

Supporting good practice in undergraduate education using Electronic Voting Systems (EVS)

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Abstract

Teaching staff in higher education institutions throughout the world are increasingly faced with large cohorts to teach. It can therefore be difficult to implement the seven principles of good practice identified by Chickering & Gamson (1987). Electronic Voting Systems (EVS) can potentially assist tutors in delivering such good practice. Both direct and indirect links between the use of EVS and Chickering & Gamson's seven principles can be made. Direct links map strongly between the principle and the use of EVS, whereas indirect links evoke other mechanisms or suggest a secondary role for EVS within teaching practice. Direct links occur between encouraging active learning and giving prompt feedback, by removing the lack of anonymity to responding in class and rapid collation of student responses to questions. Indirect links include emphasising time on task and communicating high expectations. It is argued that EVS offers significant potential towards supporting good practice in undergraduate education.

1. Introduction

Tutors in higher education are increasingly teaching large groups of students. Larger groups can be challenging to teach, as individual identities and learning needs or styles may become diluted. Tutors may struggle to engage large audiences, not through overwhelming amounts of response but by a reticence to engage on the part of the student audience. Many tutors will have experienced this, particularly when subject material is abstract or complex. Therefore, encouraging active learning within large groups can be difficult, and many tutors become the 'sage on the stage', filling the student 'vessels' with knowledge to be recited during examinations (Moss & Crowley, 2011). Because active learning increases exam performance, this difficulty of engagement needs to be overcome.

Electronic Voting Systems (EVS) offer a potential mechanism by which large audiences can be engaged in processing material delivered through lectures, ultimately enhancing student performance. In this paper the potential of EVS to support good practice for undergraduate education is addressed, drawing on the Principles of Good Practice in Higher Education, defined by Chickering & Gamson (1987), to identify direct and indirect links with good practice. Also considered is the view expressed in some quarters that EVS is simply an 'amusing novelty' (Lantz, 2010), 'pretty lights' to decorate difficult subject matter (King & Robinson, 2009), or simply a distracting and time-consuming diversion for students from assimilating material delivered by a lecturer. Should EVS be considered a replacement for traditional teaching techniques (Figure 1), or be viewed as a tool in the teacher's armoury to stimulate active learning in large student cohorts?



"I'm taking an innovative approach to teaching this semester. I'm using books!"

Figure 1. *The implementation of new technology may be best as a compliment, not a replacement, to traditional teaching methods (Source: www.glasbergen.com/wp-content/gallery/teachers-and-staff/edu31.gif).*

2. What are EVS systems?

EVS (or audience response systems, ARS [e.g. Hay & LeSage, 2009]; classroom clicker system, CCS or 'clickers' [e.g. Boyle & Nicol, 2003]; student response systems, SRS [e.g. Stav *et al.*, 2010]) use wireless technology to record and store the responses of individuals to multiple choice questions (MCQs). Typically, three hardware components are required: multiple handsets (clickers), a PC and a receiving unit. These components are supported by software to allow the creation of 'interactive' slides within Microsoft PowerPoint and retain voting data. A typical sequence of use involves a multiple choice question (MCQ) being designed and displayed followed by students responding (e.g. Lou & Lorimer, 2010). A summary of the responses to each choice is then displayed within the PowerPoint presentation. The data used to build the summary display may then be stored and manipulated to provide more detailed analysis of the responses, such as the performance of individual respondents within a session.

3. EVS to support good principles of undergraduate education

Based on reflection and experience, it can be argued that EVS brings four key advantages to learning:

- **Promotion of active learning** by asking students to synthesise and digest information after delivery, and challenging their knowledge and understanding;
- **Generation of student feedback** by providing an instant assessments of student responses to questions;
- **Generation of staff feedback** through demonstrating the effectiveness of teach-

ing through student performance;

- **Encourages attendance and engagement** by assisting in recording presence in lectures and monitoring of students' performance.

These points are discussed in detail in sections 4.1 and 4.2 and the potential for further development of the advantages is presented.

