was the delivery of a working software tool that is capable of seamlessly delivering EVS data back to students and instructors. The software is integrated with a widely-used VLE (WebCT) and can use the VLE for up-to-date maintenance of class lists. Deployment of the tool in a course at Edinburgh has demonstrated that it can be effectively embedded as part of the learning design and provision of formative feedback within a course that makes extensive use of EVS. The software is capable of being deployed at other institutions, integrating with that institution's authentication mechanism. Some of the key functionality of the software is the ability for individual students to be presented with their data based on participation in EVS sessions. To be practicable, this necessitates a mapping between student identity and handset identity, such as is maintained by a handset loanership scheme.

Students who have access to the system are able to view valuable feedback on their progress on different EVS questions (eg topics, sections of the course) and in comparison to peers, which can be integrated into course delivery materials (e.g. from the VLE or within course content directly). Staff are able to see aggregated student data, in order to review the effectiveness of their questions informing course monitoring and review. Other institutions have access to a customisable standalone software tool that can be deployed with relative ease.

9. Conclusions

EVS use has spread widely and rapidly throughout HE and it could be argued that a 'plateau' phase has now been reached. Most institutions have heard of these systems, many will have kits themselves and a group of enthusiastic users at the teaching and learning coalface. Despite this, institutional-wide schemes (such as the handset loanership model that underpins some of the key functionality of EVAF) are still not commonplace. There are several reasons for this, including not knowing what to do to or necessarily how to do it. There does appear to be a community of users willing to engage with, evaluate and potentially adopt a tool such as the one created by this project.

10. Implications

The modular nature of the EVAF software is such that it can be further developed to be interoperable with other institutional systems (e.g. other capable VLE's, authentication systems) with relative ease.

Having a mechanism to deploy this kind of feedback to students may stimulate new uses for EVS questions, moving away from only delivering them in large class lectures, which has been overwhelmingly the most common mode of use to date. In that respect, one avenue we are pursuing here is the role of student generated content for EVS questions, and EVAF provides a mechanism for feedback and discussion after the point of data capture. The system can more widely adopted if handset loanership schemes expand to really exploit what is the key feature of the software, which is the ability to unite data captured from a particular clicker with a given individual.

11. References

[1] <http://www.psy.gla.ac.uk/~steve/ilig/> [online] Steve Draper's website, based at the University of Glasgow, still remains the most comprehensive and easily accessible collection of resources all in once place that catalogue the use of EVS in the UK, as well as providing extensive literature as to why it should work as a teaching tool, and papers that have demonstrated exactly that.

[2] Hake, R. R. (1998). Interactive engagement versus traditional methods: A six-thousand-student survey of mechanics test data for introductory physics courses. Am. J. Phys. 66 1.

