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Traditional Versus Technology Enhanced Instruction in the Geometry Classroom

Andrea McFarland

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Traditional Versus Technology Enhanced Instruction in the Geometry Classroom

Abstract
Technology integration into the classroom is more commonplace today. Teachers, administrators, and the student body are given technology in their classrooms in the hopes it will help with learning. The question of whether or not this technology is beneficial or detrimental to the student's learning needs to be researched. Specifically in the Geometry classroom, the query of whether dynamic geometry software helps students learn the geometric concepts or inhibits them from fully understanding the material needs to be explored. Literature on integration of technology is reviewed, an experiment dealing with a traditional instructed geometry lesson and a technology enhanced geometry lesson is explained and results are shown. Modifications to the experiment are suggested to better help future research in order to answer the question of whether technology enhanced instruction in the geometry classroom benefits or deters from the students' learning.

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Technology integration into the classroom is more commonplace today. Teachers, administrators, and the student body are given technology in their classrooms in the hopes it will help with learning. The question of whether or not this technology is beneficial or detrimental to the student's learning needs to be researched. Specifically in the Geometry classroom, the query of whether dynamic geometry software helps students learn the geometric concepts or inhibits them from fully understanding the material needs to be explored. Literature on integration of technology is reviewed, an experiment dealing with a traditional instructed geometry lesson and a technology enhanced geometry lesson is explained and results are shown. Modifications to the experiment are suggested to better help future research in order to answer the question of whether technology enhanced instruction in the geometry classroom benefits or deters from the students' learning.
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Traditional Versus Technology Enhanced Instruction in the Geometry Classroom

Traditional instruction in the New York State Geometry classroom usually consists of lecture, some hands on activities, board work, and homework. As of late, schools have had a push towards the more frequent integration and use of technology in the classrooms. Technology such as graphing calculators, the uses of computer software and interactive whiteboards are being pushed into schools and onto math teachers as the new and ideal way to teach the concepts to students. The hook for schools to actually bid and buy the new technological products is a promise to keep students engaged in the lesson and to dispose of the problems of lack of motivation and interest. In addition to this hook, the general knowledge that high school students in this day in age are very interested in computers and video technology leads teachers and administrators to believe that the students would want to go to a classroom where these technologies are being used. The promise is presented to schools due to the need for accountability of teachers and administrators so that students perform better on standardized tests as well as students gaining the training of different types of technology for their future careers.

Interactive technology in math classrooms plus the math concepts, students, and experienced teachers should equal success in learning. However, the question of whether this technology actually helps the understanding of the geometric concepts or is just an entertainment factor for the students needs to be researched. With this question in mind, a minimal study testing the effects of technology integration into a usual geometric concept such as angles that are formed when parallel lines are cut by a transversal will be completed. The purpose of this study is to hopefully see whether or not technology actually affects the student’s ability to learn the concept and furthermore retain it, be able
to explain it, be engaged in learning it, as compared to those students who receive traditional instruction of the concept. At the end of this study the expected outcome would be that technology does enhance traditional instruction and allows the learner to retain, understand, and explain what they have learned in the geometry classroom, with student feedback, grade results, and teacher observations. Furthermore, the results of observation, student feedback, and grades will show whether or not the students are engaged in lesson and retain content rather than just be engaged to be entertained.
Literature Review

The integration of technology into classrooms has been frequently tested. The determination of whether or not this integration of technology is a positive attribute to learning and understanding of the material in the curriculum or just an entertainment factor for students to have fun in class is reviewed. A background for how technology is integrated into the classroom is discussed along with the pros and cons of this integration in the classroom taking place.