Each key advantage can be mapped onto Chickering & Gamson's (1987) Seven Principles for Good Practice in Undergraduate Education. These have been widely used in higher education to structure attempts at improving the learning experience for undergraduate students. Chickering & Gamson argue that although any of the seven principles (shown as red boxes in Figure 2) can stand alone, they are multiplicative. In effect, the product of all is greater than their total sum. The principles are also applicable to all subject-areas and students, regardless of academic content, or student ability (Chickering & Gamson, 1987). EVS may not support each of the good practice principles directly, but still offers significant opportunities to enhance good practice through more tangential links. Figure 2 shows how EVS can enhance the delivery of good practice by either 'direct' or 'indirect' links with Chickering & Gamson's seven principles. Each set of links is considered separately in the following discussion.

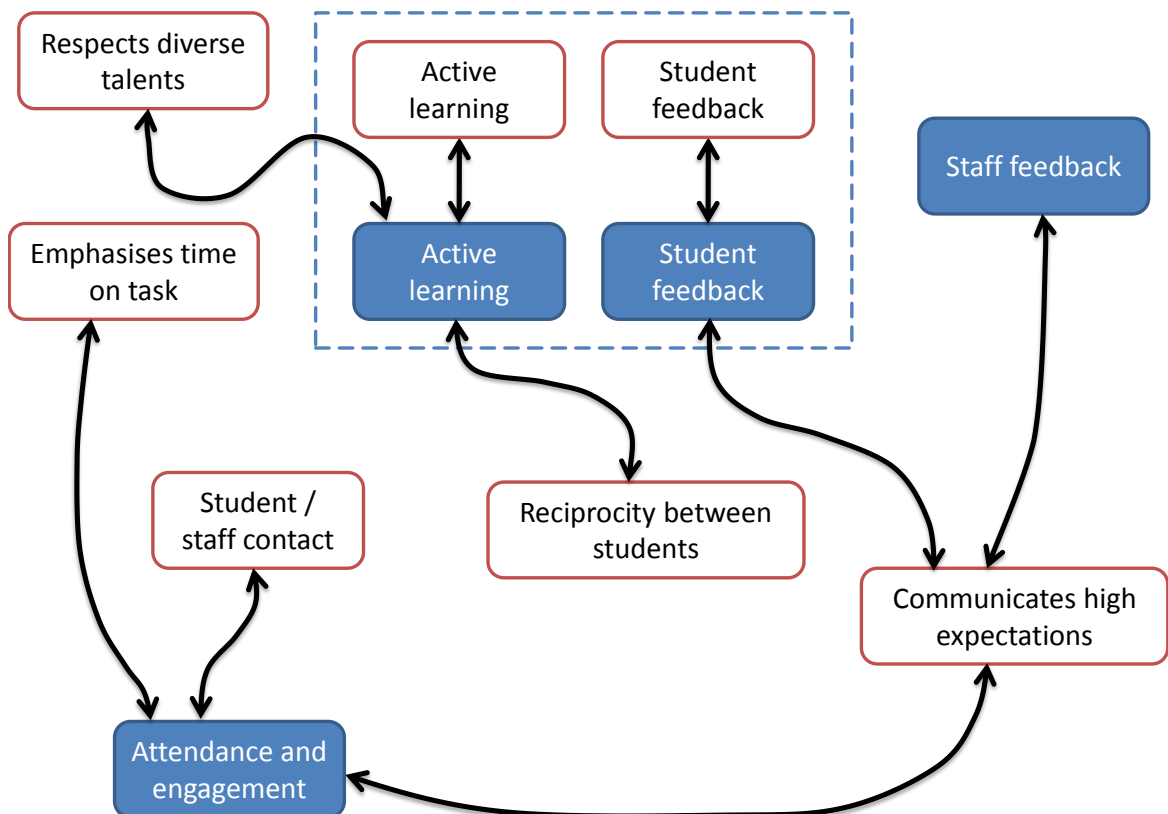


Figure 2. A conceptual model of the direct and indirect links by which EVS can support principles for good practice in undergraduate education (Chickering & Gamson, 1987). Blue boxes represent key aspects of EVS in teaching and learning and red boxes are the seven principles. Principles and aspects within the dotted box are direct links, other links are considered indirect.

