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Calculators in a Middle School Mathematics Classroom: Helpful or Harmful?

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Abstract

In this action research study of my classroom of eighth grade mathematics, I investigated the use of calculators. Specifically, I wanted to know the answer to three questions. I wanted to know more about what would happen to my students' ability to recall basic math facts, their ability to communicate mathematically during problem solving, and their attitude when my students were or were not permitted to use their calculator. I discovered that in my research, I did not find enough evidence to either support or reject my initial hypotheses, that calculators largely influenced my students' behavior, and also that my students' ability to recall basic math facts would change when using a calculator. As a result of this research, I plan to continue my research within my classroom. I plan to further investigate the use of calculators within my classroom.

INTRODUCTION

How influential are calculators in a middle school classroom? In my study, I investigated this question from three different angles. I was interested in studying the use of calculators in my eighth grade mathematics classroom. Would students' abilities to recall math facts differ when they were permitted or not permitted to use calculators in the classroom? I wanted to know if this form of technology was a help to my students or something that was holding them back from learning to their full potentials.

The use of calculators in the classroom has become very relevant to my classroom. As I have taught the same group of students for the past three years, I have seen my students' progress through the mathematical content. I have had the privilege of getting to know my students rather well over the past two years and have therefore gained a deep understanding of what they understand and how they learn.

My problem of practice has become a rather large issue in my school district. Calculator usage became a topic of interest at curriculum meetings. Teachers and administrators made various comments and asked questions dealing with when calculators should be introduced, how early into the course they should be introduced, how often students should be allowed to use calculators, and at what point students are allowed to use calculators. Many of the mathematics teachers present at the meeting felt as though calculator use should be consistent throughout the district. Since there are multiple teachers at the same grade level, many felt as though we should be the same across the board.

Before my students were allowed to use their calculators, it was important to me that they know and understand the "whys" and functions of what they are doing before they "plug" them into their calculators. Therefore, students used the calculator solely as a tool for their problem

solving, and not as their problem solving solution. The students' interpretations of their calculator work was a direct reflection of their mathematical communication and understanding.

PROBLEM STATEMENT

By completing research on calculator use within the classroom, I hoped to better prepare my students for further math courses. My first priority while conducting my research was student success. I wanted to give my students the opportunity to be the best mathematicians that they can be. I hoped to determine how to effectively implement the use of calculators by changing what was happening within my own classroom. I believed that my students, as well as other teachers within my district, would benefit from this research. A common and consistent technology plan would help our classes better flow from one level to the next.

Upon completion of my action research, I hoped to present what I have found, and return to my mathematics committee within our school district. I believed that my research would greatly influence the direction that my school district would head in the sense of technology in mathematics. As I believed that my research findings would help my colleagues align technology in the classroom from grade level to grade level, I also hoped that my findings would be beneficial to other teachers who struggled with similar questions.

I wanted my classroom to be a place where students did not need to depend on a calculator for basic computations. Instead, students should rely on calculators as a resource to better understand more challenging concepts and ideas. My students should learn to use their calculators as a means of checking their solutions after they have solved problems. I wanted my students to see their work on a calculator and then interpret what it means. My desire was to create a classroom where my students could use their insights to technology as a means of learning and motivation.

LITERATURE REVIEW

Calculators within the classroom have created many questions for many different people since their invention. I hoped that by asking the questions I was interested in and implementing calculators into my lessons using strategic methods, I would begin to see some answers to those questions. The answers that I hoped to find could help guide my teachings so that my students received the best mathematics education that I could give them.

As I began looking for some guidance into the questions that I had, I realized that the readings I had selected all had common themes. After reading through just a few of the articles, those themes became very obvious. The themes that I discovered while reading the literature I had selected were academic achievement, attitudes, the demands of technological understanding, student knowledge of basic math facts, and problem solving skills. In the following pages, I have discussed the research that I found relevant to my inquiries as it pertains to each of the themes.

Academic Achievement

I believed that the most important reason that I changed the way I do things was to help my students better understand concepts or achieve higher academically, specifically mathematically. Bridgeman, Harvey, and Braswell (1995), all of the Educational Testing Services, wrote an article about the effects of calculators on test scores. The research that Bridgeman, Harvey, and Braswell conducted consisted of 11,457 college-bound junior students from many different ethnic backgrounds and 275 high schools. The researchers wanted to find out whether calculators used on a mathematical reasoning test, such as the SAT, would affect the outcome of the scores. To better understand where individual students were coming from, Bridgeman, Harvey, and Braswell also included a short survey asking the students who were taking the test the extent in which they were allowed to use calculators within their classroom.

Bridgeman, Harvey, and Braswell's writings represented the idea that when calculators were used prior to testing, it was beneficial to the students' test scores. Bridgeman, Harvey, and Braswell discussed that when questions were not merely based on the computational aspect of math, but rather the mathematical reasoning, calculators should be allowed to help the students "concentrate on the more central problem-solving skills" (p. 323). In their findings, they discovered that while some students were allowed to use their calculators on a mathematical reasoning standardized test and others were not, overall, the students who were allowed to use their calculators had a modest increase in their scores.

Likewise, Roberts (1980), of Pennsylvania State University, with thirty years of experience within the mathematics department there, concluded the same findings in his research of calculators within the classroom. Roberts looked at a number of different researches that had been recently been completed. He took a variety of different research from all grade levels, elementary to college level, and compared and contrasted not only their results, but also how their research was conducted. His critique of each set of research led him to findings that not all of the research conducted may be valid. In his comparisons, Roberts stated that some of the research he was focused on may have had incorrect interpretations of their results due to "defective research designs" (p. 71). However, even though he had his feelings of doubt about the some of the research discussed, he was still able to conclude that when students were allowed to use calculators on routine computations during normal classroom instruction, those students benefited when they were allowed to use calculators on tests to complete routine computations during problem solving.

On the other hand, Wheatley (1980), from Purdue University, broke down the overall category of Academic Achievement into the reasons as to why the students might or might not

have achieved as high when using a calculator. One of her main focuses was computational errors. Wheatley conducted her research using 46 sixth graders from the same school. The 46 students used in the research were divided into two groups, one which used calculators frequently in class and one which was not allowed to use calculators at all. Both groups were taught by the same teacher, and both were heavily involved with problem solving. Through her research, Wheatley found that on average students who did not use a calculator tended to make two and a half times more computational errors than those who did use a calculator. Her findings were significant when it came to academic achievement. If students were making significantly more computational errors when they did not use a calculator, their scores reflected those errors, hence lowering their achievement.