[3] <http://www.SurveyMonkey.com> [online],

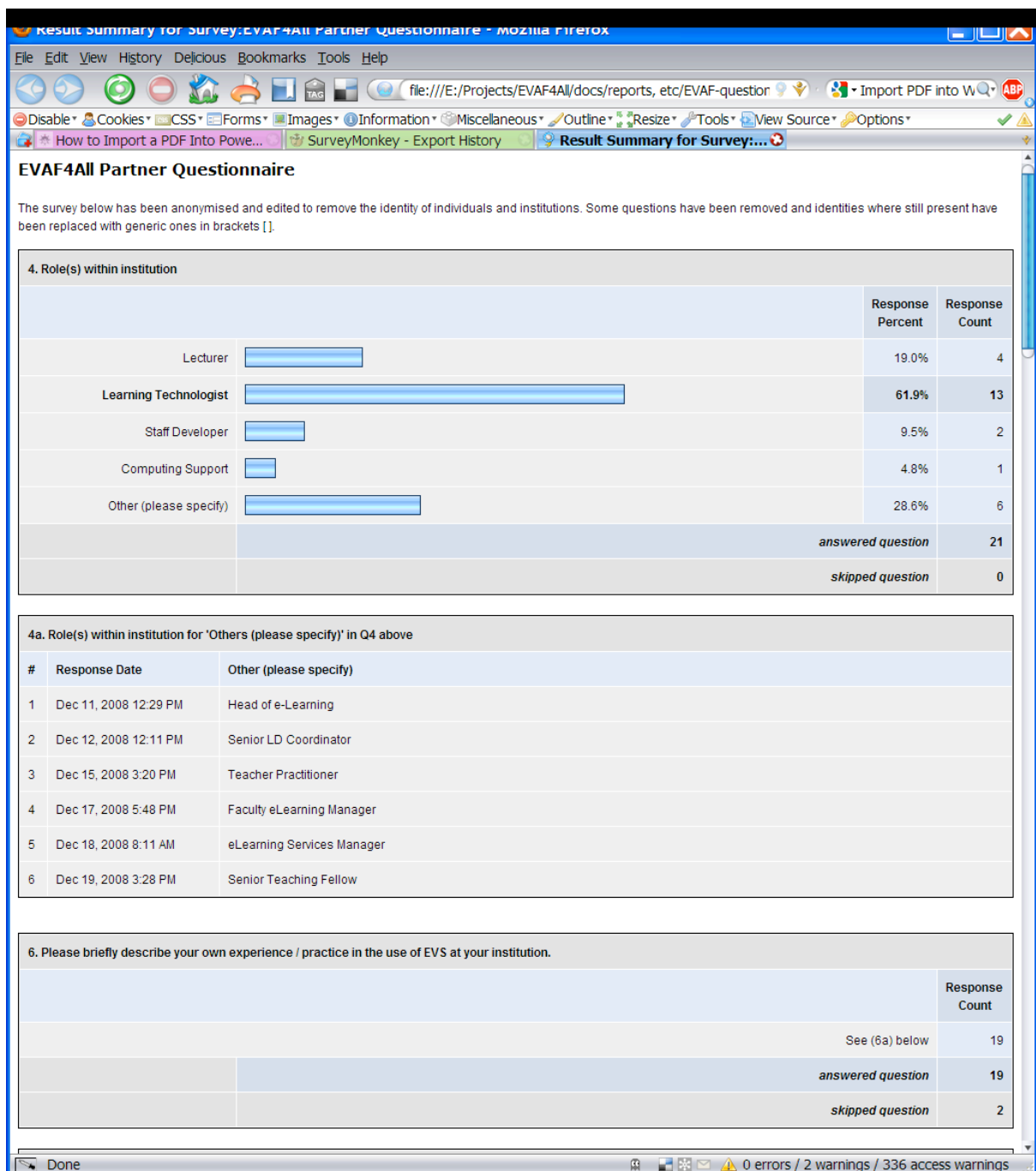
[4] Mazur, E (1997) Peer Instruction Prentice-Hall New Jersey.

[5] DUMP: A Database of Useful MCQs for Physics [online]
<http://www2.ph.ed.ac.uk/elearning/projects/dump/>

12. Appendix 1: User group survey responses (anon)

EVAF4All Partner Questionnaire

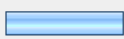
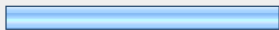
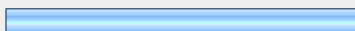
The survey below was delivered online using SurveyMonkey in Dec 2008. The results have been anonymised and edited to remove the identity of individuals and institutions. Some questions have been removed and identities where still present have been replaced with generic ones in brackets [].

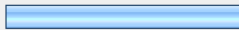
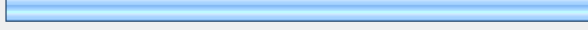



6a. Please briefly describe your own experience / practice in the use of EVS at your institution.

