The Long March or Bold Strokes: Comparing Strategies for Adopting EVS Learning Technology at a UK University

Amanda Jefferies, Marija Cubric, Julie Vuolo
University of Hertfordshire, Hatfield, UK
a.l.jefferies@herts.ac.uk
m.cubric@herts.ac.uk
j.c.vuolo@herts.ac.uk

Abstract:
In recent years there has been much encouragement to investigate the use of classroom technologies to enhance the student learning experience especially in the STEM subjects but now extending across other subject areas as well. A typical classroom technology is electronic voting system (EVS) handsets which allow a lecturer to invite students to vote for their choice from a selection of given answers. Recently, a medium-size UK University has purchased over 9000 EVS handsets for use across the academic Schools as an innovative means for supporting formative and summative testing. Numerous training and support sessions have been provided to staff with the intention of supporting new and experienced users and increasing the take up by academics. As noted in earlier research reported at ECEL 2013, the student feedback was very positive for the use of EVS for formative activities, and less so, for its use in summative assessment.

A recent review of the trends of EVS adoption at the University has been undertaken to inform decision-making and future use and support for the technology. One aspect of this review has considered the effectiveness of the strategies adopted by different academic Schools. EVS adoption and use across the University has been compared and placed within Rogers' theory of the diffusion of innovation. This paper further considers a set of six different strategies adopted for EVS use by academic Schools. They have been categorised according to several variables, including their choice of speed of uptake and the number of handsets in use. The inherent strengths and possible weaknesses of the approaches adopted are considered. Among the questions raised were, does a strategy of large-scale technology adoption over a short time period indicate a greater likelihood of long term engagement and ultimate adoption of the technology? Or, does a longer elapsed time taken for a gradual purchase and adoption of EVS technology suggest a greater inclination for the embedding of technology for enhancing learning? What other success factors should be considered alongside the training and support provided for technology adoption to enhance the likelihood of long term adoption of classroom technologies?

The discussion provides a comparison of six different strategies identified across the university and the rationale behind them and then proposes a set of strategy choices which can lead to a greater likelihood of successful adoption of classroom technology.

Keywords: EVS, clickers, classroom technologies, HE learning, institutional strategy, academic choices

1. Introduction

For several years the Higher Education community has been exploring the use of classroom technologies to support student learning and enhance student engagement in campus-based teaching environments. Learning from the experiences of schools in the U.S A. and elsewhere, the use of 'clickers' or student response systems has grown steadily at UK universities in recent years. The benefits and challenges of response systems used for teaching and assessment have been widely documented already (see for example Kay and LeSage, 2009) and their use has been applauded for the opportunities they offer for swift feedback to students (Shaffer and Collura, 2009) whether in formative or summative use and for the resulting feedback they offer to academics to ascertain how much students have understood from their learning, (Beatty, 2004) and for improvements in learning outcomes (Shapiro & Gordon, 2013; Preszler, Dawe, Shuster & Shuster, 2007). Students have reported their appreciation of the anonymity that using clickers affords them in large classes and have welcomed the competitive element that clickers can bring to learning (Heaslip, Donovan and Cullen, 2014) and finding that the use of clickers improves their understanding of course content.

The use of clickers has been hastened by the advent of reliable classroom technology that can support response systems when they are used for summative assessment and may also link with student records in the managed learning environment (MLE) to offer a prompt turnaround of assessed material. Offering further examples of their benefit for engaging students through their extensive formative use in his Physics classes, the respected Harvard educator Erik Mazur has contributed widely to the body of evidence which supports their classroom use (see for example; Schell, Lukoff & Mazur, 2013). In this paper 'clickers' or 'response systems' will be discussed through the acronym of EVS (Electronic Voting Systems), which is the more common term in the UK.

Moving on from the lessons of initial research into EVS use across UK and US universities (Dufresne, et al., 1996; Mazur & Hilborn, 1997; Draper & Brown, 2002) this paper will consider the patterns of EVS use in a medium-size UK university which has invested widely in their use for enhancing a culture which supports technology use for deepening student engagement. While originally used primarily for STEMM subjects (Science, Technology, Engineering, Maths and Medicine) this paper explores the issues of embedding EVS usage across other academic schools in the university and in particular seeks to deepen the understanding of the success factors in EVS use and the academic culture which enables them to flourish.

