To point or click, that is the question!

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Introduction

Student response systems (SRS) have become a common classroom technology, whether as a dedicated device or Internet-based, and an option that I have used for several years. However, laser pointers are also an interesting, though less commonly used /discussed, SRS option [1, 2]. Rather than an indirect system of displaying questions and gathering the student responses through server-based technologies, laser pointers support students (even in large classes) directly pointing at their answer among those presented. While finding that the use of laser pointers provides some interesting new interactions, this case study implies they do lack one strong benefit; a positive impact on attendance and the benefits that improved class attendance can bring to students.

I had taught a large-lecture course, introductory programming course, taken primarily by CS/CE majors, but open to non/potential majors as well, for many years without any SRS before moving to using "clickers" and then to laser pointers. The switch to using laser pointers was done in order to personally explore how the classroom experience might be altered by replacing clickers with them. Questions of pedagogy and practicality both arose. What does the use of laser pointers allow that the typical clicker system does not and what clicker abilities are lost when using laser pointers? What is gained or lost? While laser pointers could prove to be more

flexible in terms of dynamic interaction and flow, might students not engage as much due to the removal of the accountability and tracking that clicker systems support?

Laser pointers in the classroom

To transition into using laser pointers for classroom polling I needed a method to present the polling questions and easily "collect" the responses without software support. Figure 1 presents an example of a question with answer options being offered on a software-based polling/voting slide. Figure 3 presents the same slide as it appeared live with the results of the student polling displayed. Figure 2 presents an example of the same question and answer options, this time offered as a visual grid for laser pointer use. Rather than opening polling to gather clicker responses via software, I would stand to the side of the screen and tell the students to "point" to their choice and observe where the laser dots appeared in the large answer boxes. Figure 4 presents the slide as photographed live during a classroom polling activity, with each red dot representing a student in the process of voting.

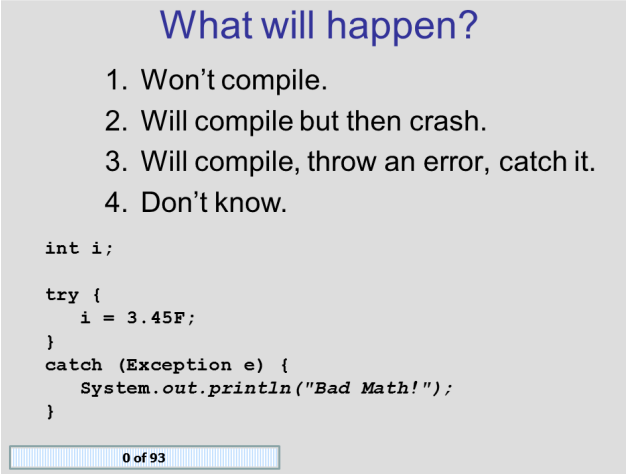

Figure 1: Clicker polling slide with question and four answer options.

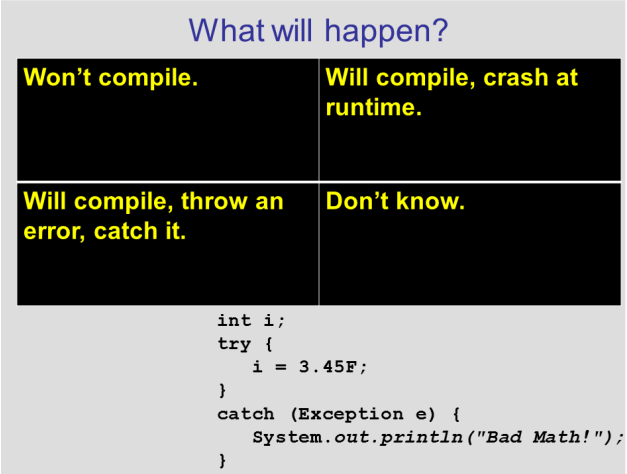

Figure 2: Laser-pointer-based polling on a question with four answer options.