4.1 Direct Links with Chickering and Gamson's Principles

EVS supports active learning through anonymity

'Active learning' is considered by many Higher Education (HE) practitioners to be a cornerstone for improving undergraduate education. A number of definitions exist, but all can be paraphrased to suggest that active learning is 'learning by doing'. 'Doing' can be a range of activities, principally reading, writing, discussing and solving problems. All four activities promote deeper learning of material through encouraging analysis, synthesis and evaluation (Bonwell & Eison, 1991). Active learning is thought to improve exam performance when compared to the traditional lecture format (Crossgrove & Curran, 2008; Freeman *et al.*, 2007; Yoder & Hochevar, 2005 in Lantz, 2010), and is therefore widely promoted as a principle for quality undergraduate learning.

One of the most basic examples of active learning is asking students to respond to a question. This is often met by a reticence to respond on the part of students (e.g. Steinert & Snell, 1999). Anecdotal experiences suggest that there may be a number of reasons for this (Box 1). Concerns of how peers will view participation are particularly important from the undergraduate perspective, and may generate particularly strong concerns when there is a reasonable likelihood of giving a wrong answer. Experiences of teaching small groups within the School of Life Sciences at the University of Hertfordshire suggests that even smaller class sizes may not improve the likelihood of student response to questions (corroborating the findings of Draper & Brown, 2004), particularly when there are strong social groups present amongst the class. Ultimately, few students will respond publically and any students that are comfortable with answering quickly become established as 'class-answerers', allowing the remainder of the class to simply wait for them to answer. This phenomenon has been observed frequently in

Box 1. Experiences of barriers to participation.

From the undergraduate's perspective:

- Fear of giving incorrect answer
- 'Uncool' image of giving correct answer
- Genuine lack of knowledge
- Confusion as to what the tutor is asking
- Feeling answer is too simple to be correct
- Disinterest in subject matter
- Lack of incentive to think of correct answer

From the tutor's perspective

- Poor phrasing of question
- Question formulated at inappropriate level
- Question unintentionally exclusive – fails to cross barriers associated with cultural, linguistic, disabilities etc
- Timing of question inappropriate to flow of material of stage of lecture
- Question set as group work but individuals rely on others to answer

lectures, and anecdotal evidence suggests that a lack of knowledge or understanding is not the only barrier to engagement: many able students shy away from responding publicly. A number of studies have suggested that raising hands, showing response cards or peer discussions regarding the response to a question may improve participation and performance by removing the peer-pressure of verbally responding in public (Freeman *et al.*, 2006; Jones *et al.*, 2001). Husinger *et al.* (2008) suggest that for cultural reasons Asian students may be particularly discouraged from giving public answers due to a potential loss of respect or esteem.

EVS supports active learning by encouraging students to respond to questions posed by lecturers because their responses are anonymous. Students who may be reluctant to discuss opinions or answers with tutors may be more likely to respond when using EVS (e.g. King & Robison, 2009; Jones *et al.*, 2001). A number of researchers have found evidence which supports the findings of Jones *et al.*, 2001. For example, Freeman and Bayley (2005) found that when comparing EVS to traditional response types (raising hands), students reported significantly higher interaction in lectures, understanding of material and self-evaluation of learning. Sharma *et al.* (2005) reported that 38% of students were 'very comfortable' to use EVS to answer questions in a large lecture, but only 4% would be happy to answer verbally. Amongst Asian students, EVS has been shown to increase participation. This may be related to Chinese students potentially being used to a tightly structured form of 'knowing' information, and that this information is perceived to be delivered by a tutor rather than a peer (Cortazzi, 2002 in Beekes, 2006). Therefore, discussion and peer-led learning may be less appealing to Chinese students than the supposed structure of an EVS-based quiz. However, the results reported by Freeman and Bayley (2005) found that language, local or international origin, gender and disability were not significant in explaining differences in students perceptions.

Freeman & Bayley (2005) explore the role of the lecturer when expecting and encouraging students to respond in class. Although a class was conducted using traditional response methods as a control for comparison with EVS responses, the lecturer felt that when using EVS he was

“freer to encourage student engagement and interaction...without offending any student because they would be anonymous...[Insisting or waiting] may have been insensitive or discouraging [when not using EVS].”