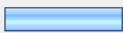


#	Response Date	Response Text
1	Dec 11, 2008 12:32 PM	We have been rolling out clickers since Oct 08 - this has been strongly focussed around the theme of classroom feedback and assessment. Lots of use, and repeat use. We have supported this take up by rolling out a number of internal events, and starting to work up the case studies of using clickers for higher order learning, and combining clickers with other technologies. For instance combining the use of clickers and SMS. See our supporting clicker site: [removed]
2	Dec 12, 2008 12:33 AM	In lectures at level one and two over last 2-3 years. Assisting others getting started.
3	Dec 12, 2008 10:32 AM	The [local] CETL and [school] purchased 350 handsets and 3 receivers in 2007. In general these are used only within the School of Biological Sciences. In 2007/8 and 2008/9 we have loaned our first year cohort in Biol Sci (200 students) a handset for a £10 deposit for the academic year (note answer to qus 4 below, loan is on a School-wide basis only at present). Some of the staff involved in first year teaching have used the system in their lectures, dry practicals and for feedback. Other courses use them on a loan per lecture basis (e.g. ethics) to promote discussion or provide a lecture break. The system is also used by the CETL in outreach projects for schools and public health initiatives. The Turning Point 2008 software was added to our central file system this year as software available across campus on all PCs and presenting PCs in lecture theatres. The software is running on softgrid delivered central ITS. The institution as a whole is looking at more widespread adoption. Another voting system is also being considered (optvote). Our library use the system for teaching avoidance of plagiarism and use of bibliographic databases. They recently purchased their own receiver and 50 handsets.
4	Dec 12, 2008 11:35 AM	We purchased TurningPoint with 16 clickers for our own use in June 2007. Through 07/08 we ran a variety of sessions about EVS with academic staff. As a result 3 schools within the University have purchased EVS, numbers being 60 (School of Education), 60 (Business School) and one for each undergraduate student (so probably 200 or so in the School of Chemistry and Pharmacy)! We also obviously make use of our own system in our training courses and events with staff. We'll be loaning our system to an academic in the School of Law in for a 3 week period in Feb 2009.
5	Dec 12, 2008 11:50 AM	Currently the physics and mathematics departments use the Interwrite PRS system in various undergraduate classes (1st and 3rd year). The system used is a mix of Infra-red (IR) and Radio Frequency (RF - Crickets) handsets. Ideally we would like to phase out the IR units as the RF handsets are more popular with the students and are easier to manage.
6	Dec 12, 2008 12:12 PM	We are currently eval / piloting and looking for the next use / where they should rest.
7	Dec 12, 2008 12:57 PM	I bought an EVS with some research money I had and have used it in seminars in my teaching. I also have an interest in researching this form of technology, particularly in the field of history education and initial teacher education.
8	Dec 12, 2008 2:27 PM	We use the voting system on the Post Graduate Certificate in Education taken by staff. We use it for Just in Time Teaching during the session. Several departments have bought their own set and make sue of it for a variety of purposes, but largely to promote interactivity and engagement. We suggest they use the same system wherever possible. It is not yet centrally supported
9	Dec 15, 2008 3:08 PM	I am at teh early stages of incorporating this into my teaching
10	Dec 15, 2008 3:21 PM	None
11	Dec 16, 2008 11:48 AM	Project Manager of university pilot of an Audience Response System (ARS), [institution url removed], Responsible for ARS-related support, training, seminars and workshops.
12	Dec 17, 2008 10:35 AM	We are just starting out using TurningPoint within our tutorial sessions. We have a group of like minded academics from different disciplines collaborating on EVS use.
13	Dec 17, 2008 10:55 AM	My personal experience of using clickers is limited having used them from the audience point of view in a demonstration on a conference. There has, however, recently been interest from staff in the Pharmacy Dept here to try using clickers. I am also in contact with colleagues in other parts of the college who have access to a small sets of clickers which we hope to be able to trial with a small Pharmacy MSc group next semester.