2. The local environment

The university in question is located in southern England and has over 27,000 full-time equivalent students registered across its campus-based and online distance programmes. It has been well-known in the UK for investing in online and blended learning to support students wherever they are based (Alltree, et al, 2010). The university has made extensive use of its own custom-built MLE since 2001, which allows student and staff engagement via virtual portals. Online engagement reached over a million page accesses in the early months of the 2013-14 academic year. Research has been undertaken for more than a dozen years into student and staff engagement with technologies to enhance learning by academics (see for example Thornton et al, 2005). EVS have been used here since 2004, but this start was originally in experimental ways and primarily across a small sub-section of academic schools, namely Engineering, Biosciences and Healthcare programmes (Lorimer & Hilliard, 2008). The handset purchases at this time were from a variety of suppliers and used within school-based programmes; the EVS purchase strategy was first co-ordinated centrally in 2010.
The widespread use of EVS technology within the university began in earnest in 2010-11 with the commitment of the university to fund the purchase of some 6,000 TurningTechnologies™ handsets and their associated hardware receivers in order to equip the majority of classrooms across the two almost adjacent campuses. This commitment for EVS purchase was undertaken in support of a student digital learning enhancement project and based on the record of the previous successful use of EVS over 6 years among undergraduate and postgraduate students and supported by ongoing international research into their efficacy and reflected on by Jefferies & Cubric (2012) and Lorimer & Hilliard (2008).

During the 2010-11 academic year, seven out of the eight existing academic schools committed to using the EVS with targeted cohorts of students and to support academic staff in engaging with the technology for supporting student learning. Extensive support was made available with training events held regularly on campus and through technology champions at a local and institutional level as previously recommended by, among others Anderson *et al* (1998). The development of pedagogies which would encourage the formative use of EVS on a regular or occasional basis was discussed and shared widely by academics (Jefferies & Cubric, 2013).

Since 2011 many academic schools have continued to expand their use of EVS; there are now over 9,000 handsets registered to students in addition to extra cohort sets purchased by schools themselves. As some academic schools have increased their use, others have seen their use of EVS in the classroom decline, accordingly a recent study has set out to evaluate how far EVS use has become embedded into the university culture and why. Having previously explored the success factors and barriers affecting technology engagement among academic staff (Jefferies, 2011) this study considers the trends of adoption for EVS use and embedding within the institution.

3. Methodology

The study described below was undertaken between February 2014 and June 2014 as part of a wider evaluation of trends in technology used for learning at the authors' institution. The following objectives were set out.

- To provide an understanding of the spread of EVS use and the roll out strategies for EVS across different Schools.
- To provide an initial analysis of recent trends of EVS use
- To identify those local success factors which had guided the strategies of schools which use EVS widely and reliably and receive positive feedback from students (Jefferies & Cubric, 2012).

A mixed methods approach using quantitative and qualitative methods was used to address this variety of research objectives. Both a broad view of trends of use and specific local usability were investigated and different methods employed accordingly with an initial email sent to academic schools to inform them of the evaluation being undertaken. Detailed quantitative data on student registration numbers for on-campus students was provided by the academic school registrars. The latter allowed a comparison between student numbers and ownership of EVS handsets to be calculated.

Two short quantitative surveys were devised and set up online for completion by Programme Tutors and the School Student Representatives. The survey requested information on the extent and quality of the use of EVS on a module by module basis. The outputs were compared with data from interviews with the local School based academic EVS champions and the eight Associate Deans for Learning and Teaching (ADLT) to provide as full a picture as possible of EVS usage.

Alongside the quantitative data, qualitative data was gathered through a combination of the following:

- A review and analysis of the individual academic school EVS reports, previously compiled in 2011-12 by school- based technology champions
- A focus group discussion and short qualitative survey with the school-based EVS Champions
- Individual discussions with the ADLT for each academic school
- Individual semi-structured interviews with EVS Champions in person, via telephone or e-mail

The qualitative data was gathered in the chronological order shown in the bulleted list above and an iterative analysis and review was undertaken. This allowed for final semi-structured interview questions to be asked of EVS champions towards the end of the study in order to target some apparent gaps in the authors' understanding of EVS usage.

