

Synergy from Teaching with Clickers and Financial Calculators

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ABSTRACT

Within the last several decades academia has adapted to using PowerPoint, on-line study aids, and e-books. The display may have shifted from blackboards to overhead transparencies to computer projectors; but the lecture structure is often largely unchanged. The last decade has seen the deployment of low cost student response units, also known as “clickers.” The adoption of clickers can dramatically change what happens in a lecture period. Some instructors have also shifted from using compound interest tables to using financial calculators and spreadsheets for solving time value of money problems. This paper adds to the literature on both topics, but the paper’s focus is the synergy attainable by using both clickers and financial calculators at the same time. Results from undergraduate and graduate courses at multiple institutions are reported.

INTRODUCTION

Interest Factors & Calculators

The tables of interest factors date back to Antwerp in 1582 [Parker, 1968]. These tables have been used in teaching for nearly 100 years, often in conjunction with slide rules or mechanical calculators, and in many cases our teaching methods have not significantly changed in all this time. In 1972 the first hand-held scientific calculator, the HP 35, was introduced, which was followed a year later by the HP 80. The HP 12c [2010], still sold today, was introduced in 1981. Most companies that sell calculators sell one or more models of financial calculators and programmable calculators that can solve for one of five unknowns: i , N , PV , PMT , and FV .

The use of financial calculators have been described in detail in many of the leading introductory finance texts by Brigham and Ehrhardt [2011]; Ross, Westerfield, and Jordan [2011]; Brigham and Houston [2010]; Besley and Brigham [2008] and have been for over 10 years. Introductory finance texts use a mix of calculators, formulas, and brief tables to teach finance students time value of money. The use of spreadsheets may also be included [Brigham and Houston, 2010; Besley and Brigham, 2008], though they seem to be rarely taught as a primary tool. The Ross, Westerfield, and Jaffe text [2010] focuses on using spreadsheets.

Student Response Systems

Research into student response systems, sometimes called student response units, classroom response systems, classroom performance systems, audience response systems, personal response systems, or simply “clickers”, began in the late 1960s [Bessler, 1969] with articles published in the early 1970s [Cassanova, 1971; Brown, 1972]. Early work was focused on improving student learning in large classes in science and mathematics. Initial conclusions were that the technology showed promise in improving student engagement in class.

Over the years, use of student response systems slowly increased, and the systems were tried in a variety of courses [Hall et al, 2005; Trees and Jackson, 2007; Premkumar and Coupal, 2008; Berry, 2009; Kenwright, 2009]. During this time, the technology itself improved. The earliest units were hard-wired, and then infrared (IR) transmitters were used to communicate with one or more base units. These required students to ‘point and shoot’, similar to operating a TV remote control. If the lecture hall was large, multiple receivers were needed to compensate for the distance to the students. The signal was not always received on the first try, and the units were a bit slow. In general, the IR units were viewed as somewhat difficult to use. More recent units use radio frequency (RF) transmitters that do not require ‘point and shoot’. The RF clickers are more reliable, faster, and generally easier to use. The prices of the RF units are similar to the IR units.

There are a variety of brands available, including TurningPoint, i>Clicker, interwritelearning (PRS), and eInstruction. Most brands require that the instructor use the firm’s unique presentation software, which operates in slideshow mode as a Microsoft PowerPoint add-on. The i>Clicker units work as an independent window on the desktop, and so there aren’t any software compatibility issues. Some clickers have a set of letters for students to select from among multiple choice question responses. Some higher cost units also allow for numeric or text input. It appears that all brands have the capacity to be registered to students as unique individuals and also to connect with course management software such as Blackboard®.

The single most complete reference on teaching with clickers is a book by Derek Bruff [2009].

ADVANTAGES AND DISADVANTAGES OF FINANCIAL CALCULATORS

There are reasons for continuing to employ the interest factor tables in the classroom. Explaining how the individual interest factors are used to determine the values of the cash flows at a common time point can aid students in learning finance.

Financial calculators have time-saving advantages. They permit students to rapidly and more easily analyze problems. Fractional interest rates that are not in the tables can be used in analysis which permits more realistic problems to be examined without resorting to time-intensive equations. There is a high potential for errors when using time value of money equations or in looking through a table and keying the numbers into intermediate calculations. Time saved through easier calculations can be reinvested in solving more complicated problems. This is particularly helpful in testing students where time is limited. The results obtained with financial calculators are also more accurate since they don’t have the rounding effects of the interest factor tables.