Background

Technology being used as a learning aid has led many to research whether technology does in fact aid students in their learning or if the technology actually acts as a detriment to the learning process. As one walks into schools today, classrooms are equipped with computers, projectors, and Internet access and are more technologically advanced than those classrooms equipped with only chalkboards and desks (Labbo, 2006; Angelo & Woosley, 2007). Schools have taken a big stance by including different types of technology into classrooms of today. According to Ertmer (2005) and the United States Department of Education (2001), technology is considered by most parents and teachers as an integral part of a high quality education. With all of this technology in place in classrooms, the view of technology being integrated into classrooms is now more focused on how a teacher use the technology they are given to enhance their lessons and help their students learn. Ertmer discussed that “ultimately, the decision regarding whether and how to use technology for instruction rests on the shoulders of classroom teachers” (p. 27). Teachers need to find ways to effectively use technology as a tool in learning environments instead of using the technology because it is there (Isiksal &
Askar, 2005; Laborde, 2007). For teachers to want to use the technology in their classroom, there has to be a solid understanding that the time that they spend on incorporating it into their lessons will help their students and not take away from the overall learning. When looking into technology integration in schools, one needs to consider both the pros and cons of the specific technology (Qing, 2003).

**Technology as a Learning Aid**

According to Becker (1994) and Ertmer (2005), computers serve as a valuable tool in classrooms when teachers have access, are prepared and have some freedom in their curriculum to be able to correctly incorporate them into their lessons. This is not always the case. However, when this scenario does occur, the ability for technology to be a learning aid is observable and measurable. Mills and Tincher (2003) suggested that to help students construct meaning in the math classroom, appealing to the students’ multiple modalities of learning with the use of technology could be beneficial. When using technology, Labbo and Reinking (1999) warned that there is not one way to integrate technology into the classroom. There are many teachers who use technology for many minuscule tasks and do not incorporate the technology in higher level learning uses (Ertmer, 2005). When teachers do use the technology appropriately in their classrooms, the results speak for themselves.

The technology present in some math classrooms includes a computer, computer software such as Microsoft PowerPoint and Geometer’s Sketchpad, and calculators, both graphing and scientific. Math teachers can incorporate this technology successfully into their curriculum. With the use of programs like Geometer’s Sketchpad, students are able to detect relationships and changes in shapes that are not usually taught in traditional
school settings (Hannafin & Scott, 1998; Isiksal & Askar, 2005). Students are able to explore relationships of shapes in the Geometry curriculum on their own and they are in an environment where they can discover the relationships without the need of a teacher telling them (Hannafin, 2001; Isiksal & Askar, 2005). Furthermore, the use of such computer software enables the students to see Geometric concepts represented visually and in an interactive way (Qing, 2003). In this matter, the student can use the technology to learn and retain more information since they were the discoverer of the relationships instead of being the receiver of the information by an instructor (Witt, 2003; Angelo & Woosley, 2007). For instance, since Geometry is very visual in its content, the accessibility and use of such Geometry software enables the students to be able to see connections of their learning of different properties of a shape in order to be able to transform it on the software (Radford, 2000; Laborde, 2007; Ruthven, Hennessy, & Deaney, 2005; Hoyles & Noss, 2003). With the use of Geometer’s Sketchpad or Cabri, students are able to justify their mathematical ideas by being able to explore independently and make and test conjectures without the need of justification from their teachers (Pandiscio, 2002). In order to use the Geometry software productively, the student must know the mathematical knowledge prior in order to be able to interpret what the software is presenting (Noble, Nemirovsky, Dimiattia, & Wright, 2004; Laborde, 2007). The use of the software in the classroom is symbiotic with the teaching of the concepts. One cannot be understood correctly without the other. In this way, technology helps to create mathematical knowledge as it also provides reasons for mathematical knowledge (Laborde, 2007). In turn, using this visual technology can help uncover students’ misunderstandings of the content and enable the teacher to reteach and stop a
misunderstanding from continuing (Jones, 2002). In accordance with Pandiscio (2002), "the point of Geometry is to learn how to use deductive knowledge" (p.218). When students are able to test and retest their hypotheses during the course of Geometry, the teacher and the student are better able to see their deductive reasoning being used and perfected (Pandiscio, 2002). Using the different types of technology in math lessons will also allow the student to see the connections between the different types of representations: visuals like graphs and diagrams, to tables of numbers (Kaput, 2001; Laborde, 2007).

