mbclick: An Electronic voting system that returns individual feedback

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Abstract
mbclick is a new electronic voting system that emphasizes the return of individual feedback. It uses students' own mobile phones, and works with both 'smart' and ordinary types. It is web-based, thereby removing the need to install any dedicated application software to make it work. It is easy to learn and use, and integrates with Microsoft PowerPoint. mbclick does away with the need to purchase and distribute traditional handheld clickers, freeing the institution and the teacher from the associated overheads. It can also be used to conduct in-class surveys. The system has been successfully trialed at the University of Manchester.

Keywords
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1. Introduction

Active learning approaches in the classroom have long been recognized as a means of promoting student engagement and understanding. Interaction between teacher and student can enrich the learning environment, facilitating students to participate actively in the learning process. For the teacher, the design of formative assessment activities is motivated by wanting to increase students' desire to learn, to engage in self-evaluation and self-assessment, and, in varying degrees, to take control of their own learning.

The work of Nicol and Macfarlane-Dick (2009) brought fresh perspectives to formative assessment and feedback processes, and articulated sets of principles considered integral to good assessment design. A selected subset of these principles, that are related to good feedback practice, and relevant to this discussion, are listed below:
• Engage students actively in learning.

• Facilitate opportunities for self-assessment and reflection.

• Deliver high-quality feedback that helps students self-correct.

• Provide opportunities for feedback dialogue, both peer-peer and teacher-student.

• Provide opportunities to act on feedback.

• Engage students in deep, not just shallow, learning.

Within the context of the classroom/lecture theatre, an Electronic Voting System (EVS), can be used to help design assessment activities that include all of the above. Such systems, also known as Audience Response Systems, Classroom Communication Systems, or clickers, directly introduce dialogue and interactivity between teacher and student, have been used for many years, and have been extensively described and researched (Bruff, D 2009, Kennedy, G.E. & Cuts, QI 2005, Fies, C. & Marshall J, 2006). With such systems, the term ‘feedback’ is variously used to describe the feedback provided by the system to the teacher, and that given by the teacher to the student. Additionally, when used in formative assessment tasks that involve small group activities, students can receive feedback from their peers, adding to the learning process. However, the focus of this discussion is on the feedback supplied by the teacher to the student.

Experienced practitioners of these systems know that they are of value in quickly determining students’ understanding of the topics being taught. In reviewing the students’ responses to the questions or issues set, the teacher is able to examine how the students have understood the material presented. This allows the teacher to use the information to examine his or her own presentation of the content and to offer more tailored information to the different responses provided by the students as to the nature of any misunderstanding highlighted by incorrect choices. This latter aspect informs the students of their misunderstanding (i.e. the student will be aware they have not quite understood the ideas presented) and what they may need to do to address this. The information provided is usually by means of dialogue and discussion immediately following each question, and is usually of high value to the student.

The quality of the feedback provided by the teacher is a critical area for the use of an EVS. For the student, the feedback takes on value once it has been internalized and understood. It can then be used to evaluate their comprehension of the topic under consideration, leading to a deeper understanding. Studies have shown that the feedback provided by the teacher in such settings can be a very effective pedagogical strategy for enhancing student understanding and performance (Beatty, I., 2004, Draper, S.W. & Brown M.I., 2004, Nicol, D. J., 2006).
2. Feedback within EVS

EVS systems work essentially by allowing a teacher to present questions—typically multiple choice questions, each with a small number of response options—to the students, who respond with handsets distributed to them in advance. The results are then displayed on an overhead chart. Commercial EVS systems often integrate with commonly-used presentation software such as Microsoft PowerPoint and are increasingly popular in various institutions (TurningPoint and eInstruction, 2011).

The information presented in the chart is valuable because it immediately informs the teacher of weaknesses in students’ understanding of the learning points being tested. The teacher then provides feedback, usually by leading a discussion based on the results, and/or presenting further test questions. Students typically either record the feedback given by note-taking, or commit it to memory. By careful design of questions the teacher can create a rich learning environment that, to the student, can also seem enjoyable and engaging.

With an EVS the classic interaction between teacher and students can be visualized as a simple cycle consisting of the presentation of questions, gathering the responses, and then providing feedback to the student (Figure 1):

Just to be clear, in the above the feedback is that imparted to the student by the teacher, via a means of his/her choice, for example, verbal, written, etc. Its main purpose is to correct any misunderstandings on the part of the student (or re-affirm correct understanding), and help develop the student’s own skills of evaluation and judgement. Usually, however, where the class size is such that it is difficult to give individual attention, the feedback is imparted to the whole class, rather than the individual student. In this respect while current EVS systems are valuable in providing information quickly to the teacher about the level of understanding in the classroom, they are not generally designed to ensure that feedback is targeted at, and delivered to, any individual student.
3. **Practicalities of using EVS**

The components of an EVS typically include a handset per student, a receiver, and software installed on the teacher’s computer. Handsets are either distributed to students at the start of the lecture and collected in again at the end, or, students may be expected to buy the handset or (lease one from the institution), and bring them to class. They are usually simple devices and it does not take students long to become familiar with their use. There is however, a learning ‘curve’ for the teacher, to become familiar with, and build confidence in using the system. Ultimately the goal is that the technology becomes, in a sense, transparent, to the learning process, enabling the learning goals to be the focus, rather than the EVS system.