(Freeman & Blayney, 2005, p.30)

Students may perceive that a lecturer is less willing to wait or insist on a response, and therefore be less motivated to engage and answer the question when using traditional response methods. Furthermore, Freeman & Balyney (2005) suggest that the lecturer may have altered the time for response between EVS and traditional response types because of the difficulty of accurately estimating how many students had answered the question but were unwilling to publicly admit they had. One advantage of EVS is that this informa-

tion is easy to acquire, allowing for accurate pacing of questioning and data on voting or abstinence from voting.

In summary, asking students to respond to questions in class is a fundamental element of active learning. Personal experiences of teaching and evidence from the literature suggests that students can be uncomfortable answering questions publicly. By anonymising responses to questions, more students can become active learners as they are more likely to answer questions.

EVS facilitates prompt student feedback

Assessment is an important tool for allowing students to understand their progress and understanding of a topic, and a good opportunity for a tutor to gauge the performance of a class and individuals within it (Nicol & MacFarlane-Dick, 2006). Lantz (2010) suggests that feedback works by offering a corrective mechanism, replacing the incorrect answer from the memory of students. In order to maximise the benefit of feedback, students should be aware of the correct answer in addition to knowing whether they are right or wrong (Travers *et al.*, 1964, in Lantz, 2010). Beatty (2004) argues that students are able to see the limitations of their own knowledge so they can correct this and concentrate their learning appropriately. Beatty (2004) further argues

[EVS]-based instruction helps [students] take charge of their own learning, seeking out the information and experiences they need to progress... it can impact their approach to learning beyond class, helping them transform into more motivated, empowered [and] aggressive learners.

Traditional systems of providing feedback rely on a physical process of marking or grading answer sheets by a tutor and returning to students. This is frequently a lengthy process for students and tutors (Russell, 2008) and can require a significant administrative input. Personal experience suggests that the time commitment for tutors assessing essays is little different to that when marking short-answer questions. In this 'manual' model of feedback provision, it is the responsibility of the tutor to provide the correct answer to students to gain the benefit of feedback. However, when undertaking a significant quantity of assessment, particularly when comments are repetitive, tutors are less likely to provide the correct answer. Therefore, the potential to provide *en masse* corrections to students' understanding in class may significantly improve their memory and retention of correct answers, potentially improving their performance in examinations.

Feedback provided rapidly is thought to be more useful to students than delayed feedback. A meta-analysis of 53 case studies by Kulik & Kulik (1988) found that delaying the results of quizzes or tests never improved student's performance in recalling correct answers, but rapid feedback significantly improved performance in some studies. Kulik & Kulik (1988) stress the importance of appreciating the conditions in which experimental or observational data is given, and encourage a cautious interpretation of their findings. However, Fulmar & Rollings (1976) found that students who received immediate feed-

back using a form of EVS performed significantly better when recalling answers than students who received no immediate feedback. Although research evidence does not support a motivational element, personal experience suggests that students who feel they understand material by offering correct answers are frequently more motivated to study further. EVS can extend this motivation to all students in a class who answer correctly, rather than an individual student responding to a question.

EVS has a significant potential to improve the immediacy of feedback given by tutors. EVS systems offer the tutor the opportunity to provide immediate feedback to a captive audience. Typically, the number of students selecting each answer is shown when voting is complete. An effective use of EVS is then for a brief discussion to take place, led by the tutor, in which the reasons for selecting the incorrect answers can be discussed and the details of the correct answer elaborated on. This is a particularly important element of using EVS, since multiple choice questions do not naturally foster deep understanding of subject matter and may over-emphasise the opportunity to cover large quantities of material with little depth of understanding (Biggs, 1996). This highlights the critical role of the tutor in devising appropriate material (see section 4.2 '*communicating high expectations*'). In contrast, Draper (2009) suggests that EVS and multiple-choice questions can be used in a deeper way, acting as a 'catalytic assessment', and suggests practical advice for this (see Box 2). EVS directly supports the principle of giving prompt feedback, and by doing so offers students the opportunity to target their learning to topics on which they perform poorly.

