# How do clickers affect student engagement and test performance?

**Andrea Arner**
**Columbus City Schools**

**Keywords:** *Clickers, Engagement, Technology, Student Test Performance*

**Abstract**: *Technological advances, although novel, are not always the best learning tools for students. One recent advancement in educational technology is clickers. Clickers are also called Audience Response Systems (ARS) or Personal Response Systems (PRS). Clickers allow a teacher to use an LCD projector to display multiple choice questions that students can instantly respond to using a small handheld device. Answers are immediately calculated and anonymously displayed in the form of a histogram. Clickers provide instant feedback for teachers about levels of student understanding and can be effective tools for creating discussion about questions. Based on informal classroom observations and conversations with students the use of clickers in a classroom is highly enjoyable. While activities that increase engagement are important, the goal of increased engagement is to increase student learning performance on end of unit assessments. Beyond engagement, clickers are only effective if they also have a positive effect on student learning as determined by performance on classroom assessments. This study corroborated previous findings, that engagement with clickers was high, students enjoyed using them, and felt that they helped them to learn, and most importantly, that overall achievement was not raised by their use.*

## Table of Contents

# Introduction


**A sample "clicker"**

Over the years, I've learned that technology motivates my students. They like to see me use technology and love when they get to use it themselves. Lessons that use technology have historically been a hook for my students. Ordinary activities, when enhanced with technology, motivate my students in ways that a worksheet simply cannot. At the start of the 2009-2010 school year, I came into possession of a new technology tool, a 32-seat student response system. My colleagues at other middle schools raved about clickers and their ability to engage students, but I had no experience with them. Student response systems, or "clickers" as they are often called, were a tool that I had heard of, but never seen or used. Clickers allow a teacher to use a computer and an LCD projector to display multiple choice questions that students can instantly respond to using a small handheld device. Answers are immediately calculated and anonymously displayed in the form of a histogram.

For my first tentative attempt at incorporating clickers into my lesson, we used them to review for an upcoming genetics test. It was an activity that by all accounts should have been dull. Students answered old multiple choice genetics test questions and old Ohio Achievement Assessment questions that covered the topics from our unit. Instead of circling correct answers on a worksheet, this time students logged in an answer with their individual clicker. The reaction from students shocked me. They were engaged, motivated, and on the edge of their seats. The activity garnered enthusiastic reviews from students. They begged for more! After only one use, they came in every day for a week asking if they got to use the clickers again in class. I felt thrilled. I believed I had found a wonderful new tool for my classroom.

As a middle school science teacher, I am always hunting for ways to make my units more exciting and tools to incorporate which will help my students master the vocabulary and concepts I need them to learn. Science labs are always engaging, but sometimes my students need direct instruction and practice applying their knowledge in Ohio Achievement Assessment-like questions. After the encouraging response from students when I used clickers for a test review, I began to wonder how else I could use them, and how best to use them to see the largest increase

in engagement and performance on classroom tests. Clearly clickers increased engagement, but I wanted to know if they also improved my students' retention of knowledge and ability to perform well on classroom tests. After all, I want my students to find learning in my classroom to be fun, but I don't want to provide fun activities at the expense of learning. Are clickers just a fun activity, or do they improve student learning as measured by performance on classroom tests? Based on these questions, I decided to study the effects of incorporating clickers into a middle school science classroom on student engagement and performance on classroom tests.

# Literature Review

Clickers are a relatively new educational tool. While there is a constantly growing body of research on the use of clickers in classrooms, the current research is narrow in its focus. The vast majority of clicker research data has been collected in large lecture style college science classes designed for non-science majors (Caldwell, 2007; Herreid, 2006; Kenwright, 2009; Len, 2007; Ribbens, 2007; Trees & Jackson, 2007). Very few studies exist about the effects of clickers when used in K-12 classrooms or when used in small classes. The research that does exist for K-12 classrooms seems to support the findings of those researchers at the college level (Kay & Knaack, 2009).