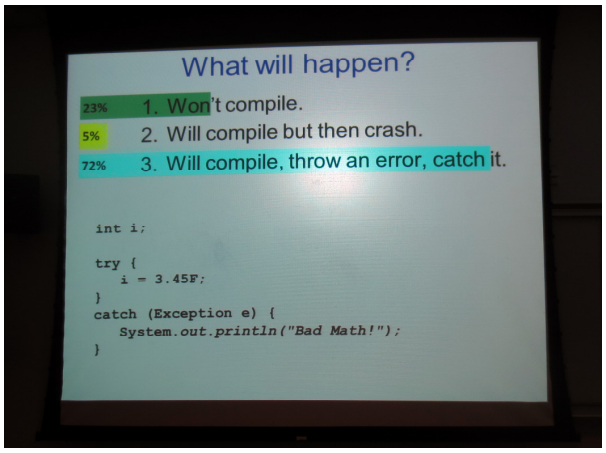

Figure 3: Clicker polling slide with color bars and percentages based on student voting.

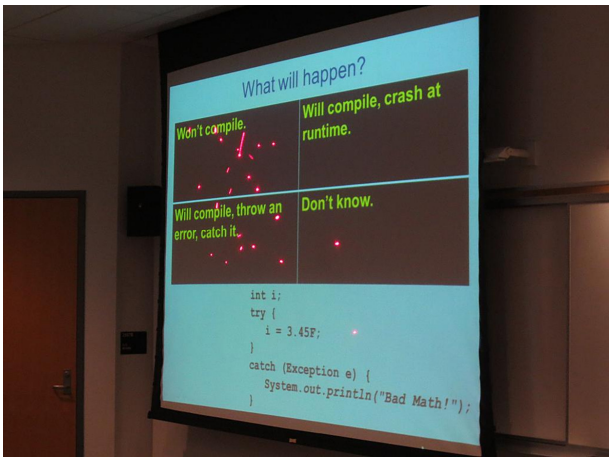

Figure 4: Laser pointer polling slide with red dots as seen during a class session.

Several differences between laser pointers and clicker-based polling options with static displays of voting results can be discussed; a) an exact tally of how many students voted for each option is not readily available, b) since students see the selections of others while voting is taking place, they could change their vote based on seeing the votes of others, c) students can "vote" in a way other than the listed options, and d) students do not have the option to vote and then rest, but rather need to continue to express their vote by pointing at their choice until the voting period is over. Figure 4 shows an example of (c) in this list; a dot representing a student's vote that is outside of any box; this was a student indicating the line of code that they saw as being the crux of the question being asked.

The lack of an exact tally of votes per option did not have a significant impact in terms of how I discussed the votes with the students, in part because with participation-based clicker polling some students would simply vote at random for their class participation points. This meant that even with exact percentages, during post-polling discussion I would treat values such as "59%" or "43%" equally as indicating "many of you voted for this option."

The students' ability to change their vote based on the clusters they were seeing added two new, and potentially beneficial, elements to their interactions; student reassessment of their voting option during polling and instructor-lead incremental exploration of the polling question. In terms of a vote reassessment, one could imagine a student who was alone in an option deciding to consider the other options that were more popular and changing their vote to the one among those that they felt was more likely correct. Of course some students might change their vote to "follow the crowd" without considering why that might be the correct answer. During laser pointer semester represented this ability never lead to a unanimous vote before discussion had begun, and there were examples of votes with "singleton" holdouts (and in one case that holdout was correct).

The ability of students to quickly change votes facilitated a different in-class experience when (with the red dots still on-screen) I would begin a discussion of the less-popular options, explaining why they were incorrect. As opposed to polling with static displays of the results, students could easy modify their laser pointer vote during this discussion. While discussing one incorrect option there were times when some students would begin to move their laser pointer vote away from one of the *other* options that had not yet been discussed. This could represent students realizing that their current vote was incorrect, based on what was being said about the other incorrect option. A goal in large-classroom lecture environments is to increase student engagement during lecture, and this behavior of reassessment of votes demonstrates an impact this approach can have in a large classroom while also verifying a level of student engagement.

