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Utilizing Student Response Systems in a High School Mathematics Class

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I want to thank my parents and grandparents for being great role models in what hard work and perseverance can accomplish. They instilled the love of teaching and to take pride in what you do. Treat people as you want to be treated was instilled at a young age and is my philosophy in my classroom. This has made me successful in and out of the classroom. Also, students don‟t care how much you know until they know how much you care has been with me in establishing respect in the classroom. This advice came from my grandma who taught math and is my inspiration in the classroom. The journey in doing this project and completing my degree has been a great learning experience and one I take pride in accomplishing.

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Abstract

An important aspect of teaching is to engage students in the learning process. Evidence has shown that the use of technology to increase engagement and participation of students in the classroom is important. The use of technology in a high school mathematics classroom to engage students was investigated in this study. The purpose was to determine if the use of student response systems or clickers in the classroom engaged more students than a classroom not using the technology. The second part of this study was to investigate whether the use of this technology increased student test scores. This study took place in a high school mathematics class during the 2010-2011 school year, in South Central Wisconsin. The study involved data gathered from classroom observations, student surveys, student interviews, quiz and test results, and the teacher‟s journal.

The student surveys and interviews were overwhelmingly positive in using clickers to increase engagement during the class period. The students agreed that using clickers made the math lectures more interesting. The teacher‟s journal and classroom observations provided insight into the use of the clickers to promote discussion, instant feedback, and effectively implementing clickers in the lecture. The quiz and test results were inconclusive. There were too many factors to consider when looking at the comparison results, such as the students‟ overall math skills. This study is important to teachers and administration who are investigating ways to incorporate technology into the classroom. The benefit that the clicker technology offers in student engagement and participation should be considered as a supplement to the classroom.

Chapter One

Introduction

The need to engage students in the learning experience is very important in teaching the current generation of students. According to Wood (2004), "students who engage interactively with each other and the instructor in the classroom learn concepts better, retain them longer, and can apply them more effectively in other contexts" (p. 796). Stowell and Nelson (2007) reported that "increasing student participation is one of many strategies that might lead to improved student learning" (p. 253). The students today are considered the technology generation. Integrating technology has been found to have a positive impact on academic results (Nagel, 2009). Teachers need to engage and increase participation of students, and adopting technology is a way to do this. The technology known as a Student Response System (SRS) or „Clickers" may be the tool educators need to engage students during lecture. Edmonds and Edmonds (2008) report that "SRS technology can be used to stimulate greater learning" (p. 432). This can be accomplished through student participation, and could be the tool worth using in my high school classes.

Definition of 'clickers'

There are various names for these devices, such as CRS (classroom response system), ARS (audience response system), SRS (student response system), or just plain „clickers". A clicker is a remote control device that each student has that allows the student to anonymously respond to questions presented in class. These devices offer a continuous exchange of information between the students and the teacher. With this immediate feedback, the results are quickly summarized and can be presented on a screen for the class to view. This tool could provide for better class participation and improved test scores because of the interaction between

students and the teacher. Lantz (2010) stated the "anonymity of clicker responses appears to increase responding from students that do not normally respond in-class" (p. 557). Premkumar and Coupal (2008) advised that, "the effectiveness of this system in improving teaching and learning depends on whether sound pedagogical principles are being used by the instructors" (p. 146). Educators are always looking for ways to actively engage students during class and these devices are viewed as a viable tool.

Purpose of the study

First, I would like to look further into the effects of using SRS on student participation in the classroom with the following question: Are more students engaged during the class using SRS compared to a class where it is not being used? I believe if students are engaged, then their test scores will increase. The second part of the study has the following question: Does using SRS not only engage my students but increase test scores as well? It will be important to investigate if there is a benefit of using this tool.

The high school students I teach during the school year will be part of the study. I will have a clicker group with one Algebra II class and one Geometry class. The non-clicker group will be one Algebra II class and one Geometry class. The study will involve a chapter worth of instruction, 3 weeks in length. I will conduct class with the non-clicker group as I normally would, where students raise their hand to answer questions. With a traditional lecture it is hard to immediately determine if students understand the material, and I am often left observing their body language. Many times the same few students answer the questions or ask questions in class. The clicker group will use the SRS for answering warm-up questions, homework check, and/or reviewing lecture material. For example, checking for understanding on the homework will involve a few questions that students answer with the clickers during class. The results will

be anonymously displayed on the smartboard for the entire class. I will be able to immediately get feedback and analyze the results on whether students understand the material and adjust my lecture accordingly. The adjustment may be that I need to go over the material from the day before for better understanding. The results will be saved for a complete analysis later. Also, I will be making observations during class, using student surveys and interviews, and comparing quiz/test results between the clicker and non-clicker groups. The information that is gathered through my journal will be evaluated as well.

Summary

Educators understand that different students require different kinds of teaching. Milner (2006) reported that "handheld formative assessment technology provides teachers with a virtually real-time picture on which students need help, where they need it, and how the teachers can help best" (p. 2). This real-time information becomes a valuable tool in the learning process and may be able to motivate students to get to the next level. Coons (1999) pointed out "this approach helps students develop a sense of responsibility for their own learning" (p. 145). The SRS can be a tool used in student participation and achievement. I want to learn if using SRS makes a difference in my students" learning. Will the time and energy that I put into developing curriculum around using SRS not only engage my students but also increase test scores? I am not only doing this study for myself, but to share my finding with my colleagues. If the results of my study show that using SRS does increase student learning, then SRS may be useful across the entire high school curriculum. Conversely, if the results show no increase in learning, then this study could save our district thousands of dollars, and resources could be allocated elsewhere.