14	Dec 17, 2008 5:51 PM	I'm aware of two different EVS in use (and for one of these, two different types of voting keypads). They're used by lecturers as a way of including some interactivity in lectures, and also by people running medical CPD programmes to assess levels of knowledge, etc. Formative use only.
15	Dec 18, 2008 8:14 AM	We have been using the systems for a number of years and have used them in a diverse number of ways from simple satisfaction surveys to assessment purposes.
16	Dec 19, 2008 3:32 PM	First started using them in 1990 (18 years ago !) with class sizes of 30 -80 when they were big bulky things. However as class sizes increased to 100, then 150 then 200 we did not buy more handsets and we lost the technical support. So they technology fell into disuse. However in more recent years (since 2006) have started increasingly to use them again, since we purchased several hundred Turning Point handsets and associated software
17	Jan 5, 2009 11:06 AM	In 2006 the E-Learning Unit (ELU, now the Learning Development Centre, LDC) at [my institution] ran a pilot EVS project to ascertain the usability and benefits of this emerging technology. The ELU bought in approximately 250 TurningPoint EVS handsets and 3 USB receivers which worked with TurningPoint 2006 software - a simple add-on in PowerPoint to easily create interactive question slides from. The ELU ran various roadshows and events to advertise EVS and highlight its value in lectures for teaching staff and presentations for non-teaching staff. A large proportion of those that saw EVS being demonstrated expressed an interest in using it for their own lectures / presentations, and about 25-50% of these went on to receive training to learn how to use the hardware and software (including the Vice Chancellor!). The EVS pilot was expanded when in March 2008 the ELU (now the LDC) bought in a further 750 EVS handsets and 7 USB receivers which were combined with the LDC EVS kit and equally distributed across the 7 schools at [the institution] and the main library. Each school now looks after its own EVS kit and training whilst best practice tips is still offered centrally by the LDC. Staff can share their experience of using EVS by attending the LDC-organised Classroom Technology User Group (CTUG) which is also available online. Overall feedback of EVS is very positive, especially since the software (now TurningPoint 2008) is so easy and intuitive to use. The only negatives we have experienced concern the logistics of distributing the handsets, ensuring that they are all handed back etc. However on balance most teaching staff feel that this outweighed by the benefits of the technology in enhancing the learning experience in the classroom.
18	Jan 5, 2009 2:03 PM	I manage our implementation of EVS at our institution and the support for it. We have used EVS for a number of years (initially PRS IR handsets and now we use PRS RF handsets). We have a mobile kit (up to 400 PRS RF handsets) which can be booked by any member of staff in the University and all our first year Biology and Psychology students are now given a PRS-RF handset to use throughout their entire first year. We provide general and tailored workshops for staff on the use of EVS for learning/peer instruction and one-to-one support, where required.
19	Jan 26, 2009 12:27 PM	These were championed by one academic in particular and a group (IT Services, Development of T&L, academics) picked a preferred system. A number of receivers and handsets were then purchased. Since then, we have been adding to that stock. We have 10 receivers permanently installed in large lecture theatres (a few schools and staff development also have their own) and 400+ handsets and a spare receiver available for loan. Usage of the voting system is steadily growing now that it is included in the new lecturer programme and we've highlighted use in the internal T&L magazine.

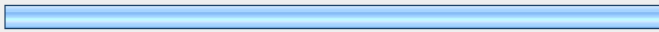

7. To what extent do staff members use 'clickers' at your institution?			
		Response Percent	Response Count
Very few people engaged with their use.		15.8%	3
A small set of users in the institution		36.8%	7
Growing use in sections of the institution		47.4%	9
Widespread use in many courses in the institution		0.0%	0
<i>answered question</i>			19
<i>skipped question</i>			2

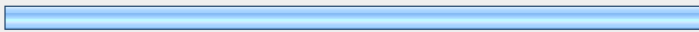

8. What clicker hardware/software does your institution use?			
		Response Percent	Response Count
PRS/Interwrite Response		31.6%	6
TurningPoint		78.9%	15
Promethian		0.0%	0
Other (please specify)		5.3%	1
<i>answered question</i>			19
<i>skipped question</i>			2

8a. What clicker hardware/software does your institution use? (for 'Others (please specify)' in Q8 above)		
#	Response Date	Other (please specify)
1	Dec 12, 2008 12:12 PM	IML

9. Some institutions now loan clickers on a per-course or per-semester basis, rather than handing them out / collecting them at the start / end of each class. Does your institution operate such clicker-loan system, either locally or centrally-managed (or is one planned)?			
		Response Percent	Response Count
Yes - institution has a loan system of some sort		15.8%	3
No - clickers are handed out on per-lecture basis		78.9%	15
Planned - a loan system is planned		5.3%	1
<i>answered question</i>			19
<i>skipped question</i>			2

10. What is your institution's primary VLE (Virtual Learning Environment)			
		Response Percent	Response Count
WebCT / Blackboard		88.9%	16
Moodle		11.1%	2
Sakai		0.0%	0
Desire2Learn		0.0%	0
Bodington		0.0%	0
No Institution VLE		0.0%	0
Other (please specify)		0.0%	0
<i>answered question</i>			18
<i>skipped question</i>			3