Shumway, Wheatley, Coburn, White, Reys, and Schoen (1981) conducted research on 50 elementary schools from five different states. Within their research, they focused on second through sixth grade students. Shumway et al.'s findings were a bit different than the other research findings that I have found. The main topic that they focused on was academic achievement. However, when it came time to make a decision on their data, Shumway et al.'s data lead them to state, "students with and without calculators show gains for basic math facts and for mathematics achievement," but that "these gains were independent of calculator use" (p. 136). In the research, Shumway et al. concluded that the students' achievement was to be expected, since the students gained knowledge throughout the year.

All four articles described focused on academic achievement. Bridgeman, Harvey, and Braswell (1995) and Wheatley (1980) found that calculators were an advantage when working with problem solving and using mathematical reasoning, and when the major concept of computation was not the first priority. Roberts (1980) had a similar perspective. As he studied

and critiqued already complete research, he concluded that when students were exposed to calculators frequently on basic mathematics computations, the students tended to do better when allowed to use a calculator on basic mathematics computations when problem solving. Finally, Shumway et al. (1981) stated that, "students with and without calculators show gains for basic math facts and for mathematics achievement" (p. 136). However, they felt that these gains were "independent of calculator use," and that it was due to students gaining knowledge and experience throughout the year.

Attitudes

Many authors in my review also discussed the different attitudes towards mathematics and/or calculators. Most of the articles that I found which discuss this issue agree that students' attitudes positively changed when a calculator was introduced into the lessons. One of the first that I came across was Roberts' (1980) findings, where he stated that "calculators influence immediate and specific attitudinal perceptions, but evidence supporting more general and lasting changes is not available" (p. 85). Like many previously mentioned researchers, specifically Ruthven (1998), Roberts did not feel that his data could specifically say students who used calculators had a more positive attitude towards math overall. His data supported this idea, but Roberts commented about lurking variables that could have affected the results of this positive attitude change. Both Roberts and Ruthven agreed that they found "no long-term influence on attainment and attitude" (Ruthven, p. 24). To prove this fact, students would have had to have been tracked through a number of years, with the possibilities of many different lurking variables affecting the outcome of this research.

The same year that Roberts published his findings, Wheatley (1980), published her findings of calculator use on problem solving. In Wheatley's study, she concluded that the

"pupils enjoyed the calculator experience and wanted to continue using it in their mathematics class" (p. 332). She also made the statement that "pupils were motivated to solve problems with the aid of a calculator" (p. 332). Wheatley was very confident with her findings on students' attitudes about calculator usage. Much the same, Shumway et al. (1981) concluded with similar findings. Each of the four men who contributed to this article belong to well known universities, with the exception of Coburn, who was a member of a public school in Michigan at the time. For this group of men, student attitudes towards math and calculators were only a couple of the variables that were looked at. In the end, Shumway et al. came to the conclusion that the data did not support their initial thoughts of calculators having a positive influence on students' attitudes towards mathematics. However, the researchers did find that students have a better attitude towards calculators than they do towards mathematics.

In 1987, Szetela and Super used a seventh grade class to see how calculators and instruction changed with problem solving. Their approach to student attitudes was slightly different than other articles. Within this set of research students completed an "attitude-toward-problem-solving test" (p. 225). On this test, "the group taught with calculators scored significantly higher than the other groups" (p. 225). The students studied in Szetela and Super's research had a much better attitude towards problem solving when allowed to use a calculator.

Once again, all five of the articles that I have previously mentioned agree that students' attitudes when working with calculators are positively increased. Both Roberts (1980) and Ruthven (1998) found that calculators have an instant positive affect on students' attitudes, but believe that it is difficult to see a long-term affect on students' attitudes. As for Wheatley (1980), Shumway et al. (1981), and Szetela and Super (1987), all three sets of research supported the same conclusion. In that conclusion, researchers found that students' attitudes towards

mathematics increased when they were allowed to use calculators within the classroom. Szetela and Super specifically stated that students' attitudes positively increased when they were allowed to use calculators when given problem solving type questions.

Problem Solving Skills

By incorporating problem solving into my research I hoped to find out whether or not calculators were a tool that my students would benefit from while problem solving. Heid (1997), from Pennsylvania State University, approached mathematical problem solving from a technological perspective. In her article, she discussed how the "technological revolution" was changing mathematics throughout the schools. Heid commented that problem solving was one of the major curricular themes playing a larger role in today's mathematics education. Although Heid's article was not about research that she had completed, she had used previously completed research to make arguments for technology in the classroom. She made a few arguments for why problem solving should be included into mathematical instruction. Heid believed that integrating calculators did the following:

> Develops students' general competencies; develops students' ability to see and judge uses of mathematics independently; prepares students to apply mathematics to everyday life; provides students with a real picture of mathematics; and helps students in learning, keeping, and choosing mathematical concepts and strategies (p. 15).

Her arguments for problem solving were fitting, but they did not stop there. She also argued that technology played a large role in putting problem solving so high on the mathematics reform list, due to the fact that technology today could manipulate different mathematical models and could be modified rather easily. Heid did a fine job of relating how problem solving and technology go together.

As technology advances, new ways to create models that could possibly further student problem solving will also become more advanced. The problem with such advances is the need for teacher education on these tools. This is a topic that I return to later in this paper. However, Szetela and Super (1987) bourght up another needed teacher development issue. How should such skills as problem solving be taught? Was there a right way? A wrong way? If so, how did I know?

For most, problem solving was that step beyond computation. With problem solving, there were multiple approaches that one can take to find a solution. Bridgeman et al's (1995) noted that higher level tests were aimed at assessing a person's mathematical reasoning rather than his or her computational skills. Bridgeman et al. commented that when students were allowed to use calculators while problems solving, they became relieved of the computational burden and could focus mainly on their problem solving skills. Like most subjects, when there was less to focus on, the main picture could be brought into a clearer view. However, Roberts (1980) concluded just the opposite, that research did not necessarily support calculator use for higher-level mathematical learning. He believed that if students at these higher-levels of mathematics were allowed to use calculators, they needed to be efficient in utilizing the calculators for sufficient conceptual attainment to improve, which may not always be the case.

On a slightly different side of things, Ruthven (1998) completed his research on the use of mental, written, and calculator strategies on number computation among 56 sixth graders. The students that he studied were among the "first to experience a full primary education under the National Curriculum" (p. 21). Ruthven found that when encouraging both calculators and mental math, the students were able to see the relationships within the concepts of the problem much clearer. Ruthven used problem-solving as a means to get students computing more frequently

without the “drill-and-kill” method in mind. Both calculators and mental math were encouraged when presented with the problem. Students are then able to see relationships between what they were doing mentally and process their thoughts from both forms.