Chapter 2

Review of the Literature

Educators are interested in improving their instruction through better communication. Technology has offered many opportunities to increase communication. The National Council of Teaching of Mathematics (NCTM) has published a report linking research and practices. The report addresses research questions and one being technology and communication in the classroom. NCTM (2008) stated "technology includes any electronic tool that promotes a dynamic and interactive mathematics learning environment, which in turn allows students and teachers to engage in calculating, representing, creating, exploring, collaborating, and communicating mathematical ideas" (p.23). Research into using Student Response System (SRS) technology or clickers in the classroom as a communication tool has been limited for the secondary level. There is more research at the university level in large lecture settings. Clickers are a set of wireless electronic devices; it includes a student handheld responder, a receiver, and software. Students answer questions by pushing buttons on the responder. The answers are recorded on the teacher"s computer for feedback. The feedback can be anonymous and projected for the class to view. The studies that have been conducted have examined four categories. The literature about the use of SRS in a high school mathematics classroom will be reviewed first. The second is the use of SRS technology and active learning. Active learning is the work that goes on to acquire knowledge or a skill. The third is the use of SRS involving student and teacher reaction. Observations students and teachers experience when using the clickers is important to examine. The fourth is the use of SRS and student academic test results.

Use of SRS in a Mathematics Classroom

There is limited research regarding the use of SRS in a high school mathematics classroom. In the first study, Kwan (2009) reported "that students are more motivated when they have direct involvement in their own learning and evaluation process…Due to the feedback feature of CRS [SRS], students can immediately see the outcome of their effort" (p. 15). This action research project included students in four regular Algebra II classes in an inner city high school, averaging 33 students per class over a six week period. To supplement the lessons, SRS technology was used at the end of lecture during the individual/ group practice session and the question and answer session. The data consisted of observations, questionnaires, and student interviews. It was found that anonymity encouraged participation, but that after a few weeks, participation declined because the novelty factor wore off. It gives the students the opportunity to learn from their mistakes instantly by seeing the results and comparing answers. The anonymity feature can protect students from embarrassment of choosing the wrong answer. Kwan also concluded that math concepts were reinforced when the clickers were used right after the lecture. Kwan did find some interesting information regarding using SRS. Kwan stated that overall achievement increased an average of 59.6% from the pre-tests to the post-tests. Kwan did conclude from his data that using technology may have improved student comprehension, teacher awareness of students struggling, and the appropriate pace of the course content. A limitation to his findings is that the material on the test was being taught through regular lecture and this would account for the large percentage increase in test scores (from pre-test to post-test), while the actual effect of the SRS on student learning was not examined.

The second study done in a high school looked at technology-enhanced algebra instruction. Souter (n.d.) studied 92 ninth-grade students in five algebra classes. This is an

exclusively ninth grade school. A comparison was made between traditional algebra instruction and the use of a variety of technologies. The technologies that were incorporated into classrooms included; graphing calculators, powerpoint presentations, algebra labs for computerized instruction, and online activities. The data was collected through student and teacher surveys, participation checklists, observations, interviews, and tests. The surveys by the students reported a positive attitude towards technology. The students claimed to be motivated to learn algebra, the classes where fun, and there was a desire to succeed and have good grades. The pretest and posttest results confirmed student comments on having good grades. Souter discovered that the "technology-enhanced classes reported more of a gain (6.6%) in correct answers from the pretest to the posttest" (p.4). Based on Souter's finding, she recommended that her school increase the integration of technology into the Algebra classes. The limitation of this study for my research is that the SRS technology was not integrated into the classroom. Research investigating SRS technology in a secondary math class is limited and needs to be addressed.

Use of SRS Technology and Active Learning

By increasing the participation level, students are actively engaged in the lecture, thus resulting in active learning. Adams and Howard (2009) reported that SRS can facilitate change in behavior of students and the instructor and therefore enhance the teaching and learning. Also, the system can provide valuable feedback to both the instructor and the students. The SRS enables a continuous exchange of information between the teacher and student allowing for active participation in the learning process.

Edens (2008) did research on the teaching approach, gender, self-regulation, and goal orientation using SRS technology. The study was conducted with 120 participants in two

undergraduate Introductory Psychology classes. The focus on comparing instructional approaches (operant conditioning versus metacognitive) with using SRS technology found no difference in terms of student achievement. This is interesting because Edens expected that the metacognitive process (self-monitoring and self-assessment) using SRS would have higher achievement. It was found that the effectiveness of SRS based on student characteristics, like gender, self-regulation, and goal orientation does play a role in achievement. Males with low self-regulation outperformed highly self-regulated students on grades while using the SRS in a lecture setting. The last finding was that student outcomes such as the level of anxiety and attendance, was influenced by using SRS both in a positive and negative way. Edens concludes, given the push for individual accountability, more research on SRS needs to be done. Also, the instructor‟s goal plays an important role in the results that SRS technology has on active student learning.

Wood (2004) found the give-and-take atmosphere that can be produced by using clickers increased student active engagement during class. It was discovered in his class that when students responded with a variety of answers, he would let them convince each other as to the correct answer. Woods describes an example in a biology class with 75 college students and how he learned from them as much as they learned from him when he first used the clickers. The advantages he listed include answering anonymously, evaluating students understanding, students paying attention, and it is immediate, real-time. The effectiveness of clickers relies on how the instructor uses them. These are all observations by Woods and he concluded that it is a lot more fun to teach with clickers.

An interesting survey done by Tress and Jackson (2007) of 1700 undergraduates enrolled in 7 large clicker courses. The class size was 200 students or more. Trees and Jackson found

that the students reported a positive perception of using clickers such as the value of feedback, and students were involved and engaged. They concluded that clickers are a tool that may facilitate active student engagement, but that they do not ensure it. Student expectations of a large lecture class and how the instructor utilizes the tool play an important role in the active learning. The limitations to the study included that the survey was given at the end of the semester and continued assessment data was not available. Also, the open ended questions at the end of the survey suggested that there is a need to refine the survey instrument.

To combat a passive learning environment of a lecture and promote active learning, the use of SRS technology is recommended by Osterman (2007). The use of SRS technology was examined in library instruction to provide a greater level of active participation by students. It was concluded that SRS helps to maintain the students‟ concentration and interest by breaking the lecture into segments. The drawback may be that less material can be covered because of the time taken up by using SRS and technology problems may distract instructors from their teaching.