**Benefits**

All of the studies reviewed reported similar benefits to using clickers. Research indicates that clickers are popular with students (Caldwell 2007; Herreid 2006; Kay & Knaack, 2009; Kenwright, 2009; King & Joshi, 2008; Ribbens, 2007). Both students and professors report an increase in engagement when clickers are part of a class session (Caldwell, 2007; Herreid, 2006; Kay & Knaack, 2009; Ribbens, 2007; Trees and Jackson, 2007), an increase in attendance (Caldwell, 2007; Herreid, 2006; Kay & Knaack, 2009; Kenwright, 2009), and a decrease in sleeping in class (Kenwright, 2009). Clickers display a histogram of the results after each question. This histogram can be used by both teachers and students to help assess levels of understanding (Caldwell, 2007; Kenwright, 2009; Ribbens, 2007).

**Test Performance**

Research findings on the effects of clickers on student test scores, on the other hand, are inconclusive. While there appears to be no negative effect on student test scores, the benefit is a bit unclear. Some studies indicate that use of clickers generally benefits students and results in improved student performance on assessments, comprehension and grades (Caldwell, 2007; Kay & Knaack, 2009; Kenwright, 2009; King & Joshi, 2008; Ribbens, 2007). However, it is difficult to determine if the benefits are the result of clickers or the change in teaching methods used and classroom atmosphere when clickers are used. Some researchers speculate that the increase in

student test scores could be attributed to the novelty of clickers or to the novelty of a new technology tool (Herreid, 2006).

**Challenges**

While there are many benefits to clicker use, any new technology presents challenges. Clickers cannot be used without an LCD projector and have other minimum system requirements. Creating clicker questions to use for the first time can be a time consuming process, but after the work is done they are easier to use each time (Caldwell, 2007; Herreid, 2006; Kay & Knaack, 2009; Ribbens, 2007). Clickers are easiest to use when assessing questions at the lower levels of Bloom's Taxonomy but may not be as effective in assessing higher levels of thinking (Herreid, 2006). Clickers can also be frustrating to learn to use (Herreid, 2006; Kay & Knaack, 2009; Ribbens, 2007). Clickers are battery operated and those systems that work using infrared (IR) frequencies can experience interference from other equipment in the room that emits IR frequencies (Caldwell, 2007; Kay & Knaack, 2009; Ribbens, 2007). Along with technical difficulties, there can be practical difficulties as well (Kay & LeSage, 2009). Passing out and collecting clickers can be time consuming (Kay & Knaack, 2009). Finally, although research indicates that most students respond positively to clickers, not all students like them (Caldwell , 2007; Kay & Knaack, 2009). Current research also shows that students do not like to use clickers when too much of their grade is based on their use or when clickers are used for summative assessments (Caldwell, 2007; Kay & Knaack, 2009; Kenwright, 2009; Ribbens, 2007).

**Best Practices**

In all of the studies reviewed for this paper, clickers were used by instructors to quickly indicate what material students mastered and what material required further instruction. Caldwell (2009), in her article about best practices for clickers, indicates some keys to clicker success. Like all forms of technology, planning and practice are important, as is a backup plan. Research also indicates that clickers are best used to help create discussion and interaction among students (Caldwell, 2007; Guthrie & Carlin, 2004; Herreid, 2006). It is the use of clickers as an impetus for feedback that seems to make them successful in classrooms. Technology should be more than teacher demonstrations and enhanced lectures; it should encourage student participation (Guthrie, 2004; McKenna, Labbo, Reinking & Zucker, 2007).

# Methodology


This study was conducted in an urban middle school in Ohio. The school is one of the district's alternative middle schools, not a neighborhood school. This means that one hundred percent of the student body is enrolled through a lottery process. The school focuses on

integrating arts into all curriculum areas. Students who attend generally have an interest in one or more art fields. The student body is 78.5% African-American and 17.7% white. Most students (73%) are designated as economically disadvantaged. Students at this school tend to perform slightly better than their school district peers on the state-wide Ohio Achievement Assessment (OAA). In 2009 the district passing average on the 8th grade science section of the OAA was 35.7%, while the school's average was 41.2%. While still below the Ohio state average pass rate of 62.8%, this is typical of the school's scores as compared to other middle schools in the district.

The students who participated in the study were all enrolled in regular $6^{th}$ grade life science. During this investigation, students studied topics related to the diversity of organisms and ecosystem dynamics. Originally included in the study were 113 students in four classes. Due to a variety of reasons (mostly related to attendance), data from 20 students were excluded from the final analysis which brought the final total number of participants down to 93 students.