Teachers and researchers have continued to try and understand the how’s and why’s of problem solving within mathematics. Through Heid’s (1997) problem-solving arguments, she concludes that technology in the mathematics classroom would help students better understand problem solving due to the fact that technology could manipulate models easily. Bridgeman, Harvey, and Braswell’s (1995) research concluded that calculators could reduce the amount of computational stress that was put on students while trying to problem solve, thus allowing the students to be focused mainly on the problem-solving skills. On another level, Roberts (1980) believed that if students in a higher-level mathematics course were allowed to use calculators, they needed to be efficient with the calculators to fully take advantage of the benefits of the calculators. Ruthven, promoted problem solving skills with a combination of both calculator use and mental math. His focus was to get the students to understand and be able to see the connections from both forms. Therefore, concluding with the research presented, calculators in combination with mental math created a means to problem solving that might allow students to focus more on the process of problem solving rather than merely on the computation of problem solving.

Student Knowledge of Basic Math Facts

As an eighth grade teacher, I expected my students to know their basic math facts. Basic skills such as adding, subtracting, multiplying, and dividing simple one digit by one digit numbers should be a concept that can be recalled easily. Shumway, Wheatley, Coburn, White, Reys, and Schoen (1981) noticed through their research that calculators did not harm nor help the

students when recalling basic math facts. The data from this research, along with lurking variables, could have been slightly skewed. While completing their research, Shumway et al., noted that a growth was to be expected over time and from one grade level to the next, therefore slightly showing an increase in their data at these points. As researchers, they noted that such little change was not significant enough to conclude that the calculators were the source of the increase of basic math facts recollection.

Technology's Demands

Technology is a fast pace industry, always growing, and always evolving. In the mathematics world of today, it seemed that a new calculator was always coming out, bigger (or smaller) and better. Most non-mathematics educators would welcome the new technology. However, for most mathematics teachers, new technology only meant new information and technology to learn. When change occurred so quickly, it became hard to manage within the classroom.

All of the articles I have previously talked about mention this variable at some point throughout their writings. Kaput (1994) noted that "using technology in mathematics education is intellectually demanding" (p. 681). Not only did the new technology take time to learn, but as all previously mentioned authors stated, with the exception of Wheatley (1980), new technology also took time to teach. Mathematics teachers were placed into dual roles, the student and the teacher, when a new form of technology was introduced.

With the rapidly changing forms of technology, there were many means that a teacher could incorporate technology into the classroom. These means were broad when it came down to the complexity of the concept being covered. As technology advanced, so did mathematical

emphases. In many states, new state standards were being established for both students and teachers, to promote technology proficiency (Means, 2003 p. 161)

In most cases throughout the research I read, teachers were given a chance to better understand the technology themselves. Szetela and Supers' (1987) gave the teachers involved in the study two and a half days of instruction to help them use the tools that they were given for the research. Overall, all of the researchers, with the exception of Wheatley (1980), agree that technology places large demands on those who choose to use them. They describe and note that if teachers are expected to incorporate these advances into their classrooms that the teachers need to be trained on how to use them. If teachers have the proper training, then both students and teachers would benefit.

In conclusion, the research that I conducted was a combination of the research that I have just discussed. Although many of the researchers that I had mentioned talked about students' abilities while problem solving, Szetela and Super's (1987) research was most like the research that I conducted. Much like Szetela and Super, in part of my research, I investigated what happened to students' abilities to problem solve when a calculator was or was not used within the classroom. However, I looked at the abilities of eighth grade students, rather than the abilities of seventh grade students, which Szetela and Super studied.

My interests in technology within my classroom came from my students' desire to use it frequently. Heid's (1997) view of calculators within the classroom--used as a manipulative for problem solving--was a concept that I hoped to find out more about while I observed different strategies my students used while problem solving.

Since I studied eighth graders within my school, I chose to use my two classes of pre-algebra students, which totaled about 60 students overall. Since my sample size was rather small,

I wanted to keep as many of my variables constant as possible. Unlike many of the authors above, specifically Shumway, Wheatley, Corburn, White, Reys, and Schoen (1981), I did not have two distinct groups: those who would be allowed to use calculators, and those who would not. I chose to allow my students specific time periods which they would be given the chance to use calculators and times when they would not be allowed to use their calculators. I was interested to see the outcome of my results, especially after reading research that had already been conducted on the topic of calculator use within the classroom. It was interesting to see that many of the articles that I found on this topic where not all that recent, many of them dating back to the 1980's.

PURPOSE STATEMENT

The purpose of my project is to gain knowledge in the field of calculator use within the classroom setting. I examined the variables of student achievement (as measured by scores on tests), student attitude (observed through interviews), and the quality of student solutions in problem solving situations. I also discuss how my problem relates to the National Council of Teachers of Mathematics (NCTM) Principles and Standards (2000) in several different areas.

My first research question was, "What will happen to students' problem solving when they are permitted or not permitted to use calculators in the classroom?" As a student in the Math in the Middle Institute, a graduate program for middle level mathematics teachers, I have learned just how important problem solving is to my students. I have noticed an increase in calculator usage among my students in Habit of Mind type problems. Habits of Mind problems were real life scenarios which were open-ended or non-routine in nature. Students may approach the problems from multiple perspectives. I became curious of this issue and began questioning

whether I was helping my students learn to problem solve better when I allowed them to use a calculator on the Habit of Mind problems.

Overall, I was unsure that by allowing my students to use calculators, their mathematical communication would be as strong as if they did not use a calculator. The NCTM communication process standard addressed the need of my students to clearly understand and successfully be able to explain the processes and means to their solutions. According to NCTM standards, my students needed to be successful when solving problems that dealt with computation, word problems, and basic algebraic concepts. This standard was addressed in my second research question. I wanted to see what would happen to my students' problem solving skills when a calculator was allowed into the classroom setting. Once again, I wanted to know, "Will my students be able to mathematically communicate their reasoning when problem solving, better if they are allowed or not allowed to use a calculator?"

The second question that I became curious about was, "What will happen to student attitudes when they are permitted or not permitted to use calculators in the classroom?" For as long as I had been with these students, I still could not get a good grasp on whether a majority of the students enjoyed using their calculators because they were comfortable with the calculators, or if students used calculators out of convenience. I wanted to gain a much better understand of how my students felt about using their calculators and if they felt using calculators was a benefit to use them on day to day tasks.

Probably most obviously, this question placed my problem of practice under the NCTM standard of technology. Kids today were more computer-savvy than most teachers. Once my students understand the main concepts, I would like to keep math interesting by introducing calculator technology. I think that technology can influence the students at times when

computation is not the main focus, but rather the concepts in which we are studying. I also believed that for some of my students who understood the computation of numbers, but seemed to process things a bit slower, technology could help them to become more confident with their mathematics capabilities.

