Clicking in the Classroom: Using a Student Response System in an Elementary Classroom

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Abstract
This action research study used a mixed methods design to gather data on the academic performance and perceptions of elementary students regarding the use of clickers. Participants in this study consisted of 22 second grade students from a large, suburban elementary school in the Midwest. Four consecutive health units were taught using the multimedia presentation software, PowerPoint. These units alternated between clicker use and non-clicker use in an A-B-A-B design. In addition to academic performance, a student survey was administered and a focus group conducted to determine student perceptions regarding the use of clickers. Initial results indicated an increase from pre to post test scores for both response methods. However, the group using clickers showed a greater mean score gain than the group without the clickers. Survey results indicated that students enjoyed the use of clickers and felt it helped improve their performance. Additional research is needed to determine the effects of using clickers in a variety of classroom situations over an extended period of time.

Introduction
In today’s digitally driven society, technology is often seen as a way to revolutionize teaching, reaching more students in more efficient ways. Increasingly, instructional technology is becoming more widely used in K-12 settings (Grunwald Associates, 2010). “Clickers” are one type of instructional technology that is rapidly gaining popularity in K-12 education settings (Penuel, Boscardin, Masyn, & Crawford, 2007). The use of clickers has been shown to increase participation and active engagement in the classroom (Caldwell, 2007). These handheld devices also allow students to receive immediate feedback on multiple choice questions and inform the teacher of the student’s understanding. Clickers make this possible in large classes and also allow the teacher to easily track student responses following the lessons. Teachers can efficiently identify misunderstanding during the lesson and following instruction.

A wide range of terms for this technology have been used that include, “audience response systems,” “personal response systems,” “electronic voting systems,” “classroom response systems,” “student response systems” and “clickers” (Kay & LeSage, 2009). Different varieties of clickers are developed and sold by a number of companies (Beatty, 2004). Each company’s software and designs vary somewhat, but they all possess some common characteristics. The clickers generally resemble small remote control devices. Each student holds his or her own clicker and presses the appropriate buttons.
to answer questions posed by the teacher during class. Most systems are set up to integrate the questions into a PowerPoint format. After the responses are received, the teacher and students can then automatically view students’ individual responses and/or a graphical representation of the class wide response (e.g., what percent of students chose each answer).

Some clickers allow numbers and text to be entered for free response questions, while others only allow students to answer by selecting from options (e.g., multiple choice, true-false, rating scale, etc.) The teacher can set up the clickers for anonymous responses or track individual responses to monitor student progress. The basic features of all clickers are that they allow all students to individually answer questions simultaneously and permit both teachers and students to view those responses instantaneously.

As is the case with most new technology, clickers did not just appear. In fact, they emerged from existing technology that has been in existence since the 1960s (Judson & Sawada, 2002). With the attention on behaviorism and B.F. Skinner’s pioneering research on behavior and learning related reinforcement and punishment, electronic response systems were used in the 1960’s to provide students and instructors with instant notification as to the correctness of answers (Judson & Sawada, 2002).

Kay and LeSage (2009) state that clickers were first introduced in 1966 at Stanford University but were not commercially available until the 1990’s. High prices for these initial systems were prohibitive, but once lower cost systems were introduced in 1999, clicker use became more prevalent in university settings (Kay & LeSage, 2009). Prices for clicker systems have become even more affordable, and clicker companies are marketing their systems to K-12 customers. Now, thousands of systems have been sold for use in grades K-12 (Penuel, Boscardin, Masyn, & Crawford, 2007). Although many positive aspects have been attributed to the use of clickers (see http://net.educause.edu/ir/library/pdf/ELI7002.pdf), little research has been done to determine their effects on student learning. Therefore, the focus of this study was to investigate the effects of using clickers on the academic achievement of students in an elementary setting.

Clicker Research

While clickers are gaining popularity in both college and K-12 education settings, the literature regarding teaching with clickers is also expanding. Many different aspects of clicker use have been studied and published, but the majority of research thus far has primarily focused on clicker use in higher education settings with primary emphasis on student/teacher perceptions, attendance, and participation. Few studies have focused on student learning and academic achievement.