School sizes will vary but it was not the aim of this study to seek a comparison between school size and levels of technology adoption. The authors' interest lay in the extent of the technology embedding across both STEMM and non-STEMM Schools given the equality of opportunity from the Centre-led provision of training and support.

4. Findings and discussion

The authors considered the different trends which emerged from the evaluative study in two ways. First of all, they considered how the different users of EVS across the academic schools might map to the Individual Innovativeness theory (Rogers, 1995) see Figure 1 below, which states that individuals who are predisposed to being innovative will adopt an innovation earlier than those who are less predisposed. Figure 1 shows Rogers' bell shaped distribution of Individual Innovativeness and the likely percentage of potential adapters in each category. On one extreme of the distribution are the Innovators, who typically seek to adopt an innovation very early. On the other extreme are the Laggards who resist adopting an innovation until as late as possible, if ever. Anderson *et al*'s work demonstrated how this curve broadly fitted with academics experiences at the University of Alberta, (Anderson et al, 1998). The users at the authors' institution were not asked to define themselves according to Rogers' placement so the proposed percentages are taken as a rough guide only. Some academic schools which were teaching STEMM subjects might be expected to have a higher proportion of academics who would confidently engage with technology in student learning. Here, it was suggested, might be found a greater proportion of the Innovators and Early Adopters (EA). While this turned out to be true to a certain extent early adopters of technology were found across all the academic subjects, with a small numerical increase in those teaching the STEMM subjects.

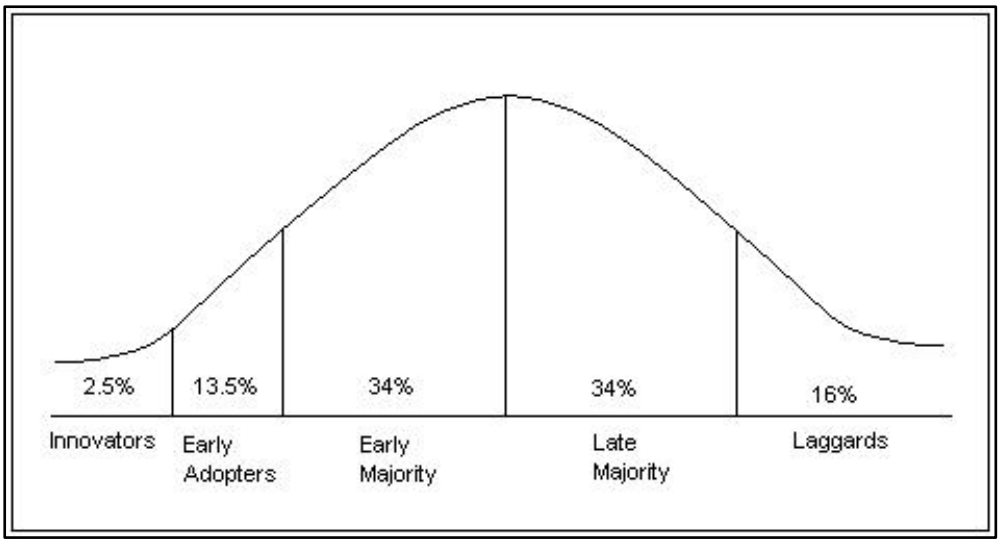

Figure 1: Rogers' Individual Innovativeness Theory (1995)

Of greater interest to the authors however was Rogers' Rate of Adoption theory which states that innovations are diffused over time in a pattern that resembles an s-shaped curve. Rate of Adoption theory states that an innovation grows gradually before experiencing a period of rapid growth. An example of how a rate of adoption might typically be represented by an s-curve is shown in Figure 2. The theory also states that after the period of rapid growth, the innovation's rate of adoption will gradually slow down.