Finally, the last thing that I wanted to know was if a calculator would change students' ability to recall basic math facts. The question that I used to guide my research was, "What will happen to students' ability to recall math facts when they are permitted or not permitted to use calculators in the classroom?" Many of my students struggled to remember their basic math facts. The combination of the two brought to my attention the fact that the use of calculators could be the reason why students were not able to recall their basic math facts easily. In my final question, the NCTM process standard of representation seemed to fit rather well. I believed that my students needed to understand that the concepts they were learning, were first represented by number sense, expressions, and equations. I believed they needed to understand the basic concepts of math and mathematical representations before a calculator could be introduced.

Through this research, I hoped to better understand my students' abilities to mathematically communicate their reasoning when problem solving, attitudes toward mathematics when technology was introduced, and ability to recall of math facts. The answers to these questions might help guide me in forming what I would like my classroom to look like. I also hoped to gain a better understanding of how my students learned and what I could do as their teacher to benefit them the most. As my research into these three questions guided my teaching, I also wanted to see how my teaching had changed throughout this process, thus leaving me to address a fourth question on my work as a teacher.

METHOD

For the past three years, I have had the privilege of following the same class from sixth grade to eighth grade. I have built amazing relationships with many of my students as well as the wonderful parents with whom I have become acquainted. Since I had followed the same class for the past three years, I had been able to see the progression of mathematics from sixth to eighth grade in our district. I believed that this had helped me grow as a mathematics teacher. In my school, because the class that I worked with was so large, I was the only teacher to loop through all three grades with the students. This next year, I will continue to teach the eighth grade as the group of students that I have followed will move to the high school.

This year, as I was teaching pre-algebra for the first time, I consistently had approximately 27 students in a class. With the large numbers in each class, boys usually outnumbered the girls, by about five to four. Overall, students in both of my pre-algebra classes were fairly average level learners. However, there were a few students in each class at the higher and lower ends of the spectrum.

I began my research in January, 2008 by making observations of the students while they worked on daily tasks and journaling their comments. The first large task I completed while beginning my research was the students' basic math facts tests. Students were given four different tests, which included one hundred problems on each test. Each operation (addition, subtraction, multiplication and division) tested the students on their basic math facts (see Appendix A).

When administering the tests, I scheduled my class so that each test would be given three times: once at the beginning of my research (February 12 and 13), once about half way through (March 25 and 26), and the final test at the end of my study (May 14 and 15). Each time I

administered the tests, I gave the addition portion first, allowing the students three minutes to complete as many problems correctly as possible. To make them aware of their time, I prompted them when they had a minute and a half, a minute, and thirty seconds left. I then gave them approximately a three-minute break, followed by three minutes to complete the subtraction portion of the tests. The following day, I then administered the multiplication and division tests following the same method. I believed that at the level my students were, it was important for students' basic math facts to be automatic, thus by timing the tests, I was able to focus on fluency and speed. The information that I gained from this testing series was my major quantitative form of data.

The other forms of quantitative data that I collected throughout my research came in the form of daily grades and problem solving rubrics. Daily grades were common within my classroom, as they were a major source of my students' collective average for the class (see Appendix B for rubric). The problem solving rubric was most often used on Habit of Mind type problems and contained concepts such as: how long did it take, how often did the student look confused, how often was the student off task, and how often did the student ask for help (from another student or teacher)? Although my plans were to mostly use this rubric on Habit of Mind type problems, I also used it while students were routinely working on problem solving throughout the daily tasks, as I was not able to complete a Habit of Mind problem each week as originally planned.

From a qualitative perspective, I collected a great deal of data through my teacher journals (see Appendix C for teacher journal form). Each week I journaled about instances that occurred in my classroom. I also noted thoughts or comments that my students made, and things that I noticed happening throughout my classroom. To help keep myself organized, I kept my

journals in a three ringed binder located on my desk, so that I would be consistent in my journaling. Early on, I learned that if I made my journal accessible, it was much easier to complete. I also learned to make small notes throughout the week, and then I combined them into one large journal entry each week.

Two other forms of qualitative data that I collected were in the form of student surveys and individual student interviews. While collecting data through the student surveys, I created a series of questions that contained both ranking type questions and short answer type questions (see Appendix D for student survey). While administering the survey, I instructed the students that they should be completely honest and explain their reasoning for why they felt the way they did. I allowed the students one, fifteen minute time period to work on the surveys before handing them in.

As for the individual student interviews, six students were randomly selected from both of my pre-algebra classes. When selecting students to interview, I asked a cooperating teacher who was holding my parent consent forms to choose two lower level learners, two average level learners, and two higher level learners. I spent one session with each student, which lasted approximately twenty minutes. During the interview, we discussed the student's feelings and thoughts about math in general. I guided them through our discussion with a series of questions and prompts (see Appendix E for individual student interview questions).

FINDINGS

As I conducted my research, an average day in my classroom first began with a daily warm-up problem or problems on the board. The first problem usually consisted of a review type problem that required my students to apply what knowledge they had gained the day before. The second problem usually made way for the learning that they would be doing that day. Once we

had covered the warm-up problems together, I then usually took any questions that my students may have had on their previous night's homework. I knew that I had to make sure that all of their thoughts and inquiries were answered before we moved on. Since I was laying my students' foundation of building blocks, I knew that if my students' understanding was not there, the next layer of building blocks that I wanted to help them lay would not be on sturdy grounds. If my students' foundations were not sturdy they would not be able to build upon mathematical concepts as high in the future.

Once I had their questions or thoughts covered, I then moved into the day's lesson. Each day, the structure of my lessons changed. Some days I would have my students work in groups, doing a bit of discovery teams; some days, I would have the class as a whole work through the lesson through class discussion. Other days, I modeled the lesson for my students. A typical day in my classroom then usually ended in independent practice for the following day. However, rarely was this independent practice independent. In my classroom, I fostered partner or group work. I liked that my students asked each other questions before they asked me; therefore I prompted individuals to check their solutions with another student as they worked on their "independent" practice. Day after day progressing through my typical day, I became intrigued about the use of calculators within my classroom and how calculators fit into my "typical lesson." In the following sections are three questions that became the most important guides in my research.