The effectiveness of using clickers has been studied over the last decade in a variety of settings with college students (Cossgrove & Curran, 2008; Shaffer & Collura, 2009; Stowell & Nelson 2007; Sprague & Dahl, 2010). Research conducted in higher education settings that has included a learning outcome component provided
mixed results. Some studies reported no significant effects and others reported significantly better scores or grades when students were taught with clickers (Cossgrove & Curran, 2008; Shaffer & Collura, 2009; Stowell & Nelson, 2007; Sprague & Dahl, 2010). However, Key and LeSage (2009) suggest in their recent review of clicker literature that, overall, the qualitative and experimental research results in this area demonstrate significant improvement in learning performance when using clickers. One difficulty in assessing the impact of clickers on academic performance is whether or not the technology had an impact on achievement or the pedagogical aspect of increasing student engagement.

Previous research indicates several benefits to using clickers which include improved attention, attendance, participation, engagement, interaction, discussion, contingent teaching, quality of learning, learning performance, feedback, and normative assessment (Key & LeSage, 2009). In addition, in a study by Freeman, Blayney and Ginns (2006), students valued the anonymity in responding and acknowledged the value of formative assessment to enhance class participation. The challenges identified for teachers include time required to learn and set up clicker systems, creating effective questions, covering desired amount of material, and responding to feedback. Challenges for students include using a new method of learning, confusion when discussing different perspectives, and negative reactions to being monitored (Key & LeSage, 2009).

K-12 Clicker Research

While the data suggests improved learning when college students use clickers, data related to learning outcomes associated with clicker use in elementary classrooms is severely lacking. No peer-reviewed articles for this topic and population were located by the authors, but several conference presentations were identified which provide support for improved learning in elementary grades using clickers (Hegedus, 2003; Lonsdale, Baber, & Sharples, 2004; Wilensky & Stroup, 2000).

Considering the lack of research on the use of clickers in elementary classrooms, learning performance data specific to this population is necessary in order to identify the value of clickers in these classrooms and highlight effective uses of the technology. The specific focus of this research was to evaluate the effectiveness of using clicker technology with elementary students. To help determine the effects of the technology versus increased active engagement by students, similar teaching formats were used during each chapter that included student participation prompts.

Methodology

Participants

Participants in this study consisted of 22 conveniently selected second grade students from a large, suburban elementary school. The school was located in a medium-sized city within 20 miles of a major metropolitan area in the Midwestern part of the United States. Overall student population for the school was approximately 82% Caucasian, 8% African American, 1% Hispanic, 1% Native American, and 8% Multiracial. The class used in this study consisted of 10 females (45%) and 12 males (55%). Three students from the class (14%) were identified as low socioeconomic status (SES) based on the requirements for free and reduced lunch. In addition, three
students (14%) had diagnosed disabilities and received special education services.

**Procedures**

This study was designed to determine if the use of clickers had an effect on the academic achievement of the second grade student participants. For the purpose of this study, four consecutive health units were taught using a standard district approved second grade curriculum. Each unit of instruction was developed using Macmillan McGraw-Hill health and wellness basal curriculum (Meeks & Heit, 2005) and content readers for grade 2. The health curriculum focused on teaching students to make healthy decisions and providing students with core content, skills, and knowledge. The four units selected for this study included a unit on the body, healthful foods, safety, and taking care of the Earth. Each two week unit consisted of nine to ten daily 30 minute lessons. Lessons included vocabulary development, content reading, content instruction, instructional activities, a unit review, and a pre/post-test. Within each unit, five of the ten lessons were delivered using multimedia presentation software, PowerPoint, and four to five were not. Multimedia presentation of content was not a common instructional method used in this particular classroom, therefore the use of the multimedia presentation was novel to both the students and teacher. The multimedia presentations were developed by the teacher and researchers using the Macmillan McGraw-Hill Health and Wellness 2nd grade teachers manual.

The units and multimedia lessons were designed to be consistent. Within each 30 minute multimedia lesson presentation, eight to ten slides were designed to require student answers to content questions. The questions were evaluated to ensure the use of equivalent questioning levels, from simple to complex questions, using Bloom’s Taxonomy of educational objectives (Bloom & Krathwohl, 1956). Each presentation had factual questions, easily answered by true/false, yes/no, or multiple choice answers. Presentations also included higher level questions, where students were given a graph, chart, or scenario which required the student to apply, synthesize, or evaluate knowledge.