Unexpected polling options invented by students

One unexpected observation was that some students invented new ways to vote with the laser pointers. Students who could not decide between options had the ability to simply waggle their laser pointer back and forth between the two, reflecting their uncertainty between those options. Some students would simply rest their laser pointer dot on the border between the two choices. Clicker systems that enable multiple votes from the same student on a single slide do not provide an obvious method to extract how the multiple votes were paired by student "live" in the classroom, so connecting which options were being paired isn't possible during discussion. Polling would allow for listing out several individual choices, and then several "mixed" choices (e.g.: "A and B but not C"), though listing all possible combinations would detract from the main purpose of the polling system, the selection and tallying related to individual options.

Another unexpected observation was that while students didn't generally play with the pointers between votes (there was some at the start of the semester) some students did find ways to utilize the pointers in positive ways when voting was not taking place. In a large-class an instructor might ask a somewhat rhetorical question about something drawn on the board (such as "what would the *student1* reference now point to in memory") expecting students to raise their hands so that someone could be selected to provide an answer. What happened on occasion was that some students would view that as a voting question and use their laser pointer to point at their answer. In this course the drawing/writing on the board was part of a memory diagram or a line of code or part of a drawing of a collection of stacks of cubes, but the practice could be applied to many in-class conceptual drawings. Regardless of the nature of what had been placed on the board, the pointers could be used by more than just one student to provide their answer.

Where clickers have an advantage over laser pointers

When compared to clickers, there are some "losses" in terms of classroom pedagogy. While laser pointers do provide some interesting ways to indicate indecision or support spontaneous large-group interactions, the technique doesn't work well for intentional "choose all that apply" questions if there are many options that apply or if the student wants to choose more than two. While the black box grid worked well with 2 to 4 options on a single slide, moving to 5 or 6 was challenging visually, and more than 6 felt untenable. Two additional (and related) "losses" as an instructor using laser pointers over clickers are the inability to record and archive the per-student results and an increase in the challenge of having to coax students into participating. These are a result of participation points being unable to be attached to the polling. In my experiences, noting that there were fewer dots than students in the room with the laser pointer version did not lead to the same "boost" in votes appearing as it had in the previous semesters using clickers on ungraded polling slides where the slide showed an exact number of how many students hadn't yet voted.

I also observed that the inability to record votes negatively impacted student participation and overall attendance. From simple classroom observation it was easy to tell when there were far fewer dots on the screen than students in the room. As the laser pointer semester progressed, the students in the room who used the laser pointers decreased steadily. There appeared to be fairly high participation at first based on the quantity of dots on the screen which appeared to be over half of the students (though not as high as when clickers were used which was commonly 80% or higher of registered students). However, while participation stayed fairly consistent throughout the semester when the clicker system was used (never dropping below the half-way mark on any

day) I observed that laser pointer participation essentially decreased each week until it appeared that only a small group of fewer than 20% of the students was continuing to actively participate. Additionally, the overall attendance level in the laser pointer classes suffered when compared to that of semesters where clickers were used (and were part of the students' grades). In terms of research, the inability to record votes removes any ability to look for mathematical correlations (such as between clicker votes and quiz/exam answers) but this observed attendance drop is a key element in the next section's discussion.

Is showing up half the challenge?

One of my starkest observations was a dramatic difference between student performance in the two semesters using clickers when compared to the semester using laser pointers. The projects/exercises and quizzes/exams used across the three semesters were of a very similar nature since the course itself had not changed and I taught all of the sections mentioned here. The questions used in the laser pointer semester were almost all the same as those I had used previously, simply converted from clicker-styled slides to the black-box/yellow-letter style. To account for the fluctuations that takes place during the drop/add period of a semester, and some students registering for a course without ever being a part of it, the information regarding student grades that is provided in Figure 5 only includes data for those students who completed at least the first programming project of the semester (due shortly after the end of the drop/add period). The “ABC” column and “DF” columns represent letter grades assigned with + and – designations of those letters as well.

Semester	# of students	ABC	DF	W	ABC%
Clicker #1	119	92	16	11	77.3%
Clicker #2	84	64	14	6	76.2%
Laser Pointer	171	108	34	29	63.2%

Figure 5: Performance of students in semesters using clickers versus the semester using laser pointers.