Problem Solving and Calculators

My first research question was "What will happen to students' problem solving when they are permitted or not permitted to use calculators in the classroom?" I found that students' problem solving was not largely influenced with the use of calculators. I kept weekly teacher

journal and gathered data in the form of my observations while my students worked on a Habit of Mind problem. While my students were working on the problem presented to them, I observed approximately three-fourths of them using their calculators in some way to help them solve the problem. I kept track of the number of students using my problem solving rubric that I kept in my teacher journal. In the same journal entry, I noted that many of these students were using their calculators to describe their thoughts on the problem. I wrote,

> While students were working hard on their Habit of Mind problem, approximately 3 out of every four students were using their calculator in some means. To make a closer observation of their calculator usage, I wondered around from group to group asking them how they felt using their calculator was helping them. Many of their responses to be very similar, "I use it to do the easy stuff like adding or subtracting" or "It saves me time, I don't have to add or subtract, or multiply or divide using paper, I can just type it in and I have the answer." I didn't stop my questioning there, I wanted to know about problem solving, so I then asked "Is that answer you found using your calculator your solution to the question in the problem presented?" Without much shock, many of my students looked at me with that "are you kidding" look on their face, and answered, "No, like I said, it helps me do some of the adding or subtracting as I look for the pattern, which is the answer." (Personal Journal, February 13, 2008)

As I learned to better observe my students while they worked in class, my observations of my students tended to lead my findings in the direction that when my students used their calculators, problem solving was easier for my students. However, when I reflected back to my grade book and compared scores from Habit of Mind problems when my students used their

calculator to when they did not use their calculator, there was not a significant difference. In the overall range of the scores on the Habit of Mind problems, individual write-ups completed using a calculator (While they were allowed to use a calculator, this does not mean that they chose to use their calculator to solve the problem) the range of the scores went from a 68% to a 100%, with an average of 84%. For the Habit of Mind problems, individual write-ups completed not using a calculator had a range of scores from 70% to a 100%, with an average of 85%. I did not believe that this difference was large enough to state that the calculator influenced my students' problem solving.

Thirdly, my final piece of evidence for this assertion was from the individual student interviews I conducted with randomly selected students. One question I asked all students interviewed was, "On a scale of 1 to 5, 1 being never, 3 being sometimes, and 5 being always, how often should a calculator be used in the classroom?" In one student's response, she rated calculator usage within the classroom as a 3. When I asked her why, she responded by saying, "well, sometimes calculators just slow us down, but when we do use them, it's because we know what we're doing… We just want to get through the easy stuff so that we can find the answer." Another student interview also rated this question a 3, but commented that, "calculators are good, because I get to check my work when I'm done." Comments like these tended to lead me to the conclusion that students felt as though they really did not need their calculator while problem solving because as students, they did not necessarily rely on their calculators. However, when students did have their calculator, they saw the calculator as a means of support.

As the evidence I have presented showed, I did not have the means to show that my student's problem solving was largely influenced by the use of a calculator. In many circumstances throughout my research, I repeatedly found that if my students were allowed to

use a calculator while problem solving, they would use it. However, on the contrary, if a calculator was not presented to them as a tool that they were allowed to use, they knew that other methods were available for them to solve the problem.

Attitudes and Calculators

The second question I researched was, "What will happen to student attitudes when they are permitted or not permitted to use calculators in the classroom?" I found that some students felt comfortable using their calculator, yet others were more comfortable not using a calculator. This was supported both quantitatively and qualitatively.

I found students' verbal comments about calculator usage on daily tasks to be very straightforward. I found interesting data through the math attitude survey that I administered. On the student survey, I asked the students to rate how they felt on a scale from 1 to 5, where 1 was the lowest and 5 was the highest. When I specifically asked the students to rank their feelings on the statement, "I am more confident answering math questions when I use a calculator than when I do not use a calculator," 52 percent of the students responded by marking a 5. Another 33 percent responded by selecting a 4. Overall, 85 percent of the students felt more comfortable answering mathematical questions when they were permitted to use a calculator.

The students were also asked how they felt they did when they were permitted to use a calculator on assignments and tests. Using a Likert scale, with one being low and five being high, the students' responses were as follows:

Average (3)- 14%
(4)- 48%
High (5)- 38%

Although all students marked a three or higher, I concluded that 62 percent of the students studied felt that when they used their calculators, they only did average or slightly higher than

average on their homework or test. This data showed that even though all students rated an average or higher, a majority of the students still did not believe that calculators helped them enough to do the best on their homework or tests.

When given a choice, the majority of the students chose to use a calculator. I wrote in my teacher journal that,

> The students were given an option whether or not to use their calculators on the Habits of Mind problem. Their calculators were not necessarily needed as they were only doing simple algebra, however, at least two-thirds (19 out of 26 students) of the students when observed chose to use their calculators (Personal Journal, March 7, 2008).

Overall, I believe that this observation relates to how I saw my students on a daily basis. Often times I saw a number of my students reach for their calculators when a calculator was not always necessary, as if my students almost did not realize that they made this unconscious gesture.

In all aspects of my research, I have not only made observations or given student surveys that showed evidence to support my findings, but I have also heard a number of comments from students regarding how they felt when they were not allowed to use a calculator. I noted in my February 11^{th} – 14^{th} journal entry,

> When I was administering the first basic math facts test to the students, and I told them that they were to not use a calculator, many of my lower ability students began to make comments. Some of the comments that I heard were, *"This is dumb, why can't we use a calculator?"* and *"Why do we need to know these? If I want to know what five times seven is, I can type it into my calculator!"* Their struggle with quick basic computations

> became very obvious as well as their desire to use a calculator to "quickly" figure the answers out (Personal Journal February 14, 2008).

Because of their attitude and their desire to use a calculator, I knew that some of my students were not going to be successful at completing the given task simply because they were not confident in their ability to solve basic math facts without the use of a calculator. I also witnessed this attitude during the second round of basic math facts tests. When I began administering the multiplication timed test, I specifically recall watching two of my students. These two students, struggled with their basic math facts, and I wanted to know if the scores from their tests reflected what they knew, or their attitude towards what they knew. While observing these two students, I realized that this test was not measuring what they knew, but merely how many problems they could complete while also observing the students around them. For these two students who struggled with simple basic math facts recollection, they knew that they would not be able to complete all of the problems, so they chose to complete only the problems that they selected.

However, here was where the unforeseen findings came into play. I found that students did not feel that calculators were always necessary when permitted in a mathematics classroom. This first came to my attention after I had the students complete the math attitude survey. One question that I asked the students was to rate how they felt on a scale of 1 to 5, one being low and five being high, was, "If I could choose when to use my calculator I would use it…" A large majority of the students answered within the middle range of 2 to 4. Sixty-seven percent of the students surveyed fell in this range. Many of the same students also made similar comments when asked, "When I plug numbers and functions into my calculator, I know that my answer is…" Some of their answers were, "*not always correct*" or "*sometimes right*". When they were asked to support these comments, the same generalization was made. Students commented that,

"*a calculator isn't always right, you might push the wrong buttons*" or "*put in the wrong numbers.*" As a teacher, these comments made by my students only emphasized the fact that the students realized what a calculator really did do. From the time that I began teaching this class while they were in the sixth grade, I constantly reminded them that "calculators only do what they are told" and that "if they are told to do something incorrectly, they would give an incorrect answer." Therefore, I believed my students understood that calculators could be used as a resource, but that they had to know what they were doing with the calculator for it to work to their advantage.