In addition, two of the multimedia lessons for each unit presented a peer instruction activity (Mazur, 1997). For these activities, students were asked a higher level question which they would answer independently. Next, the students would work together in small groups to solve a problem or complete an activity related to the question posed earlier. Then, students were asked to answer the same question again, once the group came to consensus. Finally, the class would discuss if and how their answers changed before and after the peer activity. In units taught without clickers, students responded to the questions posed on the multimedia slides by raising their hands.

Although all health and wellness units included multimedia presentations, two units incorporated the use of clickers and two units were taught without clickers. These units alternated between clicker use and non-clicker use in an A-B-A-B design. When the individual lessons were taught using clickers, question were posed to the students and the students responded by pressing the clicker buttons. A graph displaying the student answers was shown to the class. The teacher would discuss the graph with the students, indicating the correct answer and asking students why they might have answered differently. The teacher was also able to go back to the data generated by the clickers after the lesson to
determine if the class needed additional review before moving on to the next lesson. In units without clickers, the students raised their hands to answer questions and the teacher kept track of class responses on a clipboard. The teacher determined if the class needed additional review by the notes made during the lesson.

Data Collection and Analysis

This study used a mixed methods design to gather data on the academic performance of the students, as well as, attitudes and perceptions regarding the use of clickers. Quantitative data on student performance was collected by recording student scores on the pre and post-tests for each unit. The unit tests were teacher constructed and based on the standard district curriculum and unit tests provided by the basal health series. Students were given a pre-test to determine their level of knowledge related to the unit content. The same test was used at the end of the unit and pre and post-test scores were then compared to determine the academic growth of each student.

In addition to the content tests, a student survey was administered and a focus group conducted at the end of the study to determine student attitudes and perceptions regarding the use of clickers. Student responses were recorded by the teacher and researcher and analyzed to determine if any patterns or trends existed. The focus group questions consisted of open-ended questions related to the students’ overall interest and perceptions related to the use of clickers for learning.

Results

Content Tests

<table>
<thead>
<tr>
<th>Time of Test</th>
<th>Unit 1</th>
<th>Unit 2</th>
<th>Unit 3</th>
<th>Unit 4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Clickers</td>
<td>No Clickers</td>
<td>Clickers</td>
<td>No Clickers</td>
</tr>
<tr>
<td>Pre-Test</td>
<td>72.73%</td>
<td>81.59%</td>
<td>62.96%</td>
<td>80.23%</td>
</tr>
<tr>
<td>Post Test</td>
<td>88.18%</td>
<td>92.50%</td>
<td>83.41%</td>
<td>94.32%</td>
</tr>
<tr>
<td>Gain (Learning)</td>
<td>15.44%</td>
<td>10.91%</td>
<td>20.45%</td>
<td>14.09%</td>
</tr>
</tbody>
</table>

Pre and post-test mean score percentages across delivery method and unit can be seen in the table above.

As indicated in the table, both groups showed improvement from pre to post testing. However, the group using the clickers showed a greater mean score gain than the group without the clickers. The group using clickers showed an overall mean score gain of 18.04 points and the group without clickers improved by 12.79 points.
When results were viewed by gender, similar patterns were evident. Both males and females showed overall mean gains whether using the clickers or not.
Mean Test Scores

In addition, overall mean gains were higher for both males and females for the group that used clickers. Females showed an overall gain of 15 points when using clickers compared to 13.25 points without clickers. The overall mean score for males increased by 20.39 points for those in the clicker group and only 12.31 points for those who did not use clickers. Based on the mean scores, it appears clickers may have been slightly more effective with males than females.

Survey Results

Participants (N = 21) completed a short survey at the end of the study pertaining to their perceptions on the use of clickers. As can be seen in the table below, results showed that 45% of the students always liked using the clickers and 55% liked using them sometimes. In addition, 45% of the students felt the clickers always helped them learn and 55% indicated they helped sometimes. Furthermore, 55% of the students surveyed felt using the clickers always helped them perform better on tests, 40% indicated sometimes and 5% never felt they helped them perform better on tests. Lastly, students were asked if clickers made the class more fun. Results indicated that 45% of the students responded with always, 40% with sometimes, and 15% with never.