11. Does your institution have a centrally-managed identity management system?			
		Response Percent	Response Count
Yes		88.9%	16
No		11.1%	2
<i>answered question</i>			18
<i>skipped question</i>			3

13. Are you interested in being a partner in the EVAF4All project?			
		Response Percent	Response Count
In principle, Yes		94.4%	17
No, but keep me informed		5.6%	1
No		0.0%	0
<i>answered question</i>			18
<i>skipped question</i>			3

13. Appendix 2: Matrix of Institutional Systems

The following matrix represents the selection/status of various components that are envisioned to be important factors in the design/implementation of EVAF for the EVAF4All Project. The information was gathered in Feb/Mar 2009.

	EVS	VLE	SMS	Loan Arrangements	Auth
University of Edinburgh	PRS v5 (RF)	WebCT Vista (v8) PossBB9	SITS Customised	Central Loan service w. local distribution + Per-lecture Loan	Cosign SSO (called EASE)
Institution 1	TP'08	Moodle v1.9	SITS	Per-lecture Loan	CAS3/ LDAP for Moodle
Institution 2	PRS (IR + RF)	WebCT/ BB 8	SAMS (bespoke?)	Per-lecture Loan	AD/LDAP
Institution 3	TP'08 v4/4.1	BB/ WebCT Vista	Campus Soln (Oracle)	Per-lecture Loan + loan for period	LDAP (SSO)
Institution 4	PRS (IR + RF)	WebCT/ BB	??	Per-lecture Loan + loan for period	Yes - ??
Institution 5	TP'08 (RF) +TP'06 (IR)	BB 8	SITS	Per-lecture Loan + loan for period w. deposit (trial)	Vintella (Quest) + AD
Institution 6	TP'08 v4	BB 7 poss BB9	SITS	Per-lecture Loan +loan for period (school)	??

EVS = Electronic Voting System VLE = Virtual Learning Environment

SMS = Student Management System

Auth = Central Authorisation System (may be Single-sign-on - SSO)

TP'08 = Turning Point 2008

PRS = Interwrite PRS (aka Interwrite Response and eInstruction Response)

RF = Radio Frequency clickers IR = Infra-red clickers (old style)

BB = Blackboard - version 7, 8 or next-generation BB9

SITS = SITS:Vision from Tribal Group – a company providing customised student management systems

LDAP = Lightweight Directory Access Protocol AD = Active Directory

?? = Information not available

14. Appendix 3: Technical Overview and Requirements

This appendix gives a more detailed overview of aspects of the EVAF software, its design and methodology. It starts with an overview of functionality and leads onto more technical matters such as software design methodologies used and technical requirements. This is a brief technical overview - the requirements specifications and developer documentation provides more detail - and can be found via the project website.

There are three components to the EVAF software - the most visible front-end software functionality, the 'connector' functionality and deployment/configuration aspects that allow the software to be installed and integrated to another institution.

Front-end software functionality

As a front-end, EVAF allows students and staff of an institution to continually review votes that were cast during lectures using EVS (clicker) technologies. Staff across multiple courses can upload their saved voting data so that students can view, analyse and reflect on how they voted in lecture - in the context of the rest of the class. Staff can view aggregated data, review efficacy of questions and add screenshots/comments to questions. EVAF has granular user/course management allowing staff to work in teams and encouraging colleagues to share findings and good practice. Features such as the course 'leaderboard' can be used at course time to encourage subsequent voting in lectures.

Connector functionality

EVAF necessarily requires other behind-the-scenes information sources besides the voting data uploads. 'Connector' code has been developed to allow EVAF to integrate with the institution's clicker-loan system to ensure that students are allowed direct access to their votes and their votes only. EVAF can integrate with the WebCT VLE to continually synchronise class rosters to provide more accurate statistical information on voting population. 'Connectors' to other VLEs (such as Blackboard and Moodle) were investigated but the VLEs concerned did not allow 'Connectors' allow for updating via 'cron' so that individual installations can choose the degree of latency between EVAF's database and the institutional systems it depends on. Additionally, EVAF has the capacity to use local authentication mechanisms for login of staff and students.