I also found supporting evidence through the individual student interviews. As I was conducting my individual student interviews, I gained a much deeper knowledge about my students' mathematical thoughts than I ever had imagined. While interviewing these students, I led them through a series of questions that first asked them about their thoughts of general mathematics. An example of this type of question was, "On average, how would you rate your involvement in math class and why? (1 being 'not involved and a 4 being 'very involved')." In most cases, the answer of two or three was given, with a four from time to time. As I proceeded through the questions, I slowly geared each student towards their feelings on using calculators within the classroom.

The one question whose answer stood out to me the most was, "If calculators were allowed during class discussions, how much do you think that would affect your participation if at all?" I was slightly amazed when I had completed my surveys: not one student had answered this question with "a lot." In most cases, the students felt that they learned the concepts more when they did not use a calculator while trying to be involved in math class. Those same students when verbally asked to rate on a scale of 1 to 5, 1 being never, 3 being sometimes, and 5 being

always, how often a calculator should be used in the classroom, all said 3. From this data, I could say that I learned an interesting piece of information from my students. When they all responded by saying sometimes to using their calculators in class discussions, I finally began to realize that my students were not as dependent upon the calculator as I thought they were.

As further evidence for students feeling confident to do mathematics without a calculator, I had the following experience towards the beginning of April. We were beginning a new unit and calculators were not going to be used. In preparation for my students' rejection to this, I was ready to defend my stance. Surprisingly, I did not have the reaction I had prepared for. As I began the unit, a few students tried sneaking in their calculators from time to time, but did not argue when asked to put them away and not bring them back until noted. The behavior that I noticed was not something that I was expecting, but seemed to coincide with what the students told me in their individual student interviews.

Overall, students seemed more willing to set their calculators aside than I had originally thought. Although students did not mind having the device there for support, many students also felt as though they did not "need" the calculator to do most mathematics. Students made this very clear in their answers to the attitude survey that they completed as well as in their comments and individual student interviews.

Basic Math Facts and Calculators

The third research question that I chose to look at was, "What will happen to students' ability to recall math facts when they are permitted or not permitted to use calculators in the classroom?" My findings indicate that the use of calculators did not change my students' ability to recall math facts.

During the individual interviews, I first asked them to explain whether or not they thought an average eighth grade student should be able to recall basic math facts without a calculator. The overall consensus was that, “yes, they should know their basic math facts pretty well.” Many of the students also said that they had had years of practice, because they had learned their basic math facts early on in elementary. Although this statement did not come as a huge shock to me, I found it difficult to believe. This year, as I covered different concepts throughout the year, I did not think that my students knew their basic math facts as well as they should. The purpose of my asking this question to the students was to gain a grasp on where they felt they, as eighth graders, should stand when recalling their basic math facts.

I continued through the interview, asking each student to rate their own ability of recalling math facts accurately, and what about math facts made them easy or hard to recall. I thought that this last question was one of the most important questions asked. I believed that in mathematics, or any subject for that fact, it was very important for a student to feel confident with himself/herself in order for them to be successful. About half of the students interviewed said that the repetition of basic facts was what made recalling math facts easier for them to remember. The other half of students said that it was easier to recall the lower basic facts than the higher ones. To me, this last statement seemed pretty obvious, but it also made sense. The lower the numbers that were included in the basic math facts, the easier students found them, because lower numbers tended to be used more often. When students learned the basic math facts in elementary school, most people agreed that the lower the facts, the easier to remember, but the lower facts were also the facts that we were taught first, therefore asked to recall more often. By asking these questions, I have gained a much better understand for where my students stand knowing their basic math facts.

Whether my students used their calculator or not during the lessons prior to the basic math facts tests, I thought that what my students said in their answers to their individual interview questions was extremely relevant. I believed that my students learned their basic facts early on and remembered them due to more frequent recollection. However, I also believed that for some students basic math facts were something that they struggled to recall. I thought that by eighth grade, students should be able to recall their basic math facts. Therefore, I did not largely focus on basic math facts from a day-to-day perspective.

Observations and student input were great qualitative data, but what did the quantitative data suggest? As I scored the addition and subtraction portion of the skills tests, out of the 48 addition tests that I scored, nine students finished all 100 problems before the three minutes were up, however only six of those nine students had all 100 problems correct. Of the three students who did not have all 100 correct, but had all 100 completed, they missed no more than two problems. On the subtraction basic math facts tests, the numbers were quite different. Only two students completed all 100 problems, all of which were correct. Both students, academically are at the top of their class, and often times are the students who participate most often in class. In both cases, addition and subtraction, after the students who had all 100 problems completed the next group of student scores drop down. When looking at the addition test, a large number of students got between 65 and 90 problems correct. On the subtraction test, that number is much lower.

Here were the results from the basic math facts tests, from which I administered to 27 students in each case.

Round 1 Basic Math Facts Tests (Pre-Test)			
Add:	**Subtract:**	**Multiply:**	**Divide:**
$\bar{x}$ =79.1	$\bar{x}$ =57.2	$\bar{x}$ =68.9	$\bar{x}$ =60.1
S_x=19.0	S_x=21.5	S_x=23.8	S_x=25.4

Round 2 Basic Math Facts Tests (After a unit permitting calculators)			
Add:	**Subtract:**	**Multiply:**	**Divide:**
$\bar{x}$ =79.7	$\bar{x}$ =58.8	$\bar{x}$ =70.1	$\bar{x}$ =60.5
S_x=18.5	S_x=21.0	S_x=23.2	S_x=25.1

Finally, after the completion of the third Basic math facts tests, when my students did not use their calculators, my results were as follows:

Round 3 Basic Math Facts Tests (After a unit not permitting calculators)			
Add:	**Subtract:**	**Multiply:**	**Divide:**
$\bar{x}$ =81.0	$\bar{x}$ =59.0	$\bar{x}$ =71.3	$\bar{x}$ =61.2
S_x=18.3	S_x=21.7	S_x=23.4	S_x=25.7

In first comparing the data from test two, when students were allowed to use their calculator prior to testing, to test three, where students were not allowed to use their calculator prior to testing; I noticed that in all four operations, there was a slight increase in the average of the scores. As I compared data, I believed that the change within each of the different operations was not significant enough to say that when my students used a calculator their ability to recall basic math facts was better or worse than when they did not use a calculator.