Today, teachers are expected to incorporate technology into the classroom. Although I am computer literate, I am not an expert and have no specific training with technology. I find new technologies to be intimidating, and any application that requires more than basic computer knowledge is daunting. I chose to use a 32-seat clicker set provided by TurningPoint Technologies because this system was available to me. The program to create TurningPoint clicker presentations is very similar to Microsoft PowerPoint and I found that my knowledge of creating basic PowerPoint presentations was sufficient to help understand the basics of creating clicker question presentations. I did encounter a few minor issues as I learned to use them (graphs that should come up and didn't; questions that I thought I marked correct but hadn't) but these were resolved by consulting the manual. Despite the bumps along the way, clickers were fairly easy to incorporate into my classes.

For each instructional unit, several types of clicker lessons were incorporated. During each unit, clicker questions were embedded into lectures. Students could only respond to multiple choice questions using their individual clickers. Periodically during the lecture, students were given the opportunity to respond to multiple-choice questions based on the material that had just been delivered. Clickers were also used as general review at the end of a class session. During these mini-review sessions, material from the past several classes was reviewed. Finally, clickers were also used for general review the day before the unit quiz. Multiple-choice clicker questions that covered information from the entire unit were included in these sessions. These quiz-review clicker sessions consisted of 70% new questions, with 30% repeat questions. Most commonly, repeat questions were questions that were most missed by the class in the earlier clicker sessions.

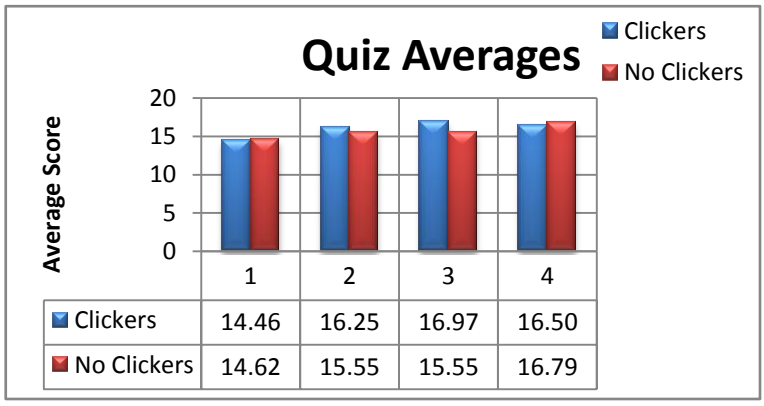
To help track performance when using the clickers, each student was assigned a clicker ID. Each time clickers were used, the program logged student responses and displayed student responses

in the form of a bar graph. While the data on the displayed histogram were anonymous, after class I could look to see how individual students responded to questions.

In order to establish whether using clickers during instruction affected student test scores, average class test scores were compared when students used clickers and when they did not. For alternating 10 day units clickers were incorporated into class sessions for two of the four classes (experimental group). The other two classes did not use clickers (control group). Clickers were used at least two times a week for 15-25 minutes each session. At the end of the 10 day unit students in all four classes completed a unit quiz and a five question student attitude survey. Data from previous unit quizzes were also used to help establish a baseline average quiz score for each class. The experiment was repeated twice over four units, with each set of two classes serving twice as the control group and twice as the experimental group. The two classes were grouped so that overall their pre-study quiz performance in my class was approximately the same. Group A's quiz average prior to the study was 80% and Group B's average was 79%.

# Results and Findings

Through classroom observation and data collected using TurningPoint software, I can be certain that clickers increased student engagement. Each time a question is asked the TurningPoint software tracks which students respond. For all questions there was 100% participation. Despite my best effort, most classroom activities do not result in 100% student participation. Typically, when I ask a question in class, only a few students are called on to respond. Even if fifteen students raise their hands, only one or two may get to share their responses. With clickers, every student responded to every question. Clickers clearly increased student engagement.