Deployment/Configuration Options

EVAF has been developed to be deployable to any institution that employs a clicker-loan system to manage the distribution of clickers to students. Connection with institutional loaner-ship-system may require a small amount of local development effort to allow EVAF access to correctly formed data, but documentation is provided to assist this. In addition to 'connector' configuration, EVAF provides some front-end configuration to allow institutions to insert their logos, institution name, boilerplate text, etc into the web application front end.

Documentation

Contextualised user documentation (for staff, students and administrators) is provided online as part of the application front end. Separate documentation is supplied to staff on how to export their data from their EVS software such that it can be imported into EVAF. Installation and configuration documentation is supplied for systems administrators wishing to install EVAF and integrate it with their own institutional systems - including connector APIs and

format of required data, etc. In-code and technical documentation describes the components of the software itself, its structure & methodology used.

Technical Platform and Methodologies

EVAF is written primarily in the Ruby (<http://www.ruby-lang.org>) and the popular Ruby-on-Rails platform (<http://www.rubyonrails.org>) which allowed for the agile development of features/functionality. Ruby-on-Rails promotes good practice in a number of areas and EVAF follows this model:

- MVC (Model-View-Controller) methodology used throughout - where front end display is separate from business logic of the application
- Convention over Configuration (CoC) emphasis used in line with good practice - where commonly used conventions are given as defaults that can be overridden if needed
- Unit Tests have been created to verify functionality - at model, controller and application behaviour level.
- Iterative approach to development and availability of 'Test' instances meant that feedback from users (eg the pilot at University of Edinburgh) was able to feed into the development process - the 'leaderboard' functionality being one example
- A 'middle ground' has been chosen in terms of version requirements for versions of Ruby, Rails - see below for details
- Stable third-party Ruby/Rails plugins and modules (all freely available) have been used where available and applicable
- The EVAF front-end does not require the use of any browser plugins

Other technologies used include SQL, XML (Web Services) and some freely available software & JavaScript APIs for components such as graphs (Google Chart API) and image manipulation (ImageMagick). Relevant Web standards have been kept in mind during development.

Software Requirements

The following software is required for EVAF for deployment.

- Ruby 1.8.6/1.8.7
- Rails 2.2.x
- SQL database - such as MySQL (v4+), PostgreSQL
- Apache or other web server (v2.x recommended)
- ImageMagick (<http://www.imagemagick.org>) for processing screenshot uploads

Availability

The EVAF software and documentation will be available at

<http://www.ph.ed.ac.uk/elearning/projects/evaf> and <http://evaf.rubyforge.org>

14. Appendix 4: Implementation and Evaluation of EVAF in Physics 1A: Foundations, Semester 1 2009-10.

About the course

'Physics 1A: Foundations' is a first-year first-Semester course in classical Physics, taken by approximately 300 undergraduate students each year. It is compulsory for all students reading towards Physics degrees (these typically comprise half the cohort) and also available as an elective option for students on other degree programmes (chiefly, but not exclusively science degrees). The course enrolls students with a wide range of previous study of the subject, ranging from one year's study post Standard Grade (Scottish Higher) to A-levels and an increasing number of International Baccalaureate (IB) candidates. This range of diverse background (in terms of both aptitude and prior study) coupled with the nature of the material (familiar, yet often counter-intuitive aspects of Newtonian mechanics) makes for its own particular set of challenges instructing a very heterogeneous class cohort.

The course has a long history of a blended learning approach, with an e-learning component designed to supplement (not supplant) the face to face teaching activities, which goes back over a decade. The course has been using the pedagogy associated with EVS handsets for approximately the same length of time. Initially, these questions were introduced and voted on with coloured cards (following Mazur's Peer Instruction approach [4]) with the switch to voting handsets taking place 5 or 6 years ago. There are three lecturers teaching on the course, aided by workshop demonstrators, technical and administrative support staff.

