WHO WANTS TO BE A MILLIONAIRE? OR: HOW INTERACTIVE VOTING SYSTEMS HELP ACTIVATING UNDERGRADUATE STUDENTS AND IMPROVING TEACHING PERFORMANCE

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Abstract

Looking back at more than ten years teaching experience in undergraduate computer science and business classes, we recognized that student activation and participation has become a major issue for teaching/learning performance. Classroom discussions of practical examples, exercises or case studies often attract only a very limited number of students in class while others stay passive and follow the discussions from outside only – in best case.

Many of the students, if they show up in class at all, just consume lectures like at a cinema and hope to really learn and understand the topic afterwards – or "just in time" when preparing for the exams. While this may eventually work for more "textbook-oriented" classes and exams covering mostly factual knowledge, it is almost sure to fail for those classes where continuous reflection, practical application to exercises or case studies, and discussion of alternatives becomes inevitable.

Thus, in order to activate more students and improve student's participation in class exercises and discussions we started to use an interactive voting system in class which consists of a number of handheld devices together with a receiver connected to the instructor's notebook. When entering the lecture theatre every student takes one of the handheld device that later allows him or her to enter Yes/No or any number as response to an instructor's question.

At the beginning of each class, usually we do some quizzes, ask some recap questions and may also ask for some grouping criteria like sex, the program enrolled in, prior experience in the field etc. that can be used later for various statistics and performance analyses. This already helps activating students and improves participation. Moreover, experience shows that especially the use of quizzes where points are awarded for correct answers increases student participation to almost 100 percent – at least for the first couple of weeks. In order to keep participation high, we also studied the difference between having individual students competing for points with each other and setting up groups or teams of students that compete with other teams. As preliminary results show, this "team competition approach" leads to better results both in long-term student participation as well as performance, i.e. number of correct answers etc. which ultimately is the main goal we want to achieve. We also discuss this result as it leads to the question of finding the right balance between teamwork and competition in general.

Keywords: Voting systems, student activation, teaching performance.

1 INTRODUCTION

The use of computers in the college classroom has become so common that on most campuses, it is difficult to find a classroom that does not have at least an instructor computer connected to a projector. Despite the widespread availability of instructional technology, we find that traditional lectures are still the mainstay of undergraduate teaching, and even when the computer is used, often a PowerPoint presentation has only replaced the chalkboard and overhead transparencies in method of preparation and delivery but not in essence of form or content [7].

Many instructors are now using the internet to provide course content and supplements to their students. Instructor web pages provide syllabus, reading and assignment schedules, descriptions of projects, cases & readings, student grades, and even chat or message board facilities. As more course content is delivered to the student digitally, we find that students no longer come to the classroom with the expectation that they will manually take pages of notes in the attempt to capture the essence of the instructor's verbal monolog. As we can easily get from the expressionless faces

from our podiums, it is hard to resist wondering if students want less education and more entertainment in the classroom.

We believe that our students are just as bright and capable as those from prior generations, but that they are creating and engaging their social world in ways shaped by the technologies that surround them. These technologies are immediately interactive, and we suspect that passivity in the classroom is not at first a mass "couch-potato" syndrome, but instead is reflective of a group of students waiting for something they can interact with in a way with which they are familiar. Recent literature relating to learning suggest that modern students are primarily active learners, and that lecture/fact-memorization courses may be increasingly out of touch with how our students are learning to engage their world [6].

In recent years, a new type of instructional technology has emerged that has the potential to engage the rising generation of hyper-capable technology users. Called "Interactive voting systems" or "Personal Response Systems", these typically hand-held devices allow large groups of students to individually engage instructional content real time in the classroom and get instant feedback about their individual responses as well as seeing how the class responded as a whole.

Beyond getting students more actively involved in the class, many of these systems allow a computer to automatically record student responses for grading purposes, thus providing a broader range of assessment options which might not be practical if the instructor was limited to manual methods.

2   INTERACTIVE VOTING SYSTEMS

Interactive voting systems (also known as wireless keypads, student response system, personal response units, electronic voting system or clickers) are an interactive teaching and learning tool now commonly used in many higher education institutions. These voting systems use radio-frequency transmitters and receivers that collect student responses and software capable of embedding into Microsoft PowerPoint.