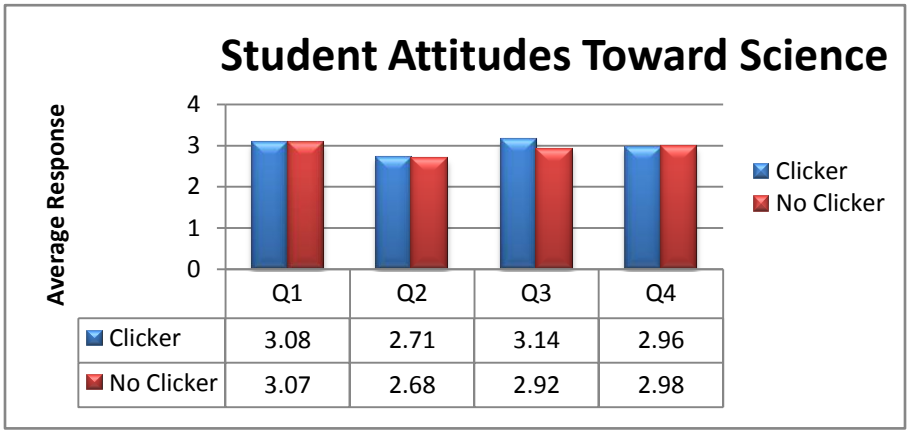

| | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Clickers | 14.46 | 16.25 | 16.97 | 16.50 |
| No Clickers | 14.62 | 15.55 | 15.55 | 16.79 |

To determine what effect clicker use had on student performance, a t-test was used to analyze the quiz scores from each of the four units. I conducted a t-test to determine whether the difference in the clicker group's mean and the non-clicker group's mean was significant. The results for quizzes one, two, and four showed no reliable difference between the scores of the two groups ($p > 0.41$). However, the third quiz the students took did result in a reliable difference ($p = 0.007$) with an effect size of 0.50 (Table 1).

The first and second quiz followed the same pattern. Half of the quiz questions were multiple-choice and the other half required students to classify organisms into phyla. Classes that used the clickers had more practice with multiple-choice type questions and less practice with classification, while classes that did not use the clickers had less practice with the multiple-choice style questions and more with the classification. Since the quizzes were designed to be equal parts multiple-choice and equal parts classification, this could account for the closeness of the scores. As the grader of the quizzes, I did notice that on quizzes one and two, students who had access to the clickers performed better on the multiple-choice portion of the quiz than their peers who did not use the clickers. However, they did not perform as well on the classification portion of the quiz.

Quiz three was more heavily based on multiple-choice and matching questions that were easily practiced with clickers. For this quiz, 80% of the quiz was multiple-choice/matching. The high percentage of multiple-choice/matching on quiz three could explain the significant improvement of the students who used clickers during the unit. The final quiz more closely resembled the make-up of the first two quizzes, with half of the quiz multiple-choice/matching, and the other half a variety of short-answer and lab application questions.

At the end of each two-week unit, students also completed a five question attitude survey (figure 1). The survey was designed to indicate student attitudes about class when clickers were used. As with the quiz data, the survey data results were not significantly different (Table 2). Regardless of clicker use, students answered with nearly identical results. However, the majority of students (78%) indicated that they agreed a lot or completely agreed with question five on the student attitude survey: "Using clickers helped me improve my quiz score." Forty-five percent of students said that they completely agreed that clickers helped improve their quiz score.




| | Q1 | Q2 | Q3 | Q4 |
|---|---|---|---|---|
| Clicker | 3.08 | 2.71 | 3.14 | 2.96 |
| No Clicker | 3.07 | 2.68 | 2.92 | 2.98 |

**STUDENT ATTITUDE SURVEY**

1. I enjoy science
2. I enjoyed this unit
3. Classroom activities helped me understand the topics.
4. I felt prepared for this quiz
5. Using clickers helped me improve my quiz score. ***

Each question students had a choice of four answers:

Don't agree
Agree a little
Agree a lot
Completely Agree

*** Answered only on units where students used clickers.

The data from this study are consistent with data from other studies conducted at the college level. Clickers are enjoyed by students, but they do not significantly improve performance on tests (Caldwell, 2007; Herreid, 2006; Kay & Knaack, 2009; Kenwright, 2009; King & Joshi, 2008; Ribbens, 2007). Other studies have also shown that students believe that using clickers raise test scores (Caldwell, 2007; Kay & Knaack, 2009; Kenwright, 2009; Trees & Jackson, 2007).

Despite the similarities in results that this study has to other published studies at the college level, there are some limitations to this study that must be acknowledged. Because this study compared the quiz performance of different students on different quizzes, it can be difficult to draw reliable conclusions. Despite best efforts to keep the four units as consistent as possible, there are inherent differences in the type of content, difficulty of the content and how well the content lends itself to clicker style questions and the difficulty of the quiz. As any classroom teacher knows, there are of course the other unpredictable and uncontrollable factors that influence the quality of a study such as interruptions from fire alarms, field trips, snow days, student illness and student moods.