Another piece of technology used in a math classroom as well as other classrooms, is Microsoft PowerPoint. With the use of PowerPoint, teachers are able to organize their lectures and include pictures, entertaining fonts and videos that go along with the content (Klemm, 2007). With the use of PowerPoint, teachers can provide both structure and clarification of the material and in addition add variety into the lesson by using different modes of technology (Pauw, 2002; Angelo & Woosley, 2007).

According to Angelo and Woosley (2007) "technology has evolved and become more central to teaching and learning" (p. 462). Jonassen (1996) added that learning with computers helps the student build knowledge when they are used as tools. With technology being integrated into the Geometry curriculum, students can explore problems more deeply with the dynamic geometry software than without (Pandiscio, 2002). In addition to helping the students build knowledge in the classrooms, the use of technology allows students to learn how to use the different modes of technology preparing them for when the students enter their chosen career or field in their future (Laborde, 2007; Hawkridge, Jaworske, & McMahon, 1990). In essence, using technology enhances the
lesson in school, but also prepares the student to learn how to use the technology in society for their careers. According to the National Council of Teacher’s of Mathematics (2000), “technology is essential in teaching and learning mathematics; it influences, the mathematics that is taught and enhances students’ learning” (p.11).

Technology as a Deterrent to Learning

The problems with technology and learning are presented by Olson & Clough (2001) by saying “Although technology could assist teachers and students in making schooling effective, in many ways it exacerbates current problems” (p. 8). Some feel that technology is only looked at to be integrated into the school curriculum as a saving grace from the current problems that occur in classes, and specifically math classrooms, that of a lack of motivation and a common disinterest in learning the content. The common student questions of why are we learning this and why do I care should enter the minds of the educator as they read this.

Technology is often used as a tool for entertainment to keep student interest (Klemm, 2007, Olson & Clough, 2001). Teachers often use the technology as an addition to their lessons, but the use of the technology often has nothing to do with the content of the lessons (Olson & Clough, 2001). In this manner, how the use of technology undermines the seriousness of the curriculum (Olson & Clough, 2001). Let us first discuss the problem with the teacher’s integrating technology into the curriculum.

Teachers of mathematics are not always trained in the latest technology that appears in their classroom. It is not that technology does not already exist in classrooms, in most it does. The distinction between idea technology such as Geometer’s Sketchpad and Cabri, and product technology like PowerPoint and presentation simulations needs to addressed
when teachers are asked to integrate technology into their classrooms (Otero, Peressini, Meymaris, Ford, Garvin, Harlow, Reiddel, Waite, & Mears, 2005). Most of the time, technology that is used in the classroom is used incorrectly, and this is due mostly to the inexperience of the educator (Labbo, 2006; Brinkerhoff, 2006). When this occurs, “teachers fail to capitalize on the educational potential offered by the technology resources” (Brinkerhoff, 2006, p. 22). Furthermore, to expect teachers to have a full understanding of the technology would require more time of the educator to put towards learning the technology in addition to the time they spend on their students already (Brinkerhoff, 2006). Integrating technology correctly has its barriers such as reliability, the teacher’s time to learn the technology and master it, determining whether or not technology is critical for the learning of the concept that day and ultimately inadequate instructional support (Otero et al., 2005). With all of these barriers that the teacher has to confront in order to use technology effectively, it is no wonder that technology is not always effective in teacher, it is being used ineffectively to begin with. Thus, the ineffective use of the technology ultimately leads to a decrease in the student’s learning (Angelo & Woosley, 2007). As a side, when the teacher does have the background knowledge of the technology, it is often that the teacher has to teach the students how to use the technology in addition to the curriculum in order for the tool to be used effectively (Laborde, 2007) and this does not always happen. According to Mills & Tincher (2003), technology integration includes five stages: entry, adoption, adaptation, appropriation, and invention. Entry - stage teachers use text - based materials and instruction to support teacher - directed activities. Adoption - stage teachers use
technology for keyboarding, word-processing, or drill-and-practice software. Adaptation—phase teachers integrate new technologies into classroom practice and students use word processors, databases, graphic programs, and computer assisted instruction. Appropriate—stage teachers begin to understand the usefulness of technology and student's work at computers frequently as project-based instruction begins to take place. In the invention stage, learning becomes more student-centered as multidisciplinary, project-based instruction, peer tutoring, and individually paced instruction occur. (p. 383)