The current educational literature cites interactive voting systems not only offering an alternative, but an engaging and effective pedagogical approach to the high school, undergraduate, and postgraduate education [1]. Potential improvements to learning and teaching have been repeatedly cited in the literature, e.g. [9], [13], [14], and include the following:

- Providing reflective reactive and anonymous student feedback;
- Providing an indication of students' knowledge gaps;
- Reinforcing and linking concepts, theories and factual information;
- Allowing for increased interactive engagement and involvement;
- Increasing student participation and discourse in learning groups;
- Provide a medium for all students to voice an opinion;
- Provide quality assurance of conceptual understanding during lectures/tutorials; and
- Offer students the capacity to reflect in lectures/tutorials in a non-threatening manner.

2.1   Technology

The interactive voting systems contain hardware and software. They are designed to allow participants to respond to objective questions via multi-button wireless handsets. A notebook or PC equipped with a receiver will tabulate and display the results.

The receiver communicates with the instructor's computer using USB cable. It uses radio frequency or Bluetooth technologies for wireless communication between handset and receiver. The handsets have mobile like keys such as true/false, yes/no, A-z characters, 0-9 digits etc. Each student handset has a unique identification number allowing the shy student to give his response privately with confidence. Software collects the student responses and assesses them. The software displays reports using charts such as pie charts, bar charts etc. that may be integrated into Microsoft PowerPoint presentations.

There are a number of electronic voting systems on the market with differing functionalities which may include:

- Multiple question types

- Ability to display the results via multiple templates, e.g. pie charts and bar charts

- Wireless or Infrared transmission technologies

- Integration with presentation software such as Microsoft PowerPoint

The use of these technologies in the classroom can be an effective solution for enhancing rapid feedback with students responding in groups or individually. Issues to consider include:

- Wireless or Infrared transmission technologies

- Maintenance, especially in replacing batteries in hundreds of handsets

- Number of handsets. One solution might be to provide each student with a handset but this could be costly. An alternative is to provide a number of loan kits (receiver and handsets) which can be amalgamated into larger sets when required. A booking system is required but this can be an effective approach.

- Loss of handsets, though in our experience this has not been a significant issue.

- Time and preparation. Preparation time is required to build questions into a presentation though of course these questions are reusable. Set up time including the distribution and collection of handsets needs also be considered.

- Installation of software on PCs in teaching rooms, or the use of dedicated portable PCs or individual instructor's notebooks.

2.2 Functionality

Voting tools support undertaking formative assessment - results can be gathered instantly to enable teachers to identify areas requiring further clarification during a lesson. Voting tools support immediate assessment, the teacher is given instant feedback of the level of understanding of each student so that differentiation of support can take place as the teaching is undertaken so that the learning process is enhanced.

During a lesson teachers can see immediately if the group or individual students are struggling. Instant on-screen results can show, for example, that a particular question was answered incorrectly by a large percentage, or that one student was always the last to answer. They can then give more instruction or adapt their teaching to suit the needs of the students.

Voting tools can be used effectively for summative testing and free teachers from the burden of manual marking and report-writing - when results or detailed reports are needed to show progress or to evaluate lessons, all the information is already stored. From this, the teacher can select which data and report format they need and simply print off a report, or export to Excel.

Classroom response systems can transform traditional question and answer sessions, end-of-lesson assessment, class surveys, voting, quizzes, tests and group activities. The systems offer different question and answer formats, from timed multiple-choice to a simple signal that a learner is ready to answer verbally.

There is instant feedback for the students, the responses of every student for every question is recorded without disrupting the flow of a lesson, there is no marking for the teacher, and the direction of a lesson can be varied immediately in response to feedback from students.

2.3 Methods and Approaches for the Use in Classroom

There is a rich variety of innovative practice how interactive voting systems can be used in both small and large lectures and tutorials:

- *Standard lecture with voting questions embedded within a Microsoft PowerPoint presentation.* There is a number of variations on this theme, though most commonly one would embed questions following the explanation of a particular concept. The rapid feedback allows the student to test their understanding and also informs the instructor about potential student misconceptions. Some instructors may present the question before a particular point or concept is covered to prompt discussion, while others may prefer to cluster their questions at the end of a session so as to test student understanding of the overall concepts and ideas discussed.

- *As above but the students are presented with multiple right answers of variable validity.* This proved to be an effective approach for engaging students in discussion and active thinking.

- *The summative assessment model* where each student is issued with a numbered handset with the results recorded for each student. This is equivalent to an online assessment but there is no requirement for students to be present at a computer terminal.