In conclusion, with the evidence that I have provided, I did not have sufficient evidence to say that calculators influenced the ability of my students to recall basic math facts. Two factors could have played a role in why I did not see much of a change. The first, the research that I conducted only spanned over a three month period, making it difficult to see a large increase in such a short amount of time. The second, in my research I was only able to use 27

students which is a very small sample size, also precluding one's ability to see large jumps in achievement.

Changes within Teaching

Finally, the last question that I wanted to know more about was "How did my teaching change?" Throughout the entire process of my research, I wanted to find out exactly what it was that I changed. I want to be the best teacher that I can for my students, therefore I will do what I can with my teaching to develop the most success in every aspect.

The first piece of evidence that showed my teaching had changed were the Habit of Mind problems. I have learned to incorporate these problems solving problems into my lessons as a means of challenge and drive for my students to become better mathematicians. As a teacher, I learned to use the Habit of Mind problems to cover multiple concepts, therefore I did not just teach the concepts and expect daily homework assessment. The use of these problems was the first change that I made in my classroom.

The second change that occurred in my teaching was due to the fact that I used the Habit of Mind problems with my students. Since I learned to use the Habit of Mind problems, the problems made me, as the teacher, focus more on what the students could do, rather than what rules they could follow. I have enjoyed using these problems as noted below in my findings of my personal journal for the week of March 17 through 21:

> I then lead them into the question, what does that number mean, or what does it represent? I strategically placed my emphasis on the "whys" of the number rather than the number itself. My motive was to show the student that I didn't really care about the number, but the reasoning and approach that the student used. When the students realized that what I was doing was getting them to describe the

process rather than the steps they went through to find their solution, the calculators were barely touched again.

Through Habit of Mind problems, I have learned to dig deeper when I ask questions. I found myself asking my students "why" more often, which excited me when I heard their response.

Finally, the last piece of evidence that my teaching had changed, came from the information that I gained while conducting the individual student interviews. After completing all of the interviews and reviewing each student's comments, I learned a great deal by just listening to what they had to say. The answers that my students gave intrigued me. I found their responses to be very honest and sincere. From these interviews, I learned such a great amount of information about my students that I would never have learned, had the process of interviewing not been part of my research project. I knew that even though my formal research had ended, I planned to continue individual student interviews from time to time within my classroom as a means of understanding my students better. I gained a great deal of insight into my individual students mathematical reasoning and classroom thoughts.

Overall, many aspects throughout my research have changed my teaching. Above, I gave examples, including the Habit of Mind problems and individual student interviews, that have greatly influenced the way I teach. Since I have only taught for three years, two of which I spent bettering my education in the Math in the Middle partnership, I believe that my teaching will continue to be the best that I can offer my students.

CONCLUSION

In the four months that I conducted the research that I set out to do, the most surprising results were related to my students' attitudes. As a mathematics teacher, I was glad to hear that a majority of my students did not feel that they needed to use their calculators to be successful

students in math. However, I did believe that for many of my students, mathematics was a challenge. By me allowing them to use their calculators, it relieved some of the computational pressure that was applied to them while working through different, more challenging, concepts.

I realized that my students were comfortable using their calculators, yet I had also realized that my students struggled with basic computations when not allowed to use their calculators. I believed that this influenced my students' attitudes when they were or were not permitted to use their calculators. I hoped to find that by continuously working on basic math facts while also incorporating technology into the lessons, students would learn to feel comfortable problem solving both when permitted and not permitted to use their calculators.

Overall, I was encouraged to have seen that my findings coincided with a number of the authors whom I studied. I think that my data most closely resembles both, Roberts (1980) and Wheatley (1980). "Pupils enjoyed the calculator experience and wanted to continue using it in their mathematics class" (Wheatley, p. 332). I think that this statement summed not only what Wheatley's research said, but Roberts' and my own findings. Although the data in their research was a bit dated, especially since new technology had been implemented, much of what my evidence revealed closely related to their findings on using technology while problem solving.

IMPLICATIONS

As a result of my findings, I plan to continue my research with the idea of returning to my mathematics committee within our school district and present the data that I find after completing another year of research. I believe that what I will find will greatly influence the direction that my school district will head in the sense of technology in mathematics. I hope to use what I have found through my research to promote the use of calculators within the

classroom as a means of support rather than a means to a solution. I feel very strongly about this idea, and hope to continue my own individual research within my classroom next year.

Since having taught at the eighth grade level for a year and having the privilege of staying there, my co-math teacher and I are attempting to purchase a class set of graphing calculators within our building. Together, we believe that the technology would be extremely beneficial to all of our eighth grade mathematics students, both pre-algebra and algebra, as we cover concepts such as linear and quadratic equations. The support that these calculators could give our students would be exceptionally high.

I am very excited to see how my research this year will influence my teachings next year. I know that within the time I have set-up and implemented the process that I originally created, I have changed my teaching a great deal. I have learned so much from making observations and picking apart my teaching that I hope to continue. I plan to continue the use of calculators as much as I did this past year, incorporating technology into lessons that I feel is appropriate, and withholding technology when I feel the basic concepts need more of a mental focus. I do not wish to make calculators the basis of my class, but as a tool my students can use to further their understanding of mathematics.

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Appendix A (This is a portion of the addition basic math facts test.)

2 + 9 =	6 + 0 =	6 + 8 =	7 + 5 =	6 + 3 =	4 + 9 =	2 + 7 =	8 + 8 =	3 + 9 =	6 + 1 =
8 + 9 =	3 + 8 =	6 + 4 =	8 + 7 =	7 + 4 =	9 + 7 =	6 + 6 =	4 + 6 =	5 + 9 =	7 + 6 =
9 + 4 =	3 + 5 =	5 + 8 =	4 + 5 =	7 + 7 =	9 + 3 =	0 + 7 =	4 + 7 =	7 + 9 =	9 + 2 =
6 + 2 =	4 + 8 =	6 + 9 =	8 + 2 =	5 + 6 =	4 + 4 =	6 + 7 =	9 + 5 =	8 + 3 =	9 + 9 =
6 + 5 =	8 + 6 =	4 + 3 =	8 +4 =	9 + 8 =	8 + 5 =	9 + 6 =	5 + 7 =	4 + 2 =	7 + 8 =
2 + 5 =	3 + 9 =	8 + 8 =	3 + 7 =	4 + 9 =	0 + 8 =	7 + 5 =	6 + 8 =	5 + 3 =	2 + 9 =
7 + 6 =	5 + 9 =	5 + 4 =	6 + 6 =	9 + 7 =	7 + 4 =	8 + 7 =	5 + 2 =	3 + 8 =	8 + 9 =