Teachers that do not have a solid understanding of the technology they are using in their classrooms will never reach the appropriate—stage that is fitting and helpful in the geometry classroom (Mills & Tincher, 2003). Most teachers will only be at an entry-stage level of understanding and using technology in the classroom. This lack of understanding by the teachers makes it difficult for students to learn mathematical concepts with the use of technology.

Specific issues that identify problems in learning when technology is used are misuse of the PowerPoint presentations and misunderstanding of graphing calculators. A common problem with PowerPoint presentations, is often the teacher can get ensnared into that type of lecturing and lose the ability to add on to lessons to clarify misconceptions with the content (Klemm, 2007; Klemm, 2004). It has been found that although PowerPoint presentations are easily incorporated into the lesson and teaching mode of the educator, it is often seen that these presentations have too much information in them and tend to confuse students (Klemm, 2007). In a typical slide show, students try to learn everything at once and get misled into thinking that they actually understand the
concept, when in fact they have not (Klemm, 2007; Cowan, 2005). Furthermore, often times the way the content is presented to students in technological forms, is not as complex as the content should be and makes the content appear simple (Olson & Clough, 2001; Qing, 2003; Phillips, 1995).

The use of calculators in the math classroom has become an expected common practice. According to Paulos (1988), the way math is taught with the use of calculators leads to the problem of innumeracy. Students need to know prior to using the calculators, exactly what the calculator is doing in relation to the content (Olson & Clough, 2001). Furthermore, when students use calculators in class to help them with the concept being taught, students often have not seriously grasped the content before the educator tells the student to just use the calculator to find the answer (Olson & Clough, 2001). In addition to circumventing in depth understanding of the content, calculators often hide misunderstandings of the content when they are used to find answers to problems. Teachers cannot diagnose the work done on a calculator unless all of the buttons pushed by the student are diagrammed (Olson & Clough, 2001).

Out of all of the misuses and misconceptions hidden by the use of technology being integrated into classrooms, the biggest issues with technology are due to its entertainment value and the elimination of mundane tasks. Teachers would rather entertain their students so they have fun at the expense of serious study (Olson & Clough, 2001). For example, Olson & Clough (2001) wrote:

...engaging prior knowledge, grappling with new experiences, struggling to make sense of those new experiences, thinking about thinking, making new connections, and finding that prior connections no longer make sense are serious
and difficult struggles requiring much effort, diligence, and perseverance on the student’s part. Those activities are precisely what television, radio, computers, calculators, graphing software, and many other forms of technology circumvent. (p. 9)

Olson & Clough (2001) continued by indicating that technology is also misused to evade dull and tedious tasks such as using the spelling and grammar check, calculators, and graphing software. All of the tasks that these technologies help with, students can complete on their own volition.

When Technology is Integrated Appropriately

In the plight to see whether or not technology integration into the classroom aids or deters from learning, research has found that the use of technology is beneficial as long as it is used correctly. Schools cannot ignore the rapid increase in presence of technology. “Technology takes an increase in importance as we continue to move from an industrial to an information based society” (Otero et.al, 2005, p. 9). Good teaching and use of technology need to co-exist (Laborde, 2007). When considering the use of technology in the classroom, teachers must first look to make sure they understand the technology they are integrating. The use of technology in the classroom involves much more than just adding technology to the course (Otero et. al, 2005). One should not use technology if it is primarily for entertainment purposes (Olson & Clough, 2001).

Research has also shown that “...technology may deeply change the nature of mathematical activity at school and consequently the teaching and learning of mathematics” (Laborde, 2007, p. 88). This change is for the better.