Clicker research is still a new and developing area, especially at the K-12 level. Further studies at the K-12 level in areas other than science should be conducted. Even at the collegiate level, most clicker studies have been conducted on students in science classrooms (Herreid, 2006; Kenwright, 2009; King & Joshi, 2008; Len, 2007; Ribbens, 2007). Despite the fact that the data from this study are not without flaws, there are still some implications that could be drawn from further analysis. No study has yet to look at how clickers affect specific groups of students. The data in this study could be further analyzed to look at how clickers affect individual students. Perhaps students with certain learning styles benefit more from clickers that do others. Clickers should also be studied in other subject areas such as math or reading.

# Discussion

Clicker research is still a new and developing area. While much of the research supports that clickers do not significantly improve student performance on tests, I believe that current use of clickers can be modified to increase student performance on assessments, support higher level questioning techniques and foster interesting classroom discussions

One of the key advantages to clickers is the instant feedback which they provide to students and teachers. During the course of this study I collected, but did not analyze, individual performance on classroom clicker sessions. The information displayed to students is anonymous, but in private teachers can look at the performance of individual students. This valuable information could be used by a teacher to provide differentiated instruction for students. Teachers could also

use this information to help inform parents exactly which areas a child needs to target when preparing for a test at home.

Most of the clicker questions used during this study were lower level Bloom's taxonomy questions. However, clickers could be used to ask higher level questions. Questions which involve synthesis and evaluation could provoke rich group discussions. While individual students would still have the freedom to select their own answer, they would have the collective brain power of their group to help guide them. In a science classroom when looking at an issue such as global warming where strong data from multiple viewpoints are available, students would need to use their current knowledge of ecosystems, reading skills, and data analysis skills to arrive at an answer. These questions in turn could be a springboard for important classroom discussion as students learn to articulate their viewpoint using the data at hand.

# Conclusion

As a result of this study I will still continue to use clickers in my classroom on a limited basis. While they did not significantly raise quiz scores on most units, they did improve student performance on multiple-choice quiz questions and increase engagement. Clickers could be used to help students prepare for multiple-choice style assessments such as the OAA or the OGT. I also hope to investigate ways that clickers could be used to promote higher level thinking and classroom discussions. Students enjoy using clickers and they do increase participation. Perhaps future studies will indicate best practices for clickers in K-12 classrooms to maximize their potential.

# References

Caldwell, J. E. (2007). Clickers in the large classroom: Current Research and best-practice tips. *Life Science Education* 6(1), 9-20.

Guthrie, R.W., & Carlin, A. (2004). Waking the dead: Using interactive technology to engage passive listeners in the classroom. Proceedings of the Tenth Americas Conference on Information Systems, New York.

*www.mhee.com/cps/docs/CPSWP_WakindDead082003.pdf*

Herreid, C. F. (2006). “Clicker” cases: Introducing case study teaching into large classrooms. *Journal of College Science Teaching* 36(2), 43-47.

Kay, R., & Knaack, L. (2009). Exploring the use of audience response systems in secondary school science classrooms. *Journal of Science Education and Technology.* 18(5), 382-392.

Kay, R., & LeSage, A. (2009). Examining the benefits and challenges of using audience response systems: A review of the literature. *Computers & Education*. 53(3), 819-827.

Kenwright, K. (2009). Clickers in the classroom. *TechTrends*. 53(1), 74-77.

King, D. B., & Joshi, S. (2008). Gender differences in the use and effectiveness of personal response devices. *Journal of Science Education and Technology*. 17(6), 544-552.

Len, P.M. (2007). Different reward structures to motivate student interaction with electronic response systems in astronomy. *Astronomy Education Review*. 5(2), 5-15.

McKenna, M., Labbo, L. D., Reinking, D., & Zucker, T. A. (2007). Effective uses of technology in literacy instruction. In Gambrell, L., Morrow, L. M. & Pressley, M. (Eds.), *Best Practices in Literacy Instruction* (344-372) NY: New York: Gilford Press.

Ribbens, E. (2007). Why I like clicker personal response systems. *Journal of College Science Teaching*. 37(2), 60-62.

Trees, A. R., & Jackson, M.H. (2007). The learning environment in clicker classrooms: Student processes of learning and involvement in large university-level courses using student response systems. *Learning, Media and Technology*. 32(1), 21-40.