Use of SRS Technology and Student/Teacher Reaction

According to Kenwright (2009), the use of clickers in the classroom is a good way to find out what the students‟ existing knowledge is before the lecture. It is a way to introduce the topic of the lecture. It is also used to find out immediately the students‟ understanding of the topic being taught. Kenwright also found that it gives all students an opportunity to answer questions and participate. There does need to be a balance between using the clickers and introducing the new material. Kenwright recommended that if used for math problems, don‟t just show the answers; you need to follow up on providing how to solve the problem for the learning process to take place.

Interesting research was done by Kaleta and Joosten (2007) on the use of clickers in four University of Wisconsin campuses. A survey on the perceptions and attitudes regarding clickers was evaluated as was the impact of using clickers on retention and grades. There were 27 instructors and 2,684 students who responded. The survey consisted of 68-items on a five-point Likert scale. Kaleta and Joosten (2007) found "that both faculty and students liked using clickers and perceived the clickers as having a strong impact upon class engagement and learning" (p.4). Student participation and interaction were reported higher by both students and instructors. Instructors stated that clickers were used mainly to stimulate discussion. Instructors appreciated the immediate feedback feature and agreed that student learning was improved using clickers. The data regarding student grades showed a significant difference in the classes. There was a 2.23% increase in students obtaining a C or better from the fall of 2004 to the fall of 2005. The use of clickers, as reported by the students was that they were fun to use. The instructors and students reported that they would recommend the use of clickers.

Hall and Swart (2007) conducted an opinion survey of 212 students in upper level college courses. The survey included 90 students who used clickers and 122 that did not use clickers. The survey addressed their participation and perceptions of technology used in the classroom. Along with the survey, academic performance was measured by test scores in one of the classes for three semesters. Hall and Swart discovered that the students indicated significantly more positive affective responses with using the SRS technology because of active learning. This technology allowed active participation in the learning process reported by students showing support for the technology. The focus on questions during lectures using SRS technology resulted in higher exam scores than when the technology was not used. Hall and Swart reported when every student responded and could compare their response to the overall class response,

that this enriched the learning environment.

A study conducted by Stowell, Oldham, and Bennett (2010) looked at using SRS technology to combat conformity and shyness. Shyness can contribute to a student‟s lack of classroom participation. They compared hand-raising and clicker responses to 50 controversial questions and the experiment was videotaped for later analysis. Also, the students completed a mood and emotion survey. There were 128 Introductory Psychology students that took part in the study. Stowell, Oldham, and Bennett found that clicker responses produced a greater variability in the group than hand-raising. This suggested that the students were less likely to conform to the group‟s opinion, revealing a greater diversity of students‟ opinions. Also, it was found that shy students felt more uncomfortable raising their hands and preferred using clickers. A limitation is that the 50 controversial questions asked is not representative of a regular classroom.

Lantz (2010) looked into ways in which clickers help students understand and organize material that is being taught in class. Students‟ reaction to the use of clickers was that they were useful. Lantz discovered that students found that clickers made class more interactive, they could gauge their understanding of material with their classmates, and felt more involved. Students have to pay attention to what is going on in class. Students mentioned technical problems as to why they disliked using clickers. The anonymity of the clickers versus raising their hand to answer questions was preferred by the students.

Martyn (2007) stated that most SRS research “targeted their affective benefits, which include greater student engagement, increased student interest, and heightened discussion and interactivity” (p. 72). Her study compared student perceptions about active learning with clickers or class discussion. A small Midwestern liberal arts college was used in the study. The

study included four sections of an Introductory Computer Information Systems class with 92 students. The participants took a seven-question survey on their perception of using clickers or class discussion. No statistically significant differences occurred. Martyn concluded that the teaching instruction was more important than the benefits of using clickers.

In a study that surveyed 498 elementary and secondary educators by Penuel, Boscardin, Masyn, and Crawford (2006), the focus was on the instructors. The questions addressed three topics: first, the educators‟ goals regarding the use of clickers; second, the instructional strategies they used when using clickers; and third, the educators‟ observations when using the clickers. A major limitation is that all the participants surveyed used the same company‟s technology and received a $10 gift certificate for responding. The educators reported having goals in using the SRS to improve learning and instruction. The instructional strategies covered many topics such as gauging student understanding, discussion generator, and adjusting lectures. The educators‟ observations when using clickers were all positive. Penuel et al compared K-12 to higher education and concluded that the teaching practices using SRS technology are the same for higher education as it is at the K-12 level. It was pointed out by Premkumar and Coupal (2008) that this technology is only a teaching and learning tool. Pedagogy has to take place first and this technology second for learning to be enhanced.

Use of SRS Technology and Students' Academic Test Results

The use of SRS is an important activity in students‟ self-monitoring or self-assessing of their learning. As for the research on the use of SRS on direct academic performance, there has been mixed results. Students performed significantly better on exam questions in the clicker lecture compared to a lecture that did not use clickers according to Shaffer and Collura (2009). An Introductory to Psychology course involving 177 college students was studied. Three of four

sections used clickers and they were used for a one hour lecture. They found that in the three sections using clickers, participation increased. When the responses to the questions from the one hour lecture were compared, the clicker classes showed significantly more questions correct. The clickers were used to engage students in discussion only. The conclusion was the use of clickers not only increased participation, but resulted in a higher percentage of correct answers.

Another study on achievement, Edmonds & Edmonds (2008) investigated whether an increase in student exam scores was related to the use of SRS technology. The study was conducted in an urban university using six Introductory Managerial Accounting courses. A control group (three courses) was compared to an experimental group (three courses). It was found that the SRS courses averaged 3.15 percentage points higher than the non-SRS courses. It is interesting to note that the courses using SRS helped low-GPA students without a negative effect on high-GPA students. Edmonds & Edmonds were not able to find negative effects of using SRS on student exam performance. A limitation is that student attendance was not able to be controlled and this could be a factor in the increased exam scores. Stowell & Nelson (2007) compared clickers to hand-raising and response card methods for student feedback in college psychology classes involving 140 undergraduates. It was discovered the highest participation came from the clicker group, but that there was not a significant difference on quiz scores, therefore not affecting academic performance.