Summary
Research has shown that the integration of technology in schools has both positive and negative aspects. Overall, the positive aspects outweigh the problems that might occur during the course of technology integration. Most of the problems that could occur with the integration are due to user error, mostly due to the educator. In essence, in order for technology to be integrated into the curriculum properly, there has to be a solid foundation and determination from both the educator and the student. “Teachers are the key to helping their students gain a conceptual understanding and using technology to reinforce it” (Olson & Clough, 2001, p. 11).
Methodology

Traditional forms of teaching geometry versus teaching geometry with the use of technology can best be studied directly in the classroom setting. To evaluate both types of instruction and their effectiveness, both types of instruction need to be performed on the same sample. The following will provide one with the ability to reproduce the study on their own sample.

Participants

The study took place in a rural school district. The high school of the school district housed about 400 students from the grades of nine through twelve. The study focused particularly on students who were taking Geometry, a tenth grade subject. The students who participated in this study were in grades nine through twelve. The students schedule was that of a four-day rotating schedule of eight classes with fifty-five minute periods. The study was broken into two iterations. The first iteration of instruction dealt with two classes. Students who took Geometry during the second and third periods of the day participated. Second period consisted of students from grade ten through twelve, fourteen in total. This class maintained a class average of 90% throughout the year. Third period consisted of students in grade ten through twelve, twenty-two students in total. This class maintained a class average of 93% throughout the year. For the second iteration of instruction, two other Geometry classes participated. Students who took Geometry during the first and seventh periods of the day participated. First period consisted of students from the grade ten through twelve, fourteen in total. This class maintained a class average of 88% throughout the year. Seventh period consisted of students from grade ten through twelve, twenty-three students in total. This class
maintained a class average of 89% throughout the year. All four classes had the same instructor. The four classes were chosen, due to those classes being on the same phase of mathematics courses needed for graduation. The classes were split into two iterations based upon total students in each class and class average. The first and second iterations consisted of two classes both with one class with fourteen students and the other class bigger with twenty-two to twenty-three students. Having a class with few students and a class with many students was chosen to eliminate the possibility of class management being a detractor of results after the study had taken place. Furthermore, the two iterations of two classes had similar class averages to maintain continuity of student performance during both iterations of instruction.

All four classes that participated in the study had the same instructor and all four classes took place in the same classroom. The classroom environment was suitable for mathematical instruction. Instruments and materials were easy to access as well as the rules and expectations were identical for all classes. Students sat in groups of two desks in rows. The classroom decorations were evident yet minimal, the classroom could be considered neat and clean.

*Instruments and Materials*

For the first iteration of the study, compasses, straightedges or rulers, blank 8 ½” x 11” paper, protractors and a pencil were supplied for the students during the lesson. For the instructor’s use, a whiteboard, overhead projector, whiteboard compass, oversized straightedge and protractor were required for the lesson. In addition to the instruments needed, copies of the notes are provided for students after the hands-on activity had taken place.
For the second iteration of the study, pen or pencils and notes were provided for the students during the lesson. An overhead display for the TI-83 calculator equipped with the Cabri Jr. program as well as a graphing calculator were needed for teacher use.

A quiz and survey were needed for research purposes during this study. A quiz was administered to each group of classes to assess the effectiveness of traditional instruction versus instruction with the use of technology (see Appendix A). After both iterations of students receive both types of instruction, a survey was administered to get the students' opinions of the instruction models and their learning from each of the instruction models (see Appendix B).

Data Collection

The effectiveness of traditional instruction versus instruction with the use of technology was evaluated based upon observations, an assessment, and student input. Observations were made and recorded during the iterations of the lesson used for the study. Teacher observations and coworker observations were used. As for the assessment, students took the same quiz and their grades were compared for mastery of the content taught during the lesson. A survey was used for students to give their input on which iteration of the lesson they believed helped them the most as well as which one they preferred for future lessons. All data was stored in a secure location in which only the researcher had access.