<table>
<thead>
<tr>
<th>Item</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>I like using the clickers.</td>
<td>Always</td>
</tr>
<tr>
<td></td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Clickers help me learn.</td>
<td>Always</td>
</tr>
<tr>
<td></td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>0</td>
</tr>
<tr>
<td>I do better on tests when we use clickers.</td>
<td>Always</td>
</tr>
<tr>
<td></td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Clickers make the class more fun.</td>
<td>Always</td>
</tr>
<tr>
<td></td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>3</td>
</tr>
</tbody>
</table>

N = 20

Student Focus Group

In addition to the survey, a short focus group meeting was conducted with the second grade students to gain qualitative feedback on student perceptions about clickers. The students were asked what they liked best about the clickers and what they didn’t like about the clickers. Analysis of student responses indicated the students liked the graphs that summarized student responses, and the questions embedded in the multimedia presentations helped them “know what is important”. One student with a disability commented that the clickers helped him “pay better attention in class”. As to what the students did not like about clickers, the majority of the students said they “liked everything”. There was no consensus as to dislikes regarding the clickers.
Discussion

Overall, these results support the findings from previous studies that suggest there may be a benefit to learning from using student response systems (Caldwell, 2007; Hegedus, 2003; Lonsdale, Baber, & Sharples, 2004; Wilensky & Stroup, 2000). The students in this study showed greater gains in learning when clickers were used despite differences in pre-tests that are unrelated to clicker use. Thus, clickers may produce positive effects on student learning when used with carefully designed lessons and compared to lessons without clickers.

The use of similar PowerPoint presentations and participation prompts in both groups helped to isolate the effect that clickers have on academic performance and minimize the focus on student engagement. One of the aspects that may have benefited learning could be that using the clickers allows immediate feedback to both the students and teacher, making it possible for teachers to make instructional decisions during the midst of teaching a lesson. After posing a question, if many of the students answer incorrectly, the teacher can immediately re-teach, add examples, or clarify. This ability to respond to student needs immediately, allows teachers to tailor instruction to meet student needs instantaneously. Similarly, students can identify mistakes in understanding during the lesson instead of waiting until they are asked to answer questions during seatwork activities, homework, or during the test.

Furthermore, clickers can also be used effectively with many questioning levels and styles, beyond basic multiple choice questions (Barber & Njus, 2007).

Embedding higher level clicker questions allows students the opportunity to apply and use their knowledge right away. The use of clickers can facilitate classroom discussion and active engagement. Students who are typically reluctant to participate appear more likely to respond when using a clicker.

The qualitative results indicated that students, as a whole, responded positively to the use of clickers. In support of the quantitative increases in learning observed in this study, the students felt they performed better when using clickers. Thus, the overall positive attitude demonstrated toward the use of clickers supports that they can be a benefit to the classroom environment. Even without an increase in learning, these results suggest that there may be other positive benefits to using clickers in a classroom.

One strength of this study was its ecological validity, in that little disruption to a typical classroom was created by our manipulation. Instructional presentation and delivery was consistent because all units were taught by the same teacher. In addition, the design allowed for comparing the effect of using clickers to the same students without clickers, rather than to separate groups of students with different individual learning characteristics.

However, some limitations to this study did exist and should be addressed. The study was conducted using a convenience sample; therefore, it only included the 22 students enrolled in the specific classroom participating in the study. Due to the small sample size, the results cannot be generalized to a larger population. Another limitation of this study is the lack of pre/post-test instrument validation. The tests used were teacher-made and not evaluated for validity and reliability. Somewhat
different material was used for each health unit in the study. Therefore, it is possible that these results were influenced by differences in the difficulty of the material between the clicker and no clicker groups. Some evidence of this is suggested by the fact that the pre-test scores were considerably higher in the no-clicker trials, suggesting pre-existing differences in the difficulty of the material.

Although much research remains to be done, and a more controlled, counterbalanced study would be beneficial, this study indicates that clickers may contribute to improved student learning outcomes and attitudes towards learning. It also offers teachers one more effective instructional technique that can produce positive outcomes for early learners. Further, research is needed to determine the classroom format and content that best matches the use of clicker technology. It would also be beneficial to investigate the impact on student performance and participation from a variety of populations such as students with disabilities, English Language Learners, and other at-risk populations. Additional studies could also focus on the controlled long-term learning implications of using student response system technology. A controlled longitudinal study that compares classes using clickers to classes without clickers would be ideal.

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