ADVANTAGES AND DISADVANTAGES OF CLICKERS

Clickers have advantages for both instructors and students. An instructor can gain immediate feedback at key points in the lecture to assess how well students understand the concepts being presented. Rather than just a few confident students responding, the anonymity encourages increased participation by quieter, less confident students. The entire class can be polled quickly so the lecturer knows whether to review the material again or continue on. Students can participate easily without risk of being embarrassed in front of their peers by a wrong answer. This is particularly true for students that may be less willing to speak publicly because English is a second language. The anonymity of responses also encourages more candid answers to questions involving ethical quandaries. Regularly polling the class about problems encourages students to remain engaged. If students see that a significant portion of the class reached the same wrong conclusion about a particular question it may reassure them that they are not alone in having some difficulty. The explanation of why each answer is correct or incorrect may be sufficient, or if many students answered incorrectly, the instructor can pose another example to be answered.

Software for the clickers can allow them to be used in a way that identifies the student responses to the instructor and connects with course management software to log the results. This capability means clickers can be used to take attendance, administer quizzes, award class participation points, and monitor how individual students are performing even in classes with large enrollments. This in turn promotes better student participation and reduces the effort required by the instructor. This can improve student performance over that achieved with traditional instruction methods. Some studies have shown that clicker utilization is associated with better instructor reviews and that large freshman orientation classes' student retention improves.

As with financial calculators, the additional cost of clickers is a disadvantage. The cost for new clickers ranges from \$35 to \$60 per unit depending on the level of functionality. The price is often halved for used clickers. The less expensive clickers are limited to entering a choice of five letter options (A – E) rather than numerical results or textual responses. Students may be reluctant to purchase the devices for use in only one class. Students can also be intimidated by the clickers when confronting a question they don't have a quick response for. A disadvantage for lecturers is the need to develop a higher level of technical sophistication to properly integrate and utilize clickers in the classroom. Lecturers need to judge how many times to utilize the clickers in a single lecture. Polling the class 3 – 15 times is usually feasible, but clickers can be over utilized which slows material coverage. As with all technological aids, errors in use and random failures will inevitably cause occasional disruptions to the class.

LESSONS LEARNED FROM THE FRONT LINES

We have experience teaching with these tools ranging from a first time user to 23 classes over more than 20 years. This provides a basis to share some personal experiences with these tools. Our findings largely support those reported in the literature.

Financial Calculators

Using financial calculators requires the same theoretical understanding as using tables, but students can solve problems much faster. In general, students learn to use the financial calculators quickly, enjoy using them, and tend to make far fewer errors when using them. This tool allows instructors to spend more time focused on teaching finance, and less time dealing with arithmetic.

Clickers

Clickers dramatically change the classroom dynamics. Students and their instructors receive immediate feedback on whether the students understand the current material. Students spend more time responding to questions and less time passively listening or focusing on matters other than the class. In large classes it is impractical to rely on an instructor's skill at studying students' nonverbal signals to judge whether a concept has been effectively conveyed. Asking the students if they understand a particular concept and are ready to proceed is often of little use since few students will publicly admit to being confused and quite often students don't realize they don't accurately understand material until they have trouble solving a problem. The cost is that the speed of the class slows down to the pace of the slowest student that an instructor is willing to wait for.

We have been using clickers in undergraduate and graduate introductory finance classes at the University of Alaska Anchorage (UAA) and at the University of Bridgeport (UB) in Connecticut. Surveying classes of both undergraduate and graduate students found that over 80% of both sets of students found the clickers beneficial, as shown in Table 1. Students were very supportive of the use of clickers in an introductory finance class. In fact, a significant number of students report that they are a primary reason that they will be successful in the class. Very few students have negative views of clickers when used appropriately. The undergraduate course is from UAA only, and the graduate courses are from introductory courses at UAA and UB combined. The feedback from the graduate students is virtually identical between the two universities.

TABLE 1. Student Responses to the Question "What was the Value of Using Clickers?"