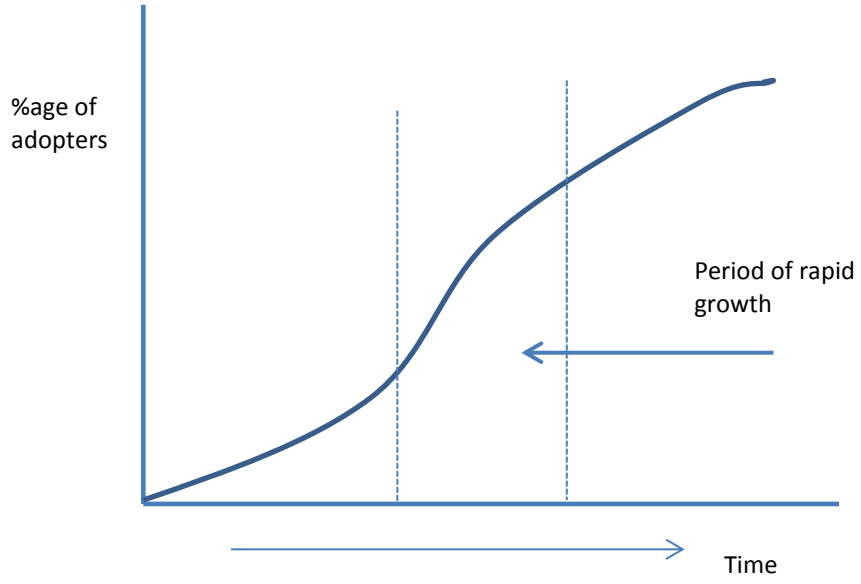

Figure 2 Rogers' Rate of Adoption theory (1995)

The authors have used the timeline of innovation in Figure 2 to explore the changes at the university in recent years focussing on the 's-shaped' curve in the figure to explore where different Schools are located and the strategy which led to that point. The initial period of a slow rate of growth was the time between 2004 and 2010 when pockets of EAs across the different (primarily STEMM focussed) academic schools explored different ways to use EVS technology and shared innovation among themselves, with limited and slow take-up in other academic areas. A period of rapid growth as discussed above had then taken place between the end of 2010 and through 2011 with a major expansion in the use of EVS classroom technologies and the enlisting of a group of users to champion and support the wider sharing and embedding of EVS technologies. Following Rogers'

characteristic s-shaped curve the evaluation of where the technology adoption trend led, was found to show distinctive characteristics for different schools and this was not fully correlated to whether they were STEMM based or not.

Secondly the authors considered the trends for individual schools according to their strategies for starting up and continuing EVS use. All schools had equal access to the centrally provided programme of technical support and seminar programme. The latter offered a range of seminars aimed at a cross-section of Roger's user types, including sessions for those who were just starting out in using EVS in the classroom as well as those who had more experience and shared their own experiences for improving practice and develop a local community of practice (Wenger,1998).

Six typical strategies were proposed during the evaluation of the trends of technology adoption and use from the original data gathered, relative to the speed of EVS adoption and subsequent trajectory of embedding. These have been categorised and described according to their primary characteristics from the authors' viewpoints as follows:-

- Big bang
- Well considered
- Steady Burn
- Steady Flicker
- Flicker and Fade
- Falter

It is evident from the descriptive titles given to the different trends above that some of the strategies have been more successful than others, and it became clear during the recent evaluation that not all of the academic schools which had previously embraced technology adoption in 2010/2011 have continued to use EVS widely.

In considering the current position of the location of the technology use on Rogers' 's-shaped' curve above, some schools are continuing to grow in their use of EVS technology while some are declining in their overall use. Three strategies were identified as showing a trend of continued growth and engagement by academics in the use of EVS technologies. These were:-

- Well considered
- Steady burn
- Steady flicker

The three which have not been so successful in engaging a growing number of academic staff with using technology were - Big bang, Flicker and Fade, Falter. Many of the schools characterised as following the more successful trends are in STEMM subjects while those schools which have moved on with their pedagogy choices and have a stable or declining use of EVS are more typically non-STEMM subjects. There are however a couple of exceptions where teams of 'innovators' and 'early adopters' still continue to use EVS in their own teaching and champion their use in non-STEMM schools.

What has led to the characteristics of increased or declining engagement with classroom technologies in each of these cases? The description of '*Well considered'* was applied to those academic schools which gave much thought to their commitment to EVS over an extended period of time. They have typically been growing their expertise over several years and have a number of enthusiasts among their academic staff. One of the exemplars of the 'well considered' group committed to purchasing a handset for each incoming undergraduate student some two years before the main expansion at the university in 2010-2011. Consequently they have been developing local staff skills over a long period of time and ensuring support from experienced colleagues on a wide range of modules. This was undertaken with top-down commitment at senior management level from the Dean of School. At any one time up to 50% of staff may be engaged in using EVS on their taught modules. The primary use has been with formative and summative quizzes which may contribute as 'low-stakes' assessments to students' final grades.

