Who Wants To Pass Math?  
Using Clickers In Calculus  
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ABSTRACT

A typical Calculus class tends not to be very interactive. Students view the class as passive. The students expect the instructor to provide the information with very little activity or effort on their part. Asking students questions and trying to get them to respond is often a challenge. Many students know the answer, but are scared to respond. It is usually the same students over and over who answer the questions. This leaves the instructor wondering whether or not the rest of the class is actually comprehending the material. The use of a personal response system (clickers) in the class allows students to respond to questions anonymously. The entire class becomes much more interactive and the instructor knows how well the entire class is grasping the concepts. Clickers can help students stay awake and alert, improve their speed in answering questions, and know whether or not they understand a concept. Finally, clickers can be used to take attendance and reduce tedious record keeping. The use of a clicker system has made a major impact on how these classes respond and a positive effect on learning has been achieved.

Keywords: clickers, math, calculus

INTRODUCTION

Personal response systems (clickers) have the ability to transform how students and faculty behave in the classroom and can enhance the learning experience (Wood, 2009, Developmental Cell, 796 – 798). The technology itself is not a miraculous boon to educators, however it can be used skillfully to greatly enhance the educational experience. Typically, using clickers does not tend to improve learning (Skinner, 2009, Journal of College Science Teaching, 20 – 23). However, it has been found that using a clicker system positively impacts students’ participation in class (Edens, 2008/2009, Journal of Research on Technology in Education, 161- 178.)

USING CLICKERS

During the fall semester of 2008, the enrollment in calculus was far larger than expected. With a classroom of over 50 students, it was important to find a way to get the students more involved in the learning process. Our University had just purchased a set of clickers and it was decided to experiment using the clickers in Calculus. A five question quiz was designed to be given at the beginning of each class session. The quiz covered the material from the previous class session. Students used the clickers to answer the questions and got a grade based upon their participation. The clicker quizzes were designed to test the conceptual understanding of the material. Performing the mechanics of using a process was left as traditional homework.

DESIGNING CLICKER QUIZZES

The clicker system used was provided to the university by einstruction. The software used was called Classroom Performance System (CPS). The CPS system has three main tabs; Prepare, Engage, and Report. By clicking on the Prepare tab, you are allowed to enter student names and assign pad numbers, create lessons, add questions to those lessons, and edit lessons. When first working with a new class, you need to enter student names and assign pad numbers. This is accomplished by using the Prepare Tab. Adding student names can be handled in two ways. You can type in the students’ names and assign each a pad number or you can import a file with the
students’ names. The imported file can be one of many types, however, a comma separated file was used in this case. Once the student names and pad numbers have been entered, next you can add lessons to the class.

Again you can use the Prepare tab to add a lesson. You can give it a name. Typically the section number was used as the name. Then you can choose the new lesson and add questions to it. When you add a question to a lesson, a question template will appear. The default template is a multiple choice question with four possible answers. You can then type in your question and answers. You can also choose the one answer that is correct. Another option that is available for a mathematics course is to add equations to either the question and/or the answers. You can create these equations using the equation editor in Microsoft word. The equations can be copied and pasted into CPS. However, there is a small limit on the size of the material that can be pasted in, so it is easy to exceed that limit. Another way to get equations into CPS is by saving the equation as a picture and then using one of the graphics question templates.

Once you have created your clicker quiz, you are now ready to engage it. You will choose the Engage tab to administer the quiz. Once the first question is visible, choosing start allows students to begin answering the question. The default timing is one minute. However, you can increase the time as the students work. The time was typically increased until most answers were in. A 20 second warning and a 10 second warning were announced. As soon as the question was finished, CPS displays the correct answer and shows how many people chose each of the answers. Then you can move on to the next question.

After class the teacher can access the reporting tab to find out how specific students did and also create a grade book and choose which activities are recorded. Any lesson can be re-graded and added to the grade book. You also have a record of attendance. For large classes, the everyday tedium of taking attendance is simplified.

ADVANTAGES

Using clickers in calculus can result in many benefits. First, all students get a chance to respond to questions. In a traditional class if the instructor asks a question, it is usually the same group of students over and over again who respond. Using clickers allows students to respond anonymously so that they are not embarrassed by their answers. It also allows the instructor to know whether or not most of the students in the course are actually comprehending the material. An instructor is better able to gauge the pace of instruction and what topics need to reviewed. During one particular quiz, the instructor noticed that only about 60% of the students were getting the questions correct. There seemed to be a general lack of understanding of the concepts. To find out if the students would learn anything by taking the clicker quiz, the quiz for the next class period was designed to ask questions about the same concept again. During the next class, about 90% of the students were getting the questions correct. This provides evidence that taking the clicker quizzes and getting instant feedback helps students learn the concepts better.