Summary

After reviewing the literature, most of the research was positive for both the student and teacher in the utilization of SRS in the classroom. The use of SRS in the classroom improving participation was a central theme throughout the research. The use of SRS does promote active learning. Teachers and students liked the immediate feedback feature and students especially

liked the anonymity that the SRS provided. The actual effect on student academic scores is still in question and more research needs to be done. Also, much of the research is done at the higher levels with large lectures, and not at the K-12 level involving smaller classroom sizes. Much more research needs to be done regarding the effect of SRS in the classroom at the secondary level. With the cost of this technology decreasing and the student generation immersed in technology, this would be important research to investigate.

Chapter 3

Project Description

Students today are of the technology generation, which is fast paced. For students to become engaged, teachers may need to implement technology into the classroom. The technology known as a Student Response System (SRS), or clicker, is a tool that I studied in my math classroom. It gives real-time information to the teacher and/or the class to evaluate. The SRS are a set of wireless electronic devices that includes a student handheld responder. The students provide answers to questions by pressing buttons corresponding to their answers. This technology can be anonymous and may increase student participation in class and improve student learning. I wanted to learn if using clickers in my math class makes a difference in my students‟ learning, by comparing a non-clicker classroom to a clicker classroom. I want to find out if the use of clickers promotes student engagement and thus participation, and if test scores will increase. I did this by observing student participation, surveying and interviewing students, comparing student quiz/test results between the classrooms, and keeping a personal journal. The study provided information that was used to answer the following questions: Are more students engaged during the class using SRS compared to a class where it is not being used? Does using SRS not only engage my students but also increase their test scores? This study produced findings regarding the use of SRS in the classroom that I can share with my administration and colleagues.

Participants

This study was done in the fall of 2010 at Milton High School. This is a public high school in South Central Wisconsin that has about 1019 students. The study took place in my classroom with Geometry and Algebra II students that I was teaching. The Geometry course is

required for graduation, while the Algebra II course is an elective. Students in the Geometry classes may be more diverse since they are required to take it, where the Algebra II students have chosen the class – primarily to get into college. I had a clicker class and a non-clicker class for each course. Each class had approximately 25 students. I taught the non-clicker classes first so that I would not jeopardize the lectures in those classes. In the clicker classes, I received immediate feedback and I was able to adjust lecture accordingly. I chose to hold classes back from using the clickers for one chapter only.

Procedural Description

I kept a checklist of my observations on participation in each of the classes. This checklist was done daily with comments regarding student participation. I conducted a written survey and an interview of my students regarding math in general and the use of technology in a classroom. The survey was given at the end of the study to evaluate the use of this technology in the classroom and participation in the math class. Also, the study included evaluating quiz/test scores for the Geometry and Algebra II students. The same quizzes/test was given in the same course and results where compared. A personal journal was created during this study for additional data.

The topic for my Geometry students was a chapter on right triangles and trigonometry. My Algebra II students studied a chapter on rational exponents and radical functions. I started all my classes with 3 to 5 warm-up questions. Each group was allowed to answer the same questions. The non-clicker group recorded answers on paper and we discussed the answers in class. The clicker group recorded answers with the clickers and the results displayed anonymously on the smartboard for class discussion. I did collect the answers to the questions from both groups, one group electronically and the other groups paper work. The same

information was given in each course during the lecture. All classes had students raise their hand to ask questions. To answer my questions, the clicker class used the clickers while the non-clicker class raised their hands. All quizzes and the test were done on paper and graded the same. Whenever possible, the clickers were used in the clicker group. For example, during homework check, I had the clicker class record answers using the clickers while the non-clicker classes raise their hands.

Analysis

The participation was evaluated based on my observations. I created a checklist for each class to determine the number of students participating. I observed during class each student and placed a check on who was participating in class and to what degree. The checklist was set up with four categories. First - student has participated in class by asking question or appropriate comment. Second - student has been engaged the entire class by observing body language. Third - student body language engagement observed only half of the class. Fourth - student has not paid attention or been engaged at all during class. I compared the numbers in the column with the different classes to determine participation (Observation of Participation Checklist, see Appendix A).

A survey (Perception of using Student Response System, see Appendix B) was given to each student in the clicker classes at the end of the unit to be evaluated. I interview 10 students on their thoughts regarding the use of the clickers for a greater insight (Interview Questions Worksheet, see Appendix C). The questions dealt with student self-evaluation of their effort in the class and with the use of technology. This allowed me to determine if the use of clickers attributed to an increase in engagement and in turn, improved student learning. I examined the data collected for trends or patterns that may emerge. I looked for differences, similarities,

relationships, and unexpected trends. My personal journal was analyzed for themes that may emerge as a result of this study.

The academic achievement results were evaluated by the quizzes and test. The scores were used to compare the non-clicker classes to the clicker classes. The study for the Geometry classes on right triangles and trigonometry covered seven sections. A quiz was given covering every two/three sections for a total of three quizzes. A cumulative test was given at the end of the chapter. The same quizzes and test was given to both Geometry classes. The Algebra II classes covered a rational exponents and radical functions that included six sections. The sections were divided up and three quizzes will be given. Also, the same cumulative test was given at the end of the chapter to both classes. The quizzes and tests allowed for a comparison of the academic scores in a clicker classroom and a non-clicker classroom.

Summary

The implementation of SRS technology into the classroom is important. The results on whether participation and academic scores are influenced by the use of clickers will be shared with the school district. Teachers are always looking for ways to engage students and share ideas. This study could have an impact on the use of clickers in a high school classroom. With limited research at the high school level, this is an important area to investigate.

Chapter 4

Results

The data collected is informative and thought provoking. The information is being used to find out if more students are engaged during the class using clickers compared to a class where they were not used. Also, the data was examined on whether or not the use of clickers increased student test scores. The different ways that the data was collected offers a variety of insight into using clickers.