EVS is not without its risks:- for example the equipment can fail, leading to frustration for teacher and student alike, thus wasting precious time. Individual handsets might be faulty or may not work because the battery needs replacing, or due to other defects. Teachers must accept that this type of failure can occur, and prepare accordingly, for example building contingency in to their teaching. To help mitigate these circumstances, institutions often provide a point of contact to assist with issues such as software and hardware setup.

For an EVS to be used effectively however, the questions presented must be relevant, addressing those concepts vital to the subject, and leading to deep learning. It can take time for a teacher to learn how to design sessions that include good-quality questions, and a teacher must be well-prepared to ensure that the expected outcomes are achieved. In comparison with delivering the traditional didactic lecture, where little technology other than presentation software is used, a lot more is demanded from a teacher who decides to use an EVS. Particularly relevant are skills relating to strong and confident classroom management.

The clickers provided by EVS systems tend to be proprietary devices, either radio frequency–based, or infra red-based, where the receiver is in the form of a dongle that is plugged into the teacher’s laptop computer. From the student perspective a clicker is yet another device that has to be carried around, in addition to their own mobile phone. The ownership of mobile phones amongst students is frequently reported as being close to 100%, and with the emergence of wifi-enabled ‘smart’ phones owners have the equivalent of a powerful computer in their pocket, potentially with full internet connectivity. The idea that students could use their own phone as a clicker when participating in an EVS has not gone unnoticed. Some EVS vendors have extended their systems to work with mobiles, allowing a student to participate via web access, SMS, or both (TurningTechnologies Responseware, 2011).
Some educational institutions have independently experimented with systems that use mobile phone and other portable wireless internet-connected devices, where one motivation has been to minimize usage costs to both the student and institution. See, for example, mlInteract from the University of Technology, Sydney (Laurel Evelyn Dyson, et al, 2009), and W.I.L.D. from the School of Arts and New Media, University of Hull (Mundy, D.P and Proctor, J, 2008).

4. The mbclick system

It is apparent that increasing numbers of students want to use their phones to access educational materials and this is certainly true of students at Manchester (University of Manchester, 2011). mbclick is an EVS that is aligned with these aims, but works with any mobile phone, not just smart-phones. Any device that is capable of being connected to the internet will also work with mbclick, so laptops can be used, for example.

The system is innovative in that it is designed around the return of feedback that is targeted to the student in a personalized way. This is possible because the students are known to the system via a one-time registration process carried out at the start of the teaching calendar. The feedback returned to the student typically explains why the student’s response was correct or not and is included by the teacher at the time the question is created. Feedback can typically also include other information, for example links to further learning activities, or materials on the institution’s Virtual Learning Environment.

A system diagram is shown in Figure 2.

![mbclick system diagram](image-url)
Questions are presented in class either with a web browser or PowerPoint. Students respond either with a browser running on a laptop/notebook computer, or their smartphone (browser or app), or via SMS if using an ordinary phone. The system includes a database that stores the results for each session held. Surveys can also be conducted using the system. In common with other EVS systems the sets of data collected are informative and can be viewed in multiple ways, both directly through the system, and via download of a spreadsheet file, for viewing off-line.

For example, the diagram in Figure 3 shows a chart of the percentage of questions answered correctly for each of eight sessions from an undergraduate course in Java Programming, presented in the School of Electrical and Electronic Engineering at the University of Manchester, during February-April 2011:

Figure 3. Percentage of questions answered correctly for eight sessions

The results for individual questions presented during each session are also recorded and charted, as shown in Figure 4:

Figure 4. Percentage of correct responses received for each question within a session

Furthermore, because each individual’s responses are also stored, an individual student’s performance can be tracked across multiple sessions, as shown in Figure 5 (note -not all sessions were attended by the student in this example):
Figure 5. Percentage of questions answered correctly by a student for sessions attended.

Such data can be valuable to a teacher when reviewing the design and delivery of lectures and other course materials, particularly the student response data: an individual that is having difficulties with specific parts of the course can be readily identified. Sessions can be archived for comparison say, with successive runs of the course. The data is available either in chart form as above, or downloadable in csv format.