Question 1	Graduate Courses (N=48)	Undergraduate Course (N=158)
A: They are the reason I will successfully complete this class	4.2%	12.7%
B: They were helpful in my learning	79.2%	71.5%
C: Neutral	14.6%	10.8%
D: Using fewer would have been better	2.1%	2.5%
E: They were a waste of time	0.0%	2.5%

As shown in Table 2, a major impact of clickers is that students learn from their mistakes. They also help the student to stay engaged in class. Clickers increase student attention in class. Students have admitted that they cannot mentally drift off because they never know when a

clicker question might come up. With greater attention and commitment to providing an answer (right or wrong) students are more involved in the class, which creates a form of dialogue.

This occurs in small classes as well and can even be seen when “loaner clickers” are used for a one-week trial. With only enough loaner clickers for a fraction of the students, the format is normally to discuss the problem with a small group and then click to provide the group’s answer. International students are often reluctant to speak up in class due to lack of confidence about their command of English or speaking with an accent. This is often accentuated by not wanting to lose face with an incorrect answer. However, once the reticent international students had received reinforcement that others shared their reasoning, they were much more willing to participate in discussions following the clicker questions.

TABLE 2. Student Responses to the Question “What is the Biggest Advantage of the Clickers?”

Question 2	Graduate Courses (N=49)	Undergraduate Course (N=158)
A: Previewed calculations for the homework	14.3%	32.3%
B: I learned from my mistakes	55.1%	34.8%
C: It forced me to wake up and respond	22.4%	27.2%
D: Instructor was quiet for a while	6.1%	4.4%
E: There weren’t any advantages	2.0%	1.3%

Thus these results cover 3 graduate and 4 undergraduate sections of finance at 2 universities over 2 academic years. Not surprisingly, the graduate students are less likely to select "the reason I will successfully complete this course." The undergraduates are also depending more heavily on the clickers to learn how to do the homework problems. Results are consistent between sections at each level and with results in our non-finance courses.

Another approach is to have students answer individually, but if a majority of the class is incorrect, the instructor can call for the students to discuss the problem with a neighbor and then respond to the question again. Students are naturally more engaged in the material when they are discussing it and have incentive to thoughtfully consider a question. This practice aids understanding regardless of whether students correctly answer the question or not. Students are much more willing to vote with clickers since it spares them from publicly offering an answer and because the display of answers is a group summary. Students’ views are shown in Figure 1, which represents responses from a graduate course at the University of Bridgeport only (N=20).

Problem solving in class with clickers can work well, but it can take a lot of time. If students are using interest tables or interest equations, problems can require extensive time to solve. Combining clickers with financial calculators speeds up problem solving, and makes the time requirement far more manageable. Without financial calculators, available time limits the types of problems that students can solve in class to those that are very simple. The types of problems do not need to be as limited if students have financial calculators. The two technologies complement each other well and combine to enhance the learning environment. In our experience, financial calculators allow for many more problems (and more realistic

problems) to be worked by students in class. The difference is significant, and is one of the benefits of using the financial calculators and clickers together.

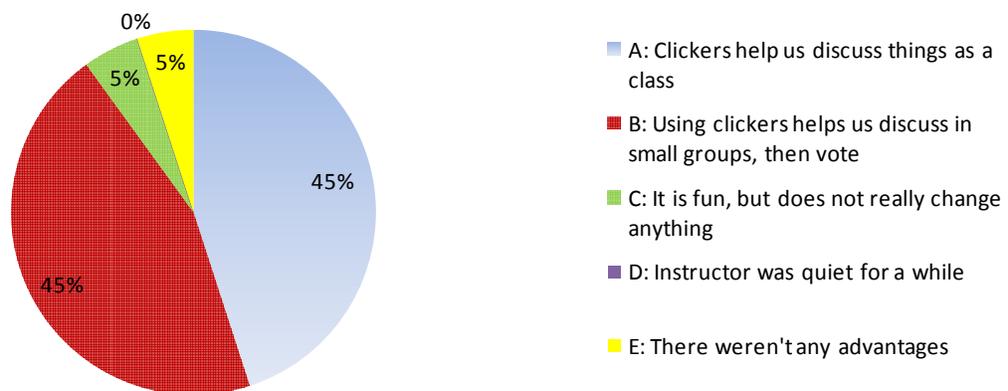


Figure 1. Student Responses to “Class Discussion and Clickers”

Clickers appear to increase learning. For example, in one discussion regarding the Payback Period, all the students in the class indicated that they understood it. A clicker problem was then presented, and half of the students got it wrong. This gave feedback to both the instructor and students about whether they understood the concept or not, and demonstrated that half of them did not completely understand it. After additional discussion, the difficulties were resolved. Without clickers, neither the students nor the instructor would have realized the lack of understanding until the next test.