Observing Student Participation

The observation of participation checklist provided me the opportunity to reflect on what was happening in the classroom on a daily basis. The data was collected daily and tallied into a percentage. The process involved each student receiving a score for a single day in regards to participation. A daily tally was made for each score (record for how many 4"s were given, 3"s given, 2"s given, 1"s given) and a percent was calculated for the 15 days of participation (see results in table 1).

The following score was given in each category for participation:

4 - Student has participated in class by asking question or appropriate comment.

3 - Student has been engaged the entire class by observing body language.

2 - Student body language engagement observed only half of the class.

1- Student has not paid attention or been engaged at all during class.

Table 1: Observation of Participation Checklist
The following data represents the percent of students for the observation period of 15 days.

	Non-clicker Algebra II	Clicker Algebra II	Non-clicker Geometry	Clicker Geometry
Asking questions or appropriate comment.	22%	21%	21%	40%
Engaged entire class period by observing body language.	52%	57%	50%	45%
Engaged only half of the class period observing body language.	16%	15%	10%	10%
Has not paid attention or been engaged at all during the class period.	4%	4%	12%	0%
Absent	6%	3%	7%	5%

The observation of student participation during the Algebra II classes was not found to have a great difference between the non-clicker class and clicker class (the second and third columns in the table 1). I believe this may be due to the fact that this is an elective class, students choose this class because they want to go to college and it is required for admissions. These students are usually juniors and seniors and realize the importance of the class and learning the material, therefore their observed participation was similar.

The observation of the students participating during the Geometry classes did have a higher percent when comparing the non-clicker class to the clicker class (the fourth and fifth columns in table 1). There was a greater percent (12%) of students who did not pay attention or were engaged at all during the class period in the non-clicker class. This is a required class to graduate the course has a diverse set of students. Some of these students are not interested in math and they would not try the warm-up question, even after being asked to participate. Therefore, using the clickers may have provided an incentive to participate.

I discovered when using the clickers that everyone would sign into the computer system. Also, each class would answer the 3-5 warm-up questions and I found everyone engaged from the start of class. During the lecture, incorporating a couple of clicker questions as a concept check helped keep the students‟ attention. They needed to pay attention so that they could answer the questions. The clickers encouraged students to participate because it would show the number of students who had not answered and the students urged each other to answer. It was like a game they were playing with each other to get the correct answer. Then if someone got an incorrect answer there would be discussion on how they got that answer. The data showed 19% (see table 1) more students in the Geometry clicker class would be asking questions and making comments. The non-clicker class needed to answer the same questions on paper, but I was not able to see if everyone answered the questions or if they were correct immediately. I would still go over the answers, but observed a much quieter class without the big discussions.

Student Survey and Interviews

The students in the clicker classes took a survey regarding their perception of using clickers in class at the end of the study. The results for the Algebra II and Geometry were similar for many of the statements (see Appendix D for complete results). The students would use a 5 point scale from strongly agree to strongly disagree for 32 statements. It was interesting to note that for the Algebra II class, 22 out of 26 students have not only heard about clickers, but have used them before. In the Geometry class about half of the 24 students had heard about clickers and used them. Again, the juniors and seniors may have used them in other classes and used that experience to address the statements.

The Algebra II students‟ perception of using clickers was positive (see table D1). When answering the statement „clickers helped me to participate in class,‟ 62% agreed and strongly

agreed; and „using clickers helped me to pay attention in class," 69% agreed and strongly agreed showing that using clickers helped students to be engaged during class. Both statements received zeros for disagreeing or strongly disagreeing. Also, 77% agreed and strongly agreed to the statement, „prefer using clickers more than listening to lectures only", again reinforces the students" perception of being engaged during class. A big part of engaging students in class is having the lecture interesting and 92% agreed and strongly agreed that „using clickers made lecture more interesting". As for the statement „using clickers helped me get a better grade in this class compared to not using clickers," only 16% agreed and strongly agreed with 61% being neutral. The students were not sure if using clickers increased their grade.

The Geometry students" perception was positive (see table D2). The Geometry students" perception from statements like „clickers helped me to participate in class" and „using clickers helped me to pay attention in class" were 67% and 71% respectively agreeing and strongly agreeing. The Geometry students felt strongly about how they could see their answers quickly, comparing their answer with other students, and seeing how many other students got correct answers, with each being around 80% agreed and strongly agreed. They like the competition effect of the clickers. As for „using clickers helped me get a better grade in this class compared to not using clickers," only 21% agreed and strongly agreed while 54% were neutral. This is similar to the Algebra II class.

The results from the survey were overall positive with very few disagreeing or strongly disagreeing with the statements regarding the use of clickers. When asked „I would recommend using clickers again in this class," both Algebra II (88%) and Geometry (84%) classes agreed and strongly agreed with the statement. There were even 5 students who starred the strongly agree choice. This would show that students like the engagement that the clickers brings to the class.

The interviews that were conducted involved 5 students from each clicker class. There was a theme throughout the interviews and they liked using clickers because the clickers helped them pay more attention in class. It gave them something to do during the lecture so they paid attention and in return understood the concepts. They liked being anonymous because they did not want everyone knowing if they got the answer right or wrong. But on the other hand, they did like to compare their answers to other students anonymously. The immediate feedback helped them figure out what they did wrong and they could ask questions right away or they got the right answer and felt good because they understood the material. All the students were positive about using the clickers and wanted to keep using them in class.

Quiz/Test Results

I wanted to find out if the use of clickers not only engaged my students but would increase their test scores. The following tables include the results from the three quizzes and chapter test given. The results are inconclusive with the use of clickers and test scores. Table 2: Algebra II Class –Non-Clicker Class Quiz and Test Results.

Table shows percent who received that grade based on 23 students.

Grade	Quiz 1	Quiz 2	Quiz 3	Chapter Test	Average for Chapter
A	13%	26%	65%	47%	37.75%
B	26%	35%	13%	22%	24%
C	26%	13%	0%	18%	14.25%
D	26%	4%	18%	4%	13%
F	9%	22%	4%	9%	11%

Note: A=100%-90%, B=89.9%-80%, C=79.9%-70%, D=69.9%-60%, F= below 59.9%

Table 3: Algebra II Class –Clicker Class Quiz and Test Results.