4.1 Creation of questions and feedback

To create questions a teacher will first login and access course units that he/she teaches. Typically multiple-choice questions are created that are text-only, or if required, a mixture of text and images. Questions can have single or multiple answers, and feedback is created for each possible answer option. The feedback is usually a short piece of text explaining why the choice is correct/incorrect, and can also include links to further course materials, or further questions, for example. The feedback is returned to the students' phone and also sent by email to them at the end of the session. An example taken from a question about programming from the Java course is shown in Figure 6:

Incorrect. Although a constructor always takes the name of the class, it does not have any return type (or void), like a method. The declaration should read public Temp (int X, ...;

Choose 1 option
- 1) public void Temp (int X, Y, double Z)
- X 2) public void Temp (int X, int Y, double Z)
- 3) public Temp (X, Y, Z)
- 4) public Temp (int X, int Y, double Z)

Figure 6. Example of feedback returned explaining why the selected option (option 2 in this case) is incorrect and illustrating which is the correct response.
The feedback returned to the student corresponds to the option chosen (option 2 in the above example), and explains why that option is incorrect. The correct answer is also shown (marked by a green tick). Such feedback adds value to the session and can be stored in any way the student chooses to organize it. Later, the student can login to the system, review all the session questions and see the feedback associated with each of the answer options, not just the ones chosen.

Access to the system is entirely web-based, and designed to be easy to use. A teacher requires no more than a few minutes to learn enough to be able to start creating questions with feedback. A web site is being prepared that illustrates the basic functions of the system for both teachers and students using instructional videos. An administrator account provides the means to register course units, teachers and students, and to perform archiving operations.

4.2 Trials and results

A number of trials were held during semester 1, 2011/12, with lecture classes of up to 300 students, in selected Schools across the University (Jasper, M, 2011). Most students (87%) accessed mbclick via the University’s Wi-Fi system. Smart phones (64%) and laptops (17%) were the most common devices for students, with the remainder participating via SMS-enabled mobile phones. Students were asked to complete a survey in which they were asked several questions. Overall students were very positive about mbclick, over 90% of survey respondents indicated that it would improve their overall satisfaction with their programme of study. Lecturers were positive about the amount of time it takes to set up and use mbclick, and felt that their workload did not increase significantly.

The experience gained in the trials has proved to be extremely valuable. The data collected helped determine which students had difficulties with different areas of their course, and to what extent. It was also helpful in designing better quality questions and feedback to improve their understanding and knowledge of the subject. Students were enthusiastic about the sessions. The following are a sample of comments obtained from questionnaires completed at the end of sessions: “good to get instant feedback”, “help keeps me alert”, “allowed me to interact with the lecturer and stay awake”, “interact with the lecturer with privacy”, “points out flaws in my knowledge”, “personalise the lecture”, “instant feedback very useful”. A second series of trials, conducted during semester 2, is broadly aimed at further testing the potential benefits of the system.

4.3 Practical considerations

Although the trials indicated that the system is popular, there were a number of issues that emerged, to do with both classroom management and the technology, whose importance quickly became apparent.
As with any EVS system a teacher needs time to learn and practice with it, and build up confidence in using it in the live classroom. Although the mbclick system is easy to use, a web site with instructional videos, FAQs, contact details, and general help is in preparation. There will also be materials that help students and administrators learn how to use the system.

The system relies on a wireless infrastructure that provides good WiFi and 3G/GSM coverage, but of course not all locations guarantee this. The bandwidth requirements ultimately depend on the class size. In tests, the requirements for each user were found to be quite modest: typically 4kB of data are sent or received in responding to each text-based question. In a group of say, 100 users, demand would be expected to peak during the polling window. In the worst case this would result in a demand of approximately 3Mb/s. At the University of Manchester wireless access points that are deployed in or near classrooms, are multiple-antenna, supporting 802.11 a/b/g/n, and easily meet the bandwidth requirements. A further consideration is to ensure that authentication timeouts due to inactivity are extended to cover the time of the session.

Since students will be asked to turn on their mobile phones within the classroom, good classroom management is needed to ensure that phones are operating in silent mode, and that they are not being used for other purposes unconnected with learning activities, that might otherwise consume a large percentage of the available bandwidth.

5. Summary

mbclick provides the basic functionality one would expect of an EVS but goes further in that it can return individual feedback to the student, direct to their mobile phone/device. This feature alone is of high value because it provides the teacher with an automated way to deliver high-quality feedback that helps students self-correct and engage in deep learning. It also provides a detailed record of students' responses, so that a profile of individual performance can be built up. For the student, having detailed feedback sent to their phone makes it feel personalized and individual.

Below is a summary of the features of the system:

- By relying on students' own mobile phones, the need for institutions to purchase, distribute and manage large numbers of clickers is removed.

- mbclick is web-based, thus eliminating the need to install and configure additional software for the teacher/student.

- The system is fast and responsive, and is simple to use and manage

- It can be used across all subject area disciplines.
• Similarly to other EVS systems it stores the results of each session such that it is easy to identify the performance of individual students.

• It returns individual feedback to the student, direct to their mobile phone/device.

• Students can log in afterwards and review all the session questions as well as seeing the feedback associated with each of the answer options, not just the ones they answered.

• Good WiFi and 3G/GSM connections and speed are required, as expected of any wireless system.

• mbclick can be used to conduct in-class surveys, replacing paper-based and conventional on-line versions

6. References


TurningTechnologies Responseware (2011):
http://www.turningtechnologies.com/studentresponsesystems/mobiledistancelearning/higheredresponseware/


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