- The *"game show"* model where one student is the main participant in the 'game', and the other students act as an audience, giving advice to the main participating student.

- The *tutorial enhancement model* where a technical problem is given to the students at 20 minute intervals. Students have to apply the necessary calculations and then select the correct answer.

- The *group model*, which is very useful for larger classes. Groups of 3 to 4 students are issued with one key pad, and each group had to agree on a group response (see Chapter 5).

3 INTERACTIVE VOTING SYSTEMS AND ACTIVE LEARNING

The benefits of active learning are widely acclaimed in higher education. According to [5], modern students are primarily active learners, and lecture courses may be increasingly out of touch with how students engage their world. Chickering and Gamson [3], two early proponents of active learning, designated "encourage active learning" as one of the seven principles of good practice in higher education [11].

Interactive voting systems offer one approach to employing active learning in the classroom. Duncan [4] described how they address three of these seven principles for good practice in undergraduate education. Interactive voting systems help instructors

- actively engage students during the entire class period,

- gauge their level of understanding of the material being presented, and

- provide prompt feedback to student questions.

With interactive voting systems, students have an input device that lets them express their views in complete anonymity, and the cumulative view of the class appears on a public screen. Although they are becoming increasingly popular in higher education, most research has targeted their affective benefits, which include greater student engagement, increased student interest, and heightened discussion and interactivity. According to West [15], however, past studies on learning outcomes suggest that better learning outcomes result from changes in pedagogical focus—from passive to active learning—and not from use of a specific technology or technique.

Interactive voting systems can provide added value, however, when compared to some active learning methods such as class discussion. In a normal class discussion situation, only one or two students have the opportunity to answer a question. Even if the answer is correct, the instructor has no way to gauge if the other students knew the correct answer. A student who is unsure of the correct answer may be unwilling to take the public risk of being incorrect. One of the best features of an interactive voting system is that it allows students to provide input without fear of public humiliation and without having to worry about more vocal students dominating the discussion. Even in small-enrollment classes, many students are reluctant to respond to faculty questions; the anonymity of responding with a handheld device guarantees near or total participation [2].

Martyn [10] described this benefit: *First, many students are hesitant to respond to an answer until they know how others will respond. We have all observed students glancing around the room when a question is asked, gauging the number of hands that have been raised until a "safe" number are in the air for them to add their own. Therefore, the anonymity that an electronic system provides allows students to respond in a safe manner, which encourages them to take risks with their responses. Second, it is difficult, if not impossible to ask multi-answer questions with a simple show of hands. You can imagine yourself saying "Okay, put up your right hand for A, left hand for B, both hands for C, and stand up for D."*

Another benefit of interactive voting systems over traditional active learning methods is that they follow the principles of game-based learning. Students of the twenty-first century have grown up using computer games for learning and entertainment.

4 RECOMMENDATIONS FOR THE USE OF INTERACTIVE VOTING SYSTEMS

However, the use of interactive voting systems in undergraduate classes itself will not be able to solve all the problems as discussed concerning student activation and motivation. As discussed in chapter 3 they need to be supplemented by other means of active learning that facilitate student interaction. The use of interactive voting systems may not be regarded the end point, more as a place from which to start. Nevertheless, with some thought, they can be very useful indeed. Here are some ways in which they might be employed.

- For a quick mental arithmetic workout at the start or end of a lesson. Teachers may project ten questions on the whiteboard, and set up the voting system to allow only some seconds per question. The activity is a good one in itself, but it will also give the teacher a very good idea of widespread problems in a particular area. For example, if almost none of the students obtain the correct answers for some programming questions, that's an indicator that perhaps this area needs to be revisited. It may require further checking out – perhaps the students were having a bad day – but it's a quick way of getting that sort of overview.

- It does not take a great leap of imagination to see how the previous example might be extended to education technology or any other area of the curriculum. For example, quick tests on terminology may not be the most exciting thing in the world, but it is important to ensure that students use the correct terms for programming concepts, keywords, algorithms and so on.

- The idea can be extended to before and after tests. When starting a new topic, teachers may run a quick test to see how much the students already know, or think they know. They can keep a record of the scores, and run the same test again at the end of the project. If there has been an overall improvement, a record of that can be kept e.g. for the attention of any visiting inspector. If there has not been an overall improvement, it needs looking into. Again, the idea of this sort of test is to give a quick impression. We don't think that, without a great deal of thought and preparation, they can be regarded as valid or reliable in the technical sense of those words.