Procedures

Prior to the lesson being implemented, students and their parents or guardians were informed with a letter about their student’s participation in the study (see Appendix C). Minor consent forms were also handed out in order for the surveys to be used for
research purposes (see Appendix D). After students and their parents or guardians were aware of the study, the first iteration of the study was implemented to the second and third period classes on the same day. Students had received the same introductory lesson the day before. This introductory lesson consisted of definition and vocabulary of parallel lines and transversals.

The first implementation of the study considered the use of traditional instruction in the Geometry classroom. As students situated themselves at the beginning of the period, the teacher instructed students to clear off their desks except for a pencil and continued by passing out a blank 8 ½” x 11” piece of paper. The teacher proceeded to hand out a compass, a ruler, and a protractor to each student. Students were reminded about proper use of the geometric tools they were given. The teacher informed the students that they were to discover relationships between angles formed when parallel lines were being cut by a transversal. The teacher proceeded to do a step-by-step construction of parallel lines being cut by a transversal. The students followed every step of the construction. The teacher checked frequently to make sure students were following each step without difficulty. The student’s constructions were not all the same. The teacher allowed the students to draw a transversal any direction they chose. After students completed the construction, the teacher instructed students to measure the angles made by the parallel lines being cut by the transversal with their protractor. Students measured the eight angles that were formed by the construction. The teacher walked around the room helping students use the tools and to make sure the students were doing what they were asked. When the teacher observed that most of the students had found the angle measures, the students were instructed to look at the angles and see if they were
any similarities in the measurements. Students were given five to eight minutes to do this. After students had recorded their observations, the teacher instructed the students to compare their constructions with their neighbor. After the discussion, the teacher brought the students’ attention to the front of the room to record their observations. The teacher asked for volunteers of what the students had seen during their measuring and discussions. The teacher recorded their discoveries on the front board. Following the student’s suggestions of what they had found, the teacher brought their attention to what they had discovered and connected it to the lesson that day. The teacher proceeded to hand out the note sheet (see Appendix E) for the lesson to the students. The teacher used the overhead projector with the notes on transparencies to go over what they had discovered in their construction and discussed geometric relationships that existed. The students filled in the notes as the teacher went over them. The teacher then connected the concepts of lesson with practice examples on the note sheet. The students were assigned homework to practice the concepts on their own to see if they had comprehended the material. The students were also reminded that there would be a quiz on the material on the following class-meeting day.

On the same day, the second iteration was implemented to the seventh period class and on the following day, the second iteration was implemented to the first period class. The second iteration of the lesson was instruction with the use of technology. After students settled, they were instructed to get a blank sheet of paper out on their desk and a writing utensil. The teacher used their TI - 83 graphing calculator and overhead display to show the students parallel lines cut by a transversal with the angles already measured with the use of the Cabri Jr. program on the calculator. Students were then instructed to
look at the display on the screen and to write what relationships they observed on their piece of paper. The teacher moved the transversal so that the angle measurements changed and the students could observe more than one construction. Following this, the teacher then allowed the students to share their observations with the rest of the class. The teacher recorded their observations on the front board. The teacher kept the calculator display on the screen so students could still observe the picture as students were making their suggestions. After the students were exhausted of their observations, the teacher brought the students attention to the concepts that they were going to learn that day and the relationship to the observations that they had already made. The teacher proceeded to hand out the note sheet, which was the same for both iterations, for the lesson to the students. The teacher used the overhead projector with the notes on transparencies to go over what they had discovered in their construction and discussed geometric relationships that existed. The students filled in the notes as the teacher went over them. The teacher then connected the concepts of lesson with practice examples on the note sheet. The students were assigned homework to practice the concepts on their own to see if they had comprehended the material. The students were also reminded that there would be a quiz on the material on the following class-meeting day.

The following day the instructor saw all sections. The homework that they were assigned was gone over and questions were answered. The teacher reviewed the material that they learned the day before on the board with the students finding the pairs of angles and identifying their relationships. The students were given five minutes to study and the quiz was administered. Students with testing modifications had their modifications
administered. All students completed the test in the time allotted. The teacher then proceeded on with the next lesson.