Appendix B

Scoring Rubric for Habits of Mind Problems	Points Possible	Points Earned
Writing: **0 points**-no/little attempt to write a paragraph with 3-5 complete sentences explaining process and solution, and multiple sentence structure and mechanics errors **1 point**-2-3 complete sentences, but no *clear* explanation of process and solution, and sentence structure and mechanics errors **2 points**-3-5 complete sentences with a little, or unclear, explanation of process and solution, and sentence structure or mechanics errors **3 points**-3-5 complete sentences with a somewhat clear explanation of process and solution, or clear explanation with minor sentence structure or mechanics errors **4 points**-3-5^{+} complete sentences with a clear explanation of process and solution and accurate sentence structure and mechanics	4	
Diagram: **0 points**-no diagram or diagram doesn't illustrate the written description with inaccurate or no labels **1 point**-diagram is unclear with inaccurate or no labels **2 points**-diagram is somewhat clear with inaccurate labels **3 points**-diagram is mostly clear and accurate with minor errors **4 points**-diagram is accurate with appropriate labels	4	
Solution: **0 points**-Solution not given **1 point**-Solution is given, but incorrect **2 points**-Solution is given, but partially incorrect or an incomplete solution **3 points**-Solution is given, correct with minor error **4 points**-Solution is given and correct	4	
Presentation: **0 points**-Did not participate in presentation **1 point**-Scarcely participated in presentation or unclear explanation **2 points**-Somewhat actively participated in presentation w/unclear explanation **3 points**-Actively participated in presentation, w/somewhat unclear explanation **4 points**-Actively participated in presentation, w/clear explanation	4	
Total	16	

Teacher Journal Week of _____

Description:

Reflection:

How it relates to my research questions:

What does it mean to me:

Research Questions to focus on:

1. What will happen to children's problem solving when they are permitted or not permitted to use calculators in the classroom?
2. What will happen to student attitudes toward mathematics when they are permitted or not permitted to use calculators in the classroom?

Reflection Questions:

1. How does each of the two incidents I wrote about relate to my research questions?

   Problem Solving: (permitted/not permitted to use calculators)

   Student attitudes toward mathematics: (permitted/not permitted to use calculators)

2. What went really well this week, related to my problem of practice (Calculator Use)?

3. What changes have I seen in my students' attitudes this week as they were allowed/not allowed to use their calculators?

4. What did I learn this week about my students' problem solving when they were permitted/not permitted to use their calculators?

5. What did I learn this week from my students' attitudes when they were permitted/not permitted to use their calculators?

Appendix C

Teacher Journal Week of _____

Possible Journal Topics:
Monday

_____
Tuesday

_____
Wednesday

_____
Thursday

_____
Friday

_____
Details of Two Events:
Description:

Reflection:

How it relates to my research questions:

What does it mean to me:

Research Questions to focus on:

3. What will happen to children's problem solving when they are permitted or not permitted to use calculators in the classroom?
4. What will happen to student attitudes toward mathematics when they are permitted or not permitted to use calculators in the classroom?

Reflection Questions:

6. How does each of the two incidents I wrote about relate to my research questions?

Problem Solving: (permitted/not permitted to use calculators)

Student attitudes toward mathematics: (permitted/not permitted to use calculators)

7. What went really well this week, related to my problem of practice (Calculator Use)?

8. What changes have I seen in my students' attitudes this week as they were allowed/not allowed to use their calculators?

9. What did I learn this week about my students' problem solving when they were permitted/not permitted to use their calculators?

What did I learn this week from my students' attitudes when they were permitted/not permitted to use their calculators?

Appendix D

Name _____

MATH SURVEY

Please give your honest response to each statement, 1 being low and 5 being high.

1. I like math.	1	2	3	4	5
2. I am good at math.	1	2	3	4	5
3. math skills are important for other skills.	1	2	3	4	5
4. I am able to show the work required to solve math problems.	1	2	3	4	5

CALCULATOR USE

Please give your honest response to each statement:
1 being never, 3 being sometimes, and 5 being always.

5. I am allowed to use a calculator in math…	1	2	3	4	5
6. I feel comfortable answering questions on my homework without a calculator.	1	2	3	4	5
7. I am confident using different functions on my calculator.	1	2	3	4	5
8. I am confident that I can recall my math facts easily without a calculator.	1	2	3	4	5
9. I enjoy using a calculator to help me solve math questions.	1	2	3	4	5
10. I am more confident answering math questions when I use a calculator than when I do not use a calculator.	1	2	3	4	5
11. I do better when I use a calculator on my assignments and tests.	1	2	3	4	5
12. If I could choose when to use my calculator I would use it…	1	2	3	4	5
13. I know that when I put my work into the calculator, the calculator is _____ right.	1	2	3	4	5
14. I depend on my calculator…	1	2	3	4	5

15. One good thing that happened in math is:

16. One not so good thing that happened in math is (please do not use any specific names):

17. The person I go to most when I have a mathematical question is:

18. When I am given a Habit of Mind problem I feel:

Why?

19. When solving a Habit of Mind problem, I find that calculators make it:

Explain.

20. The time I spend working on math homework outside of school is:

21. The time I spend using a calculator on my homework is:

22. When I plug numbers and functions into my calculator, I know that my answer is:

Why?

23. If I do not have my calculator to do my math work, I feel:

24. When I am asked to show my work, my calculator <u>does</u> or <u>does not</u> help me.

Why?

25. If I am not allowed to use a calculator I feel:

Appendix E

Individual Student Interview Questions

Research Question:
3. What will happen to students' ability of recalling of math facts when they are permitted or not permitted to use calculators in the classroom?

Student: **Class:** **Date:**

1. **What do you like best about Math?**

2. **What do you like least about Math?**

3. **What makes math easy or difficult for you?**

4. **What could teachers do to help students with math?**

5. **On average, how would you rate your involvement in math class? Why? (1 being 'not involved' and a 4 being 'very involved')**

6. **What helps to get you involved in math class?**

7. **Do you participate in class discussions? Why or why not?**

8. **If calculators were allowed during class discussions, would you be more confident participating in class discussions? How much do you think that would affect your participation, if at all? Please explain.**

9. **Do you think that an average 8th grader should be able to recall math facts without a calculator? Please explain.**

10. **On average, how would you rate your ability to recall math facts accurately? Why? (1 being 'not well' and 4 being 'very well')**

11. **What about math facts makes them easy or hard to recall?**

12. **On a scale of 1 to 5, 1 being never, 3 being sometimes, and 5 being never, how often should a calculator be used in the classroom? Why?**

13. **Are you confident in your math ability? Why?**

14. **Are you confident in your math ability more or less when you use a calculator? Why do you think that is?**

15. **Are you more confident when you work without a calculator or when you work with a calculator? Why do you think that is?**

16. **What advice would you give me for next year about having students use calculators in class?**

17. **Is there anything else I should know about you to better understand your ability to recall math facts in math or your general math experience?**