Table shows percent who received that grade based on 26 students.

Grade	Quiz 1	Quiz 2	Quiz 3	Chapter Test	Average for Chapter
A	8%	15%	38%	27%	22%
B	38%	35%	23%	38%	33.5%
C	8%	27%	19%	4%	14.5%
D	27%	8%	12%	23%	17.5%
F	19%	15%	8%	8%	12.5%

Note: A=100%-90%, B=89.9%-80%, C=79.9%-70%, D=69.9%-60%, F= below 59.9%

The Algebra II non-clicker class and clicker class shows that the non-clicker class has more A‟s by over 15%. The clicker class has more B‟s with 9.5 % over the non-clicker class on average for the chapter. There are many factors that could play into these figures, such as the academic level of the students and students who have quiz and test anxiety. According to these results the clickers did not make a difference on student academic performance in the Algebra II classes.

Table 4: Geometry Class –Non-Clicker Class Quiz and Test Results.
Table shows percent who received that grade based on 24 students.

Grade	Quiz 1	Quiz 2	Quiz 3	Chapter Test	Average for Chapter
A	75%	29%	33%	38%	43.75%
B	17%	13%	17%	29%	19%
C	0%	0%	12.5%	12.5%	6.25%
D	4%	17%	12.5%	8%	10.375%
F	4%	41%	25%	12.5%	20.625%

Note: A=100%-90%, B=89.9%-80%, C=79.9%-70%, D=69.9%-60%, F= below 59.9%

Table 5: Geometry Class –Clicker Class Quiz and Test Results.
Table shows percent who received that grade based on 24 students.

Grade	Quiz 1	Quiz 2	Quiz 3	Chapter Test	Average for Chapter
A	42%	21%	59%	50%	43%
B	29%	17%	21%	29%	24%
C	21%	8%	8%	13%	12.50%
D	0%	33%	4%	4%	10.25%
F	8%	21%	8%	4%	10.25%

Note: A=100%-90%, B=89.9%-80%, C=79.9%-70%, D=69.9%-60%, F= below 59.9%

The Geometry classes did not have a difference between the A‟s for quiz and test average scores. The clicker class did have 5% more B‟s, and had 7% more students earn C‟s with 11 % fewer students failing for the chapter average. The clickers here might have helped the lower achieving student, but again many factors play into these results. Overall, the Geometry class did see a difference in test scores when comparing the clickers to the non-clicker classes for the B, C, and F grades. This is an area that could be investigated further. There are many factors that can affect quiz and test scores. The use of clickers to engage students and increase test scores may be beneficial for the average student.

Personal Journal

My personal journal showed many positive comments in using the clickers along with some frustrations. Everyone was excited about using the clickers and eager to log into the system. I found that the students liked a variety of questions. I would ask a few homework questions as part of the warm-up. This not only encouraged doing homework, but engaged students throughout the class period. I would ask multiple choice questions as well as true/false questions and have students type in their answer. I felt sometimes with the multiple choice questions students were just guessing and this was frustrating. When students had to type in their own answer they needed to be exactly as I typed them in to be correct. For example, the answer is 1,500 and if a student typed in 1500 it would say incorrect. The students were good about it accepting this downfall of the system. I found keeping it light and fun while using the clickers was important. Students were always concerned if I was going to use their answers for a grade. I never did, but other teachers in my school do use them for quiz or test grades. Keeping it a game atmosphere allowed competition without the stress of a grade and I believe this kept all students engaged the majority of the class period. It also opened up discussion on how someone might have gotten the wrong answer and not only what the correct answer was, but why. The dialogue it promoted each day was a great advantage.

The frustration came from when technology did not want to cooperate. My computer went down on two occasions and it took a little time to bring everything back up. Also, incorporating the clickers and questions into the lesson took time away from working on homework in class. I found it averaged about 12 minutes a class period. I like students to start homework in class so that I can answer any questions they may have. Using clickers did not allow for much homework time. The non-clicker classes did get more homework time because

there was not as much discussion for the same problems that the clicker classes had. It was interesting to note the difference in classes and engagement. The non-clicker class would quietly do the problems and then I would go over the answers without much discussion, therefore allowing more time for homework.

I noted that the advantage of using the clickers allowed all students to respond to questions and they could respond anonymously. The instant feedback allowed me to know whether or not my students comprehended the material and exactly who needed extra help. I noted that the students were more alert in class because of the instant feedback they received. A disadvantage was the amount of time the clickers took up in class. Also, it took more time to develop curriculum using the clickers and to design appropriate questions.

Another theme throughout my journal was that students were learning from their mistakes because of the instant feedback on what the correct answer was. This would occur through discussion and students or myself showing how to do the problem correctly on the smartboard. When I required students to work with a partner to solve a math problem and submit the same answer the classroom became intense at times. It allowed the students to learn to collaborate, work as a team to come to a joint solution. This can be a difficult skill to learn and I noted in my journal the positive aspects of this. Again, this promoted discussion not only in the small groups, but in the large group after the results were shown. It engaged students to think about their answer and what they did right or wrong in solving the problem. I believe the students did participate in class more by using clickers. I also noted that the instant feedback and discussions that developed in class were good gauges on my effectiveness in teaching the concepts. It was a good learning tool for me when I listened to the discussion and could

understand why my students were getting the wrong answer. I was able to make notes and reflect on my own teaching in a new way with the help of clickers.

Chapter 5

Conclusions

It is important that teachers engage students in the learning experience and technology is one way to accomplish this. Students today are of the technology generation and require instant feedback on what they are doing. My high school math class is no exception. This new technology would bridge the gap between a traditional math class and students‟ interest in the use of clickers. It is important to engage students through what interests them and the clicker technology does just that.