Box 2. Using multiple choice questions and EVS for catalytic assessment and deeper learning (from Draper, 2002, p291).

1. Assertion–reason questions, which can be and have been used with EVS.
2. Taking an MCQ and having the learner generate reasons, for and against each response option, rather than simply ticking one. (This is usually done on paper as a private revision technique.)
3. Confidence-based marking, which is normally delivered by ICT and could be done with EVS with some (but not all) software.
4. Mazur's method of using brain-teasers to prompt peer discussion, which is routinely done using EVS.
5. Having students create MCQs as part of presentations using EVS.
6. Having students create MCQs for use in tests that may be administered either by using EVS or on paper.

4.2 Indirect supporting of Chickering & Gamson's Good Practice.

In addition to the direct links of feedback and active learning, EVS can contribute to many of the other Principles in indirect ways. 'Indirect' in this context refers to the supporting link being less clear or more obscure. Indirect links may not have such a strong association

with an element of good practice, and may support the element when used with certain caveats. Each element of good practice is treated separately below, to more clearly elucidate their relationship with EVS.

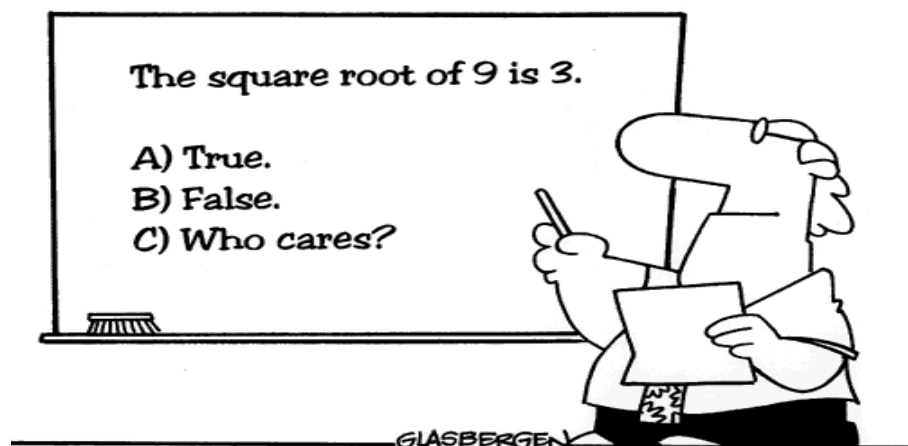
Encourages contact between students and faculty: EVS may help students interact with tutors more frequently. This is primarily through the way in which tutors respond to incorrect or correct answers from students. EVS can help produce a learning environment within a large lecture theatre where the traditional power-relationship between student and tutor is broken down in favour of a communal learning environment, where the tutor responds directly to the students. Whilst this is not a substitute for one-to-one or small group teaching, the illusion of appearing to remove a hierarchy of power may potentially improve students' perception of contact. Evidence gathered informally from teaching undergraduates suggests that activities where students are more reliant on fellow students than the tutor for information and responses helps to create a less hierarchical learning environment. For example, second year undergraduates participating in a geomorphology module at the University of Hertfordshire were asked to summarise a lecture under broadly defined topic headings using a whiteboard. Students contributed what they thought were the key elements of the material delivered. Participation was high and estimated to be over 75% of the class. The feeling of ownership and engagement with learning was clear amongst those students. Although EVS was not used in this example, EVS could potentially support this approach, particularly if used to respond to group discussions or when followed up by explanations of answers given. An additional mechanism for encouraging contact amongst all members of a class can be through using EVS as an ice-breaking or introductory tool. Students may be asked more personal questions (e.g. age, gender, degree programme; Draper *et al.*, 2002) to heighten awareness of their peers and contribute to a 'learning community' (see below, '*reciprocity and cooperation*').