The description of *'Steady Burn'* indicates a steady start to the process of experimenting with and engaging on a small-scale with EVS technologies. There has typically been a small core of staff who

developed their classroom pedagogy early on in the chronology and acted as innovators/early adopters. An investment in staff training and extensive local in-house support was provided at grassroots level from the departmental champion. As a result the schools in this group have typically increased their user base among academic staff slowly but steadily and the user base has grown steadily over time.

The description of *'Steady Flicker'* also indicated a slow start to the adoption of EVS, primarily but not exclusively in non-STEMM academic schools where there had been little prior emphasis on concentrated use of technologies to support learning and teaching. In some schools there was a small core of specialist and more innovative academic staff who were keen to explore and share practice on a regular basis. A typical characteristic of the adoption described as *Steady Flicker* was the smaller class sizes where students would be known individually to the academic leader and where there was an existing more conversational approach to pedagogy which encouraged student interaction without an additional need for EVS handsets. Some academics in this group took electronic attendance registers regularly with EVS while using them less for polling and summative assessment. An example of a non-STEMM subject using the EVS was by an academic in Humanities who used the more sophisticated handsets for the students to submit answers to her formative homework tests, uploading their answers electronically at the start of her classes. The distinction here is that although the user base remains fairly small a consistent interest is maintained in pockets throughout the school.

The description of '*Flicker and Fade'* was applied to those schools where the number of users stayed at a lower than expected level and growth in EVS usage did not experience an increase when compared with other schools. Schools described thus might be STEMM or non-STEMM focussed. The issues over engagement were however complex and differed for each school. Some schools had a policy of using Mac-based computers in their labs and encouraging student ownership of Macs because of the availability of Mac-based software in their area. The EVS handsets chosen initially did not have a reputation for working well with Macs and after initial enthusiasm EVS use was dropped because of difficulties of using them with the embedded Turningpoint™/Powerpoint™ software. Other schools within this descriptor had a small core of regular users which did not expand as in other schools. The overall collective experience was minimal and academic staff made limited use of centralised training. Some formative use was made across undergraduate programmes in these schools. Whereas the 'Well Considered' schools had enthusiastic and committed support from senior managers, this was less evident in the Flicker and Fade schools and as a result there was less commitment to employing an Educational Technologist.

Those schools which were described as '*Faltering'* in their use of EVS were typically from non-STEMM subjects, which could not see how their pedagogy, described by practitioners as 'hands-on' might develop further through using EVS. Some academics experimented with EVS early on but decided that it was not enhancing the student experience and ceased to promote it further. The overhead of writing quality questions was too high for some academics compared with the perceived benefits of using the EVS technology.

The description of '*Big Bang'* was attributed to a group of STEMM and non-STEMM schools, which showed great enthusiasm initially when the EVS classroom technologies project was launched. They exhibited a number of hallmarks of success early on, such as the engagement of senior management and their buy-in to EVS use and widespread support for encouraging use with mainstream academics. Their top-down leadership involvement led initially to a speedy introduction of EVS technologies, with their use for summative assessments being mandated in one school across the main undergraduate programmes. However, the speed of engagement with EVS as a potential for supporting swift feedback on summative assessments was not matched by a commitment to involve all the necessary teaching staff in extensive training and confidence building. In one non-STEMM school the fast introduction was undertaken without considering the additional need for administrative and educational technologist support. Their focus for using EVS was predicated on the potential for time-saving on the academic workload through the use of EVS for summative assessment rather than on building the use of EVS into the pedagogy of learning and assessment. This contradicted Anderson et al's assertion that: '*The compelling reasons that attract mainstream faculty must be based on pedagogical effectiveness.'* (1998). Thus instead of the expected progress to broaden EVS use in future years as had been experienced by schools following either a 'Well considered' or 'Steady Burn' trajectory, EVS was rejected by academic staff and engagement became limited to a small minority using EVS for formative support and polls.