Second, the calculus course where the clickers were used is immediately following lunch for many students and the students tend to be sleepy and tired. Since the students have to respond, they appear to be more alert. Since the students are more alert when the new material is covered, it should result in better comprehension. The clicker quizzes are typically given at the beginning of the class period to get the students awake and alert before new material is covered. Participating in the clicker quizzes forces the students to start thinking instead of passively sitting in the classroom. This makes the students more actively involved in the educational process.

Third, since the clicker quizzes are timed, students are encouraged to improve their speed while answering questions. Improved speed is an important aspect of a good mathematical education. By knowing the material better, the students are able to answer conceptual questions better and quicker. The students’ ability to complete exams in the allotted time should be improved.

Finally, using the clickers provides students with instant feedback on how well they understand the topic. Students interested in improving their grades should be able to benefit by knowing what topics to spend extra time studying. Also knowing that you had the wrong answer and immediately knowing what the correct answer is should help the students to not make the same mistake the next time.
Several other advantages have been realized by using clickers in calculus. First the drudgery of taking attendance is no longer a problem. The clickers are used to take attendance and no class time is taken up. The clickers can be used to poll the class on what homework questions they would like to see done in class. This is a big advantage since everyone gets input into which questions that will be demonstrated. You can also use the clickers to randomly choose a student to answer a question. This way the students know that you are not biased in who is chosen to answer a question or work a problem.

DISADVANTAGES

There are some disadvantages that are important to consider when using clickers in class. First, the instructor will need to devote a lot of time to designing the clicker quizzes (especially the first semester that the clickers are used). Designing the quizzes that not only work, but test the underlying theory are difficult to compose.

Second, the cost of the clicker system is fairly expensive. In our case, the clicker systems were purchases by the school and can be used by any class in the University. However, there may be problems with scheduling and keeping track of the clickers. You can also have students purchase their own personal clickers in the bookstore and then the University gets free use of the software. In this situation, the cost is passed directly on to the students. If the students only use the clickers for one class, the cost may be considered too much. In either case, the cost of using a clicker system must be considered before implementing it in a class.

Third, using the clickers in class will take up some amount of class time. It has been found that about ten minutes of class time is taken up doing the typical 5 question clicker quiz. However, we have considered the time well worth the results.

Finally and most importantly, problems with the reliability of both the computer system and the clickers can be a problem. Fortunately, the problems have been rare. Sometimes clickers stop working for a variety of reasons such as a dead battery or just a problem with the clicker. To solve this issue, a couple of dummy clickers are setup for students to use in an emergency. The biggest problem is when the network or computer system is down in the classroom. This has happened about 5 -6 times per semester. The instructor must be flexible and prepared to do something else if the clicker system cannot be used.

RESULTS

Comparing the previous calculus class where clickers were not used with the current calculus classes where clickers were used, resulted in some observations. First, the tests scores did not seem to change in any significant way (they were neither higher nor lower overall). However, a larger percentage of students ended up passing the clicker calculus classes (88% & 91% passed the clicker classes compared to the 79% that passed the non-clicker class). While these results were not unexpected, more study needs to be done. The typical exams test the students' ability to perform the processes and do not test a deeper understanding. The clicker exercises were specifically designed to increase that deeper understanding. In the future, more questions of that nature may be added to the final exam to get a better sense as to the success of using the clicker quizzes.

There is evidence that taking the clicker quizzes help the students to learn the concepts. It appears that the students learn from their mistakes since they get instant feedback on what the correct answers are. So simply taking the clickers quizzes seemed to actually improve their understanding of concepts.

CONCLUSION

The use of clickers in Calculus classes seems to be a benefit to the educational process. The benefits outweigh the problems and we will continue to use clickers in the future. The benefits include keeping the class more interactive, involving all students in answering questions, keeping the class more alert, improving speed in answering questions, instant feedback on correct answers, and ease in taking attendance and grading. The disadvantages include time needed to design the clickers quizzes, cost of using clickers, time used during class to administer quizzes, and dependence on computer/clicker system working consistently.
AUTHOR INFORMATION

Nora Strasser is a Professor of Mathematics at Friends University in Wichita, KS. She is also the Division Chair for Natural Science and Mathematics. Her research interests include using computers to improve education, web-based learning, and visualization. She has a Bachelors degree in Mathematics and a Masters degree in Mathematics from the University of South Dakota. She also has an Ed. D. in Higher Education with an emphasis in Mathematics Education from Nova Southeastern University. She has been teaching Calculus for over 22 years and has actively sought to improve learning by using innovative technologies whenever possible in her classes.

REFERENCES