Clickers do slow the pace of the class. *Dialogue takes longer than monologue.* Less material can be covered in the same amount of time, but the level of learning is greater. The top students may not be *exposed* to quite as much material, but average (and probably top) students *master* more material. Overall, student learning is greatly enhanced, and the grades earned tend to be higher. When surveyed, students recommended the use of clickers in spite of the added cost, as shown in Figure 2. This data is from the University of Bridgeport only (N=20). These students were also asked if they would recommend using clickers in another course, and the responses were identical.

The instructor must find an appropriate balance regarding how many clicker questions are used. A typical lecture style can be supplemented by one question about every ten to fifteen minutes. Using clickers as a supplement to the traditional lecture is one approach that many instructors use, especially if they are new to using them. Another author has shifted to clicker based lectures which may consist of 15 clicker questions and 5 figures, tables, and bullet point summaries. In the first approach, clickers are used to supplement the lecture. In the second approach, clickers are used as the core of the lecture.

Students have indicated that they do not want clickers to be used as continuous quizzes for the right answer, nor do the authors think that would be useful. Software can be used to track whether students get the questions right; however, the most experienced of us has only done a handful of clicker quizzes in over 20 courses and has never tried to track the percentage correct. Another option would be to record the percentage of clicker questions on which a student voted

as the class participation metric. This allows even very shy students to have a way to participate, and the grading of class participation is based on a more objective quantitative measurement.

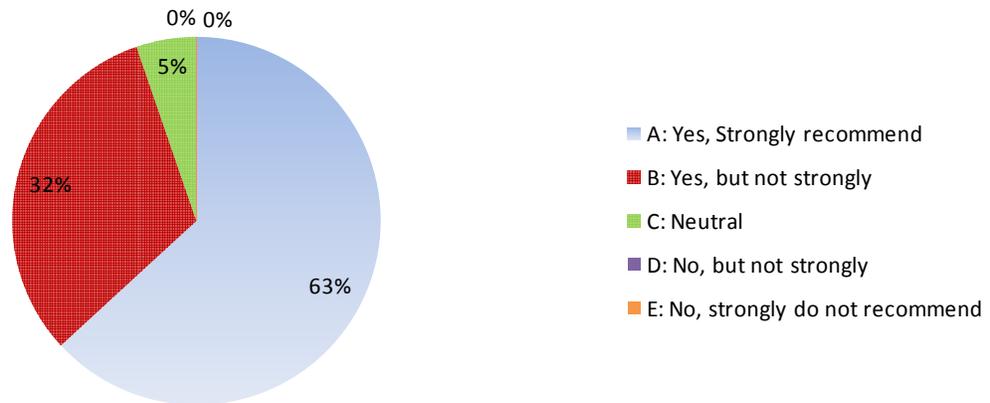


Figure 2. Student Responses to the Question
“Would You Recommend Using Clickers in this Course in the Future”

Using clickers can generate interest and genuine excitement when students get the answer right. Clickers facilitate learning, as well as generating more genuine interest in class. This can make the educational experience more enjoyable for both students and instructors.

CONCLUSIONS

Used together, financial calculators and clickers can be particularly beneficial in teaching finance. Financial calculators allow students to more rapidly and easily analyze complicated problems while reducing the potential for errors. Using financial calculators allows students to focus on analyzing the problem rather than completing tedious calculations.

Clickers encourage students to be more engaged in class and allow instructors to efficiently obtain feedback from the class at regular intervals. Rather than relying on experience and intuition to judge how well students are grasping the concepts, instructors can quickly and objectively determine if a sufficient majority of the class is ready to proceed or whether another example problem is needed. This is a powerful tool in teaching a subject where complex concepts can stymie students that normally excel in quantitative analysis.

Using the two technologies together is particularly powerful in the introductory finance classroom. The use of financial calculators allows students to quickly solve more realistic practical problems. This allows more effective use of clickers to gauge the students' conceptual understanding of how to find the value of cash flows.

These technologies cannot be implemented without additional costs to the student and/or the university. The majority of students are unlikely to voluntarily purchase these tools unless they are required for a class. If they are required for class, then it is the responsibility of the lecturer to make proper use of them to ensure the students have the best opportunity to benefit from their purchase (and to avoid justifiably scathing student critiques when technology is required to be purchased and then not used).

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