How does this variety of engagement and their descriptors for classroom technology use tie in with Moss Kanter's views on promoting organisational change and development? She described in a series of papers and textbooks that organisational leaders engage in two types of actions that help promote organizational change: 'bold strokes' and 'long marches' (Moss Kanter et al., 1992). 'Bold strokes are typically those strategic decisions or major initiatives which might include investing critical resources in the development of a new technology or a dramatic new product. The 'long marches' can be described as focussing more on continuous improvement initiatives and operational matters such as improving quality and customer relationships, restructuring work and organizational alignments, as well as a host of other actions which function to improve organizational effectiveness.' (Manley et al, 1998)

Moss Kanter's description of 'bold strokes' and a 'long march' when applied less to organisational change *per se* but instead to the introduction of new technology indicates that either of these might be a successful strategy to follow. It is therefore the detail of the embedding of the changes into the culture which can be seen as critical to whether the change leads to longer term transformation or not. In considering the notion of the 'long march' the implication is that slow and focussed progress and growth might generally lead to sustained success but it is clear from the examples of EVS introduction above that it is not necessarily the speed of the introduction of technology which leads to success or failure. A 'long march' was described as the approach taken by five of the example school descriptors above but only some of their strategies ultimately led to the embedding of classroom technologies within the school culture. The three descriptions of *Well considered*, *Steady burn* and *Steady flicker* show steady progress over several academic years which has ultimately led to the successful embedding of EVS technologies. The keys to their success appear to lie in the leadership and top-management support for embedding technology, the extensive use made of central training and the provision of 'technology buddies' in the form of the school-based EVS adopters, also known as 'local champions', with an existing network of enthusiastic innovators and early adopters.

Previous research has indicated high levels of student satisfaction experienced when use is made of classroom technologies to enhance student engagement with taught material, (Jefferies & Cubric, 2012). This indicated that there was no significant difference in students' satisfaction across subject groups whether STEMM or non-STEMM related, but a significant difference in satisfaction between formative & summative use with frequent formative use being praised and only low-stakes approaches for summative use being preferred. Commitment by academics is clearly required to ensure that introducing new technologies is a successful strategy and does not lead to growth which then stagnates and dies. This was the picture for the '*Flicker and Fade'* and '*Falter'* approaches. In these schools there were insufficient early adopters and a senior leadership less committed to introducing and embedding classroom technologies. The examples of a 'bold strokes' initiative in terms of the *Big Bang* approach was unsuccessful in embedding classroom technologies into the schools involved. This was not because of the lack of initial leadership and senior support but through the misunderstanding of many academics of the need for greater involvement in the training offered and fuller personal engagement with the technology they were using. It was not therefore the speed of the introduction which caused the rapid subsequent decline in use but a combination of other factors, including the absence of a carefully examined pedagogy to scaffold and support the EVS use.

5. Conclusion

What can be learnt about the different strategic approaches explored here to anticipate those which will lead to successful adoption and embedding of technology in academia? In this paper we have compared strategies for EVS technology adoption in one university, in an academic and social media environment which is a world away from Anderson *et al*'s original 1998 paper, which considered barriers to technology adoption by academics. Technology is now an integral part of the professional and social lives for nearly all mainstream academics regardless of subject but still some academics choose not to adopt certain technologies.

As with other organisations, the key indicators include top-down and local management support but an additional hallmark of successful embedding has been the core group of local early technology adopters from each academic school who are willing to engage with colleagues by sharing the potential of EVS technology. Whether the embedding of technology within the classroom develops fast or slowly it is the human support for colleagues at a local level to develop their pedagogy and scaffold their use of technology to enhance learning, which has been crucial to its lasting embedding.

Acknowledgements:

The authors gratefully acknowledge the contribution of their colleagues, especially the members of the Learning and Teaching Institute and the 'EVS champions' at the University of Hertfordshire.

References:

Alltree, J., Jefferies, A., Russell, M. (2010) *The Blended Learning Unit, University of Hertfordshire: A Centre for Excellence in Teaching and Learning, Evaluation Report for HEFCE, March 2010*, available online at: http://www.herts.ac.uk/fms/documents/teaching-and-learning/Hertfordshire-CETL-Evaluation-Report-March-2010-Final.pdf

Anderson, T.,Varnhagen, S. & Campbell, K. (1998) Faculty Adoption of Teaching and Learning Technologies: Contrasting Earlier Adopters and Mainstream Faculty, *The Canadian Journal of Higher Education* Volume XXVIII No. 2,3, 19

Beatty, I. (2004).Transforming Student Learning with Classroom Communication Systems. *EDUCAUSE Research Bulletin*, (3), 1-13, available online at: http://www.educause.edu/ir/library/pdf/ERB0403.pdf

Draper, S. W., & Brown, M. I. (2002) *Use of the PRS handsets at Glasgow University*, Interim Evaluation Report: March 2002.