The next lesson depended on what iteration the students received. The students, who received the instruction in the first iteration, second and third period, received the second iteration of the lesson. Furthermore, the students who received the second iteration first, first and seventh period received the first iteration as their next lesson. The next day, students were given their graded quizzes and were then asked to fill out the survey on their reactions and beliefs of the two iterations of the lesson they had received.

The surveys were collected that day. Students, who were absent either day the lesson iterations were given, were not allowed to participate in the survey. The classes were observed each day by the same coworker. Observations from the teacher and the coworker were recorded. All surveys and observations were kept by the instructor in a safe and secured place.
Results

Following the completion of the two iterations of instruction, the quiz results, observations, and surveys were collected. The first iteration of the experiment consisted of the second and third periods of the day. The second iteration of the experiment consisted of the first and seventh periods of the day. Not all students were present during the iterations of the lessons. Those students who were not present in both iterations of the experiment did not partake in the survey and their scores on the quiz were not included in the quiz grade analysis. The researcher and another teacher at the school who taught Geometry the year prior performed the teacher observations that were recorded.

First Iteration

Second and third period classes participated in this part of the experiment. There were 14 students enrolled in second period. The class average was 90%. Eleven students participated in the experiment from this class. Two students were not present during the whole week of instruction due to a senior trip and one student had extensive absences and did not make up the work until a later time. There were 22 students enrolled in third period. The class average was 93%. Twenty students participated in the experiment from this class. Two students were not present during the whole week of instruction due to a senior trip.

Following up the construction lesson, second and third periods took a teacher constructed quiz (see Appendix A). The quiz was scored out of one hundred percent. Second period’s mean average for the quiz was 86.5%. Third period’s mean average for the quiz was 92.3%. The mean averages were recalculated eliminating the extreme
scores to eliminate outlier scores that would skew the data. Second period’s average for the quiz was 88.4% and third period’s was 93.3%.

Teacher observations were recorded of the two classes. These observations were of the lesson, so the results from the observations related to both classes. It was observed that students were able to see relationships on their own, without the need for the teacher to prompt them or show them the relationships they were supposed to find. Students were also able to show their understanding of the relationships in the discussion and homework. Students were also able to use their prior knowledge that parallel lines had the same slope and construct the parallel lines using that information with a compass and straightedge. It was further noted in the observations that in the third period, it was much harder to manage all the students constructing and helping them with their problems. Students gave up on their constructions if they made too many mistakes. Students did not make precise measurements when using their protractors or they did not use the geometric tools properly to when constructions were made.

Second Iteration

First and seventh period classes participated in this part of the experiment. There were 14 students enrolled in first period. The class average was 88%. Eleven students participated in the experiment from this class. Two students were not present during the whole week of instruction due to dropping the class and one student was on a senior trip. There were 23 students enrolled in seventh period. The class average was 89%. Twenty-two students participated in the experiment from this class. Two students were not present during the whole week of instruction due to a senior trip.
Following up the technology-enhanced lesson, first and seventh periods took a teacher constructed quiz (see Appendix A). The quiz was scored out of one hundred percent. First period's mean average for the quiz was 87.1%. Seventh period's mean for the quiz was 90.6%. The mean averages were recalculated eliminating the extreme scores to eliminate outlier scores that would skew the data. First period's average for the quiz was 88% and seventh period's was 90.9%.

Teacher observations we recorded of the two classes. These observations were of the lesson, so the results from the observations relate to both classes. It was observed that with the use of the Cabri Jr. program on the graphing calculator, the teacher could control the lesson with more ease. The classes were able to move further into the material and the problems without the time taken on constructions. Students needed more time to make connections to the relationships and the teacher needed to prompt the students more for answers. The teacher had to modify the lesson and review vocabulary of the lesson further.

Survey Results

Surveys were collected from all four periods, ten surveys from second period, 21 surveys from third period, 12 surveys from first period, and 22 surveys from seventh period. All surveys collected were from students who participated in both iterations and the quiz. Not all surveys were returned. The survey consisted of eight questions in which the students were asked to answer to the best of their ability (see Appendix B). Question one asked the students which method of instruction they liked the most. Eight