The research involving the use of clickers is limited in a secondary school math class. Much of the research is done at the university level in large lecture halls. It has been found that the use of clickers in the classroom was positive for students and teachers. The central theme throughout the research was that using clickers promoted active learning and participation in the classroom. The increase of participation in the classroom was addressed using data from various sources. There is still a question on whether the use of clickers affects student test scores. Because of the limited research done with the use of clickers at the secondary level, this study is important.

Discussion of Results

I found it interesting how well the use of clickers was received. Students were excited about using clickers daily. This tool did provide for better class participation. All the students in the clicker classes would log into the system and provide answers. The class would monitor themselves by making sure the correct number of students logged in and that everyone answered the questions. It was interesting to discover how using the clickers promoted discussion among the students. They not only wanted the entire class to get 100%, but would discuss why someone

selected or put in a wrong answer. This created a new learning environment. Students were learning from other students‟ mistakes. The students were anonymous, so no one knew who answered what. I could always find out who was struggling and help the student during homework time. This technology was like a game to my students and they wanted to do their best. The immediate feedback on how they did individually and as a class was at times intense. When working with a partner to solve a math problem there was a lot of discussion and at times disagreements. This tool proved to be a great way for students to learn to work together. I did discover through this study that using clickers did increase my students‟ engagement in class.

The effect that clickers had on improving test scores is still in question. The results that I obtained did not suggest that clickers had any effect on scores. The scores were very close when I compared clicker to non-clicker classes. I believe there were too many factors that affect test scores to make a sound conclusion. I do feel that the average Geometry student may have had greater success and impact on their test scores when using clickers. Overall, from my study I was not able to determine whether or not clickers had an impact on test scores. Therefore, further studies need to be done in this area.

I did not anticipate the amount of time that clickers would take during class. When you allow students to answer the question, everyone was getting done at different times. This did cause down time for some students as they waited for classmates to answer. Also, the total amount of time added to the lecture averaged 12 minutes. When you only have a 50 minute class period, time is taken away from class work. The students did not seem to mind the extra time and the use of clickers may have helped in their understanding of the material. This is where I would like to see more research done. Do students understand the material better using clickers or just traditional lecture?

Recommendations

The use of clickers in the classroom should be used in a supportive role. They do encourage participation as long as the teacher is promoting it. If clickers are only being used for taking quizzes and not promoting discussion, the participation will not occur. Thus true engagement in the learning process is not occurring. The teacher needs to take the time to develop curriculum around the use of clickers that promotes engagement and offers thought provoking questions. Also, the teacher needs to take advantage of the instant feedback it offers and have students learn from their mistakes. Incorporating a variety of questions, such as multiple choice, true/false, and open ended allows students to keep engaged. Otherwise, this technology becomes boring and students lose interest in class. The use of clickers does allow for a break in the routine in a straight lecture and engages students.

Before using clickers a teacher needs to reflect on what the objective is for using them in the classroom. If it is to engage students, this study supported clickers for this use. It does depend on the teacher pedagogy and the effective use of clickers by the teacher. Clickers do engage students and the study found overwhelming positive responses in using them.

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Appendix A Observation of Participation Checklist Class Hour ________

The Interaction of Student Response Systems in a High School Mathematics Class

4 - asking questions or appropriate comment
3 - engaged entire class period by observing body language
2 - engaged only half of the class period observing body language
1 - has not paid attention or been engaged at all during the class period
0 - absent

Students Name	Day 1	Day 2	Day 3	Day 4	Day 5	Comments

Appendix B

Perception of using Student Response Systems (clickers)

Had you heard of clickers before this class?	YES	NO
Had you used clickers before this class?	YES	NO

Please respond to each statement by circling one of the following:

SA – Strongly Agree A – Agree N – Neutral D – Disagree SD – Strongly Disagree

I like math.	SAANDSD
Math is important to me.	SAANDSD
I often raise my hand to ask math questions.	SAANDSD
I am likely to answer questions during traditional lecture.	SAANDSD
Clickers helped me to participate in class.	SAANDSD
Using clickers helped me to pay attention in class.	SAANDSD
Clickers helped me get instant feedback on my answers.	SAANDSD
Clickers have been beneficial to my learning.	SAANDSD
Using clickers helped me get a better grade in this class compared to not using clickers.	SA ANDSD
I learn more using clickers than not using clickers.	SAANDSD
I study and prepare more when we use clickers in class.	SAANDSD
I prefer using clickers more than listening to lectures only.	SAANDSD
I prefer to be anonymous in classes.	SAANDSD
I like to quickly see if my answer is right or wrong.	SAANDSD
With clickers, I like to see how many other students got the correct answer.	SAANDSD
With clickers, I like to compare my answer with other students.	SAANDSD
I did not mind using clickers because no one can see my answers.	SAANDSD
Getting feedback on my ideas helps me learn better.	SAANDSD
Participation with clickers improved my understanding of the math topic.	SAANDSD
Participation with clickers increased my feelings of belonging in this class.	SAANDSD
Participation with clickers increased my interaction with the teacher.	SAANDSD
Participation with clickers increased my interaction with other students.	SAANDSD
I am more likely to answer questions using clickers.	SAANDSD
Clickers were helpful in understanding the material.	SAANDSD
Using clickers produced more overall interaction in the classroom.	SAANDSD
Using clickers made lecture more interesting.	SAANDSD
Using clickers enhanced the clarity of examples.	SAANDSD
I enjoyed participating in class with the clickers.	SAANDSD
Using clickers provided a smoother transition to the answers.	SAANDSD
Clickers were fun to use in class.	SAANDSD
I would like to use clickers in all my other classes.	SAANDSD
I would recommend using clickers again in this class.	SA ANDSD

Note the above statements compiled from the following resources:

Kwan, R.W. *(2009, April). Using a classroom response system to improve student achievement in a high school mathematics class. Retrieved from* http://www.sierranevada.edu/UserFiles/File/MAT_THESES_09/spring/Raymond%20W.%20Kwan.pdf

Penuel, W.R., Boscardin, C.K., Masyn, K, & Crawford, V. (2007). Teaching with student response systems in elementary and secondary education settings: A Survey Study. *Education Tech Research Development, 55*, 315-346.