- One may also set up an interactive voting system with students' actual names. Although there's a slight overhead in terms of setting up time, it's worth doing because then teachers can see who "got" it and who didn't. That will help to give a more personalised level of instruction next time and/or to do some remedial work with a group of students or even the whole class.

- A great development in the last couple of years has been the facility to construct surveys on the fly. Let's say the instructor decides, because of an item on the news that day, to have a discussion with the students on the advantages and disadvantages of making their location public when using services like Twitter or Facebook. When it's time to find out how many people are in favour or against, he may simply write the options on the whiteboard, assign a number or letter to each, and ask everyone to vote. He will get an instant graph and that can lead to further discussion [12].

As with any other kind of technology, the strength of interactive voting systems becomes apparent when used in conjunction with other technologies (whiteboards, document cameras) and plain old-fashioned good practice.

5 OUR APPROACH: BALANCING COMPETITION AND COOPERATION

In order to activate more students and improve student's participation in class exercises and discussions we started to use an interactive voting system in class which consists of a number of handheld devices (currently 50) together with a receiver connected to the instructor's notebook via USB cable (see Fig. 1).

Fig. 1: The Setup of the Voting Systems: Handheld Devices and Receiver to be connected to the Instructor's Notebook [8]

When entering the lecture theatre every student takes one of the handheld device that later allows him or her to enter Yes/No or any number as response to an instructor's question.

At the beginning of each class, usually we do some quizzes, ask some recap questions and may also ask for some grouping criteria like sex, the program the student is enrolled in, prior experience in the field etc. that can be used later for various statistics and performance analyses. This already helps activating students and improves participation.

Moreover, first experience shows that especially the use of quizzes where points are awarded for correct answers increases student participation to almost 100 percent – at least for the first couple of weeks. However, first experiments showed that as quickly as students get motivated in the game they also lost motivation again once the tasks became more challenging and questions more difficult to answer.

In order to keep participation high, we also studied the difference between having individual students competing for points with each other and setting up groups or teams of students that compete with other teams. As preliminary results show, this "*team competition approach*" leads to better results both in long-term student participation as well as performance, i.e. number of correct answers etc. which ultimately is the main goal we want to achieve. Obviously, students are more motivated to support their team competing with other teams than they were in an individual one-by-one competition.

Thus, we developed the following team competition approach that shows best results so far in both student participation and correct answer rate as an indicator for teaching performance:

At the beginning of each class we build groups of 3 or 4 students each depending on the actual number of participants. These groups are built dynamically for each class as we cannot assume the same students to show up every class. During the lecture, after each block a small number of questions is shown on the screen which the student teams are expected to answer. These range from very simple questions that can easily be answered by each individual student - up to those questions for which the answer is not obvious at all and that need some thinking and possibly discussion within the team. As at the end the overall number of correct answers for the entire student team is counted, students quickly start to cooperate, discuss and evaluate various possible answers in order to optimize the group's result.

Thus, the use of an interactive voting system not only contributes to an increased participation and motivation as reported by many other authors too, but also improves the teaching performance as it forces students to cooperate and discuss increasingly challenging questions in order to compete with their fellow teams.

Therefore, our approach combines the competition approach that in principle improves student motivation together with the cooperation/teamwork approach leading to a deeper understanding and reflection of the lecture's topic and thus to an improved teaching performance after all.

6   CONCLUSIONS

Who Wants to Be a Millionaire? Well, we can't really make anyone a millionaire, but the use of interactive voting systems can help to make lectures exciting and keep students engaged. Just like the famous game show, it enables teachers to ask their audience - students - questions, receive instant feedback on their responses and find out who will be the winner at the end. Even if the prize is not a million dollars to take home, students like to participate and appreciate the alternative teaching and learning approach that wireless keypads offer improving engagement and interactivity - maybe first mainly for the thrill and the fun, but ultimately also for the mastery of the topic itself.

Interactive voting systems also help teachers to understand whether students have learned the topic taught by them or not. Reports show that the students who learn using interactive voting systems understand the subject much more quickly - which, of course, may also result from the different, more active, learning style in general. However, it has also been observed that the use of interactive voting systems in a team competition setup as proposed in this paper helps students in improving awareness, social and communication skills as well as information preservation and thus contributes to a better teaching performance.

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