Develops reciprocity and cooperation among students: Cooperation and reciprocity can be enhanced in learning environments when EVS is used. Learning communities may take a number of forms, including curricular communities sharing course content, residential communities and student type communities (Lenning & Ebbers, 1999 in Zhao & Kuh, 2004). Zhao & Kuh (2004) suggest that learning communities significantly increase students' academic performance and social and academic engagement with their peers. EVS is most likely to support classroom communities, where students are engaged with 'group learning processes' and 'cooperative learning techniques' (Lenning & Ebbers, 1999, in Zhao & Kuh, 2004). Using EVS unites students with a common learning technique, potentially creating a community atmosphere. Sharing responses to questions heightens the sense of belonging to a 'learning community'. Boyle & Nicol (2003) found that students overwhelmingly agreed that discussion amongst peers before casting votes through an EVS was helpful to understand the subject material. A shared sense of responsibility for answering questions and performing in line with the tutors 'high expectations' and recognition of the performance of the class as a whole may also contribute to creating a learning community. EVS could also be used in a group situation, where groups are set more challenging or discursive questions and then decide collectively on

their response. Working in formal groups is also potentially beneficial to undergraduate education, through sharing information, enhancing academic exchanges and experiencing different approaches to learning (Blumenfeld *et al.*, 1996).

Emphasises time on task: EVS facilitates an opportunity for a clearly defined period of time to be dedicated to consolidating understanding of material and testing recollection of facts. This is closely aligned with ‘emphasising time on task’. Students will be clearly aware of the time they have spent answering questions relevant to their subject material. EVS represents a short time – high energy form of learning, which could be an effective addition to long time – low energy learning techniques such as reading or note taking. Students are required to focus on the task for a short period of time, which may be of benefit to students who may struggle to concentrate for long periods. EVS use in class has also been shown to increase attendance compared to non-EVS classes (see Hay & LeSage, 2009, and references contained therein). This can provide a platform to increase engagement with tutors, peers and subject material (e.g. Freeman *et al.*, 2007). This is important because class attendance have been found to be significantly and positively correlated with the number of classes attended ($r^2 = 0.24$, $n = 173$, $p < 0.0001$; Freeman *et al.*, 2007).

Communicates high expectations: EVS clearly communicates to students an ‘expected’ level of knowledge. Students become aware of their own performance by answering questions and knowing if they selected the correct answer or not. Communicating high expectations is strongly dependent on the nature of the questions being asked, and can only occur when students are responding to carefully pitched questions. If questions are too difficult, and the tutor appears to have expectations that are unrealistic, students are likely to become demoralised and disinterested in their performance. Questions pitched too low communicate a low level of expectation of students’ knowledge and performance (Figure 3). One potential method to address the correct pitching of questions would be to progress towards more complex material during one quiz. This approach should also highlight when students are tackling questions beneath, in alignment with, or in advance of their expected knowledge.



Many students actually look forward to Mr. Atwadder's math tests.

Figure 3. *Communicating high expectations through setting appropriate multiple choice questions for EVS is essential.* (Source: www.glasbergen.com/wp-content/gallery/goldie/goldie24.gif).

Respects diverse talents and ways of learning: It is recognised that students have a number of different ‘cognitive styles’ used when learning. Cognitive styles are defined as ‘an individual’s consistent approach to organising and processing information during learning’ (Riding & Sadler-Smith, 1997). EVS is unlikely to promote an approach to learning that is satisfactory to all students. EVS is more likely to be a contrast to what many students may have experienced during their education before university, and also different to their likely expectations of lectures and seminars. However, exposing undergraduates to a range of learning styles is likely to be beneficial for them, improving their adaptability and highlighting styles that may be new to them.

5. Conclusions

In conclusion, EVS offers the opportunity for tutors to support the principles of good undergraduate education as presented by Chickering & Gamson (1987). These links are either explicit (e.g. providing feedback and encouraging active learning) or less clear (e.g. enhancing student-tutor contact time). Evidence from the literature and reflections on personal experience suggest that when EVS is used to assist learning, students are empowered to take ownership of their learning, engage with tutors and subject material and participate in a learning community. Improved attendance and attention during classes may further enhance students’ learning experiences. Interactively, these processes can enable students to improve their academic performance compared to when EVS is not used. Although unpacking the precise contribution of each element to students’ overall learning experience, EVS undoubtedly has a strong potential to improve the implementation of good practice in undergraduate education.

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