What is reflected is a drop in the student success rate (defined here as a "C-" or better) in the laser pointers semester when compared with the clicker semesters. The topics and course materials were effectively the same in all three semesters. Due to the nature and structure of the academic year, most of the teaching assistants were even the same between the second clicker and the laser pointer semesters. The difference in student success between the two clicker semesters is a very small one. However, the difference in the student success rate between either of the clicker semesters when compared to the laser pointers semester is more than 10%. The thing that had changed was the use of laser pointers over clickers, and the associated decrease in attendance and participation.

Of related interest to the question of the impact of clickers, a previous case study of a non-majors information technology course I undertook over a period of two years (one year with clickers, and the previous year without them) [3, 4] did not show statistically-significant improvement among students on exam questions that has been presented as polling questions but did reflect a positive correlation between attendance (measured by clicker participation scores) and higher overall performance in the course. As with the current case study, the course used in this previous case study had clicker polling used as a participation-based grading item, not a quiz-based one. There is a diverse pool of research that has explored, and either shown or implied a positive correlation and possible causality between attendance and student performance in a

variety of situations and disciplines as well as general education courses [5, 6, 7, 8, 9, 10, 11]. Others report having seen "clear benefits for students to be gained in attendance" at the university level [12] and that "student attendance substantially affected achievement" [13] with at least one study that has explored attendance as an independent variable [14]. While questions still exist regarding the relationship between socioeconomic status and attendance and the question of whether SES is a confounding factor, based on the body of research and the observations in this case study, the temptation to draw a connection between classroom response technology and attendance and outcome is high. These types of papers and articles and the observations I've made regarding the laser pointer semester appear consistent.

Logistical issues of laser pointers

This article would be incomplete as a resource if it did not mention some of the logistical issues related to laser pointers. In terms of initial costs, since I wanted to provide and then collect the laser pointers each day (for both cost and safety reasons) I purchased 75 inexpensive laser pointers in bulk. While far less expensive that professional quality pointers (under $1.50 each as opposed to $15 and over) they were also less sturdy. By the end of the semester slightly more than 20% of them had broken beyond repair. There were also simple maintenance issues such as batteries needing to be tested each week to ensure reliability the next week.

To distribute and collect the laser pointers, three small boxes were used to distribute laser pointers through the room and at the end of the class session students were asked to drop the laser pointer they were using into one of two boxes left near the exits. This approach worked well for the most part in that it was quick and low-impact for me to implement. However, one way in which this was problematic was the loss of pointers; within the first three weeks seven

had not been returned and by the end of the semester just over 20 laser pointers were missing. I also observed that a small number of students had held onto a laser pointer and brought it back each week.

In terms of student distraction (or distracting students) some students played with their laser pointers but it was a small number, and was only observed being done while students were coming in and getting their laser pointers, and briefly during voting time. It did not appear to be distracting for the other students who were genuinely participating in the polling. There was one case where one student was pointing his laser pointer at another student's head, but a quick and gentle admonishment ended that and it was not a recurring problem.

What's next?

Logistically, I found the use of laser pointers simpler in terms of class preparation and the lack of post-session bookkeeping, and the voting felt less mechanical. My general impression is that laser pointers could provide an easier and more flexible way to have some more anonymous interaction with students in small classes, and to have more interaction in general in larger classes. However, due to the significant differences with regard to improving student attendance, and the apparent high value of attendance, the classes where laser pointers should be used over clickers should likely be ones in which student attendance and motivation are not existing challenges. Perhaps with students in moderately sized upper-level classes which do not have attendance issues might benefit from the interaction and lower overhead of laser pointers.

The experience of using laser pointers with this lower-level course left me with new questions. Does the use of laser pointers encourage more second-tier thought after seeing where peers are

voting, or does it encourage students to just wait to find out what the right answer seems to be based on peer voting? Does the increased attendance connected with scored polling have a direct impact on student performance even if their motivation for attending is forced? While tempting from a scientific standpoint to have a more controlled study where one section used clickers and the other used laser pointers, this did not seem ethically sound in the context of the course discussed in this case study considering the observed negative impact of laser pointer use when compared to clicker use. Even though it would be the student's choice to not attend a future version of the course that used laser pointers for polling, such an experiment still feels unwise to pursue.

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