Use of EVS

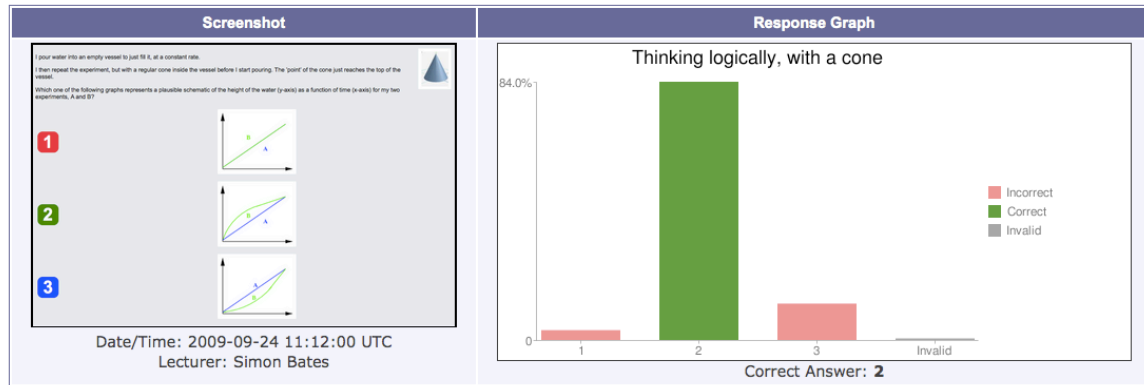
EVS methodology and pedagogy is well-embedded in the course. All course lecturers make extensive use of clicker questions, asking approximately 2 per lecture (over 32 lectures). The placement of questions in the lecture is varied (ie not all at the start, middle or end) as is their nature. Some are used as refresher questions, some as concept reinforcement, some as a basis for Peer Instruction activities within the lectures. A large bank of suitable conceptual questions has been developed over a number of years and made available to the community via HEA Physical Sciences Centre project funding [5]. In addition, EVS handsets are often used in the lectures to gain attitudinal information or 'quick and dirty' feedback on certain issues not directly related to the subject content of the course.

Use of EVAF in the course

EVAF was not introduced to the students until around week 4 of an 11 week teaching Semester. This is the first Semester of (most) students' first year at University and there is plenty of information that students are bombarded with at the start of the course (and doubtless in other courses they are taking too). Experience shows that things have settled down after approximately 3 weeks of the course, and additionally a useful number of EVS questions have already been covered in lectures. At the end of the 3rd week of lectures, EVAF is shown to the students at the start of a lecture as 'the place where all the clicker data goes' and students are shown how to access the tool from the course homepage on the VLE. At the start of the 4th week of lectures, the course lecturer demonstrates how to view real data captured in the previous lecture and explains the sorts of things that students can do with it. The screenshot below shows a typical view of a question (this is a 'staff' view: the student view is similar but indicates both their own response and the correct one).

View Analysis: Thinking logically, with a cone

This shows detailed information about the question. Also shown below is a graph of the whole class response to the question.



Class Response

There were 185 total responses (184 valid, 1 invalid). The correct answer was '2' and 156 people (84.3%) chose the correct answer.

The tool is linked not only from the course homepage on the VLE, but also linked through the online content sections that are the EVS questions. (It is possible to link *directly* to individual questions datasets in EVAF, however the option we have used is to include a 'top level' link to the course page for EVAF that can then be drilled down into individual questions).

Course staff have already made use of EVAF to evaluate student performance on various questions, with a view to development of future questions / replacement of questions. This will be formally considered in the summer at the annual course monitoring meeting.

Uptake

Google analytics was used to track site visitors to EVAF from the Physics 1A course. There were 650 visits to the site during the course, averaging between 10 and 35 visits most weekdays. Usage tended to tail off towards the end of the course, but persisted beyond the cessation of teaching and into the examination period in December. Visitors spent on average few minutes on the site during each visit and approximately half the traffic on the site were returning visitors. One aspect that seemed to capture the imagination of the students was the introduction of a 'leaderboard' feature on the site: there was a competition run with a small prize for the student who answered the highest percentage of correct answers. This was clearly quite motivating for the stronger students in the class. The commenting functionality of the site (where students could comment on particular questions) rather like a discussion board thread was not used.

In the light of this modest but encouraging uptake, the course team are considering future plans for the use of the system in the course next year. At present, EVS questions are used in a single mode of delivery - asking questions in lectures. We are experimenting with / considering other methods of use, such as building 'consolidation' or review exercises on the EVS questions into the tutorial workshop sessions for the course, and also the use of

student generated content (EVS questions) within the course. EVAF is going to be used in the second Semester follow-on Physics course, Physics 1B.