Dufresne R.J., Gerace W.J., Leonard W.J., Mestre J.P. & Wenk L. (1996) Classtalk: a classroom communication system for active learning. *Journal of Computing in Higher Education* 7, 3–47.

Heaslip, G., Donovan, P. &Cullen, J.G. (2014) Student response systems and learner engagement in large classes. *Active Learning in Higher Education,* 15(1) 11 –24

Jefferies, A. & Cubric, M. (2012) *Evaluating Electronic Voting Systems (EEVS) Briefing Paper for JISC Assessment and Feedback Programme*, *Strand B* available online at: http://jiscdesignstudio.pbworks.com/w/page/48734953/EEVS%20Project

Jefferies, A. (2011) 'Introducing and Using Electronic Voting Systems in a Large Scale Project With Undergraduate Students: Reflecting on the Challenges and Successes' In Greener, S.& Rospiglio, A. (Eds) *Proceedings of 10th European Conference for E-Learning*, Brighton, UK, API pp. 319-325

Jefferies, A. & Cubric, M. (2013) 'Planning for Success in Introducing and Embedding Technology to Enhance Learning' In Ciussi, M. & Augier, M. (EdS) *Proceedings of 12th European Conference for E-Learning*, Sophia Antipolis, France, API pp. 156-163

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

Lorimer, J. & Hilliard, A.(2008) Use of an Electronic Voting System (EVS) to Facilitate Teaching and Assessment of Decision Making Skills in Undergraduate Radiography Education. In*:* Remenyi, D., (Ed). *Proceedings of 8th European Conference on e-Learning*,2009 Bari, Italy. ACI, 351-357.

Manley, T. R., Martin-Vega, l., Shaw, W. H. & Mighdoll, P. (1998)Understanding organizational culture and its role in organization transformation and development. *International Conference on Engineering and Technology Management. Pioneering New Technologies: Management Issues and Challenges in the Third Millennium.* IEMC '98 Proceedings.1998 San Juan, PR IEEE, 342-349.

Mazur, E. & Hilborn, R. C. (1997). Peer instruction: A user's manual. *Physics Today*, 50(4), 68-69.

Moss Kanter, R., Stein, B. A. & Jick, T. D. (1992) *The challenge of organizational change: How companies experience it and leaders guide it.* New York.

Preszler, R.W., Dawe, A., Shuster, C.B., & Shuster, M. (2007).Assessment of the effects of student response systems on student learning and attitudes over a broad range of biology courses. *CBE-Life Sciences Education*, 6(1), 29-41.

Rogers, E. (1995) *Diffusion of innovations* (4th ed.)The Free Press, New York

Schell, J. Lukoff, B., Mazur, E (2013), Catalyzing Learner Engagement using Cutting-Edge Classroom Response Systems in Higher Education, in Wankel,C.& Blessinger,P. (ed.) *Increasing Student Engagement and Retention Using Classroom Technologies: Classroom Response Systems and Mediated Discourse Technologies (Cutting-edge Technologies in Higher Education, Volume 6)*, Emerald Group Publishing Limited, pp.233-261

Shaffer, D.M. & Collura, M.J. (2009) Evaluating the Effectiveness of a Personal Response System in the Classroom. *Teaching of Psychology,* 36(4) 273–277

Shapiro, A.M. & Gordon, L.T. (2013) Classroom clickers offer more than repetition: Converging evidence for the testing effect and confirmatory feedback in clicker-assisted learning. *Journal of Teaching and Learning with Technology*, 2(1) 15 - 30.

Thornton, M., Alltree, J., Jefferies, A., & Jones, I. (2005) 'Introducing Web-based learning: An investigation into its Impact on University Lecturers and their Pedagogy.' *Journal of Information Technology Impact*, 4, pp. 91-98

Wenger, E. (1998) *Communities of Practice: Learning, Meaning, and Identity,* Cambridge, Cambridge University Press.