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Appendix C

Interview Questions Worksheet

Questions	Student reply
1. Do you like using clickers in class?	
2. Why or why not?	
3. Do clickers help you learn?	
4. Why or why not?	
5. Do you like that the answers are anonymous?	
6. Explain?	
7. Do you like to get feedback on your answers?	
8. Explain?	
9. Do you like the immediate feedback that the clickers offered?	
10. Explain?	
11. Do you like that you can compare your answer to others?	
12. Explain?	
13. What is your overall grade for using clickers in the classroom?	
14. Comments?	

Note the above questions compiled from the following resource:

Kwan, R.W. *(2009, April). Using a classroom response system to improve student achievement in a high school mathematics class. Retrieved from* http://www.sierranevada.edu/UserFiles/File/MAT_THESES_09/spring/Raymond%20W.%20Kwan.pdf

Appendix D

Table 1 Algebra II Clicker Class Survey - 26 total students surveyed
Results from Perception of using Student Response Systems (clickers)

Had you heard of clickers before this class? YES – 22 students NO – 4 students
Had you used clickers before this class? YES – 22 students NO – 4 students

The following table is the percentage of students who:
SA – Strongly Agree A – Agree N – Neutral D – Disagree SD – Strongly Disagree

Statement	SA	A	N	D	SD
I like math.	27	38	15	12	8
Math is important to me.	23	46	27	4	0
I often raise my hand to ask math questions.	8	19	31	27	15
I am likely to answer questions during traditional lecture.	8	12	45	27	8
Clickers helped me to participate in class.	24	38	38	0	0
Using clickers helped me to pay attention in class.	31	38	31	0	0
Clickers helped me get instant feedback on my answers.	38	43	19	0	0
Clickers have been beneficial to my learning.	15	54	27	4	0
Using clickers helped me get a better grade in this class compared to not using clickers.	12	4	61	19	4
I learn more using clickers than not using clickers.	12	27	34	23	4
I study and prepare more when we use clickers in class.	12	15	50	19	4
I prefer using clickers more than listening to lectures only.	27	50	7	8	8
I prefer to be anonymous in classes.	4	34	50	8	4
I like to quickly see if my answer is right or wrong.	38	38	20	4	0
With clickers, I like to see how many other students got the correct answer.	15	54	31	0	0
With clickers, I like to compare my answer with other students.	27	42	31	0	0
I did not mind using clickers because no one can see my answers.	20	57	23	0	0
Getting feedback on my ideas helps me learn better.	27	50	23	0	0
Participation with clickers improved my understanding of the math topic.	12	50	26	12	0
Participation with clickers increased my feelings of belonging in this class.	12	27	46	15	0
Participation with clickers increased my interaction with the teacher.	12	35	38	15	0
Participation with clickers increased my interaction with other students.	12	34	42	8	4
I am more likely to answer questions using clickers.	27	57	12	4	0
Clickers were helpful in understanding the material.	23	38	35	4	0
Using clickers produced more overall interaction in the classroom.	23	46	31	0	0
Using clickers made lecture more interesting.	34	58	8	0	0
Using clickers enhanced the clarity of examples.	15	43	42	0	0
I enjoyed participating in class with the clickers.	31	57	12	0	0
Using clickers provided a smoother transition to the answers.	23	46	27	4	0
Clickers were fun to use in class.	42	46	12	0	0
I would like to use clickers in all my other classes.	31	27	34	8	0
I would recommend using clickers again in this class.	54	34	12	0	0

Table 2 Geometry Clicker Class Survey - 24 total students surveyed
Results from Perception of using Student Response Systems (clickers)

Had you heard of clickers before this class? YES – 12 students NO – 12 students
Had you used clickers before this class? YES – 10 students NO – 14 students

The following table is the percentage of students who:
SA – Strongly Agree A – Agree N – Neutral D – Disagree SD – Strongly Disagree

Statement	SA	A	N	D	SD
I like math.	17	42	25	12	4
Math is important to me.	29	46	25	0	0
I often raise my hand to ask math questions.	17	21	33	17	12
I am likely to answer questions during traditional lecture.	4	25	33	25	13
Clickers helped me to participate in class.	21	46	25	4	4
Using clickers helped me to pay attention in class.	29	42	21	4	4
Clickers helped me get instant feedback on my answers.	42	38	8	8	4
Clickers have been beneficial to my learning.	17	38	33	8	4
Using clickers helped me get a better grade in this class compared to not using clickers.	4	17	54	17	8
I learn more using clickers than not using clickers.	0	33	46	17	4
I study and prepare more when we use clickers in class.	4	33	26	29	8
I prefer using clickers more than listening to lectures only.	21	33	25	17	4
I prefer to be anonymous in classes.	17	33	29	13	8
I like to quickly see if my answer is right or wrong.	38	46	12	0	4
With clickers, I like to see how many other students got the correct answer.	25	54	17	4	0
With clickers, I like to compare my answer with other students.	29	50	17	4	0
I did not mind using clickers because no one can see my answers.	33	38	21	8	0
Getting feedback on my ideas helps me learn better.	17	46	33	4	0
Participation with clickers improved my understanding of the math topic.	4	42	29	17	8
Participation with clickers increased my feelings of belonging in this class.	8	17	54	8	13
Participation with clickers increased my interaction with the teacher.	8	29	46	13	4
Participation with clickers increased my interaction with other students.	12	21	46	17	4
I am more likely to answer questions using clickers.	38	42	12	4	4
Clickers were helpful in understanding the material.	4	38	54	4	0
Using clickers produced more overall interaction in the classroom.	25	46	25	4	0
Using clickers made lecture more interesting.	38	21	29	12	0
Using clickers enhanced the clarity of examples.	13	50	33	4	0
I enjoyed participating in class with the clickers.	29	38	29	4	0
Using clickers provided a smoother transition to the answers.	21	42	33	0	4
Clickers were fun to use in class.	46	25	25	0	4
I would like to use clickers in all my other classes.	21	25	42	8	4
I would recommend using clickers again in this class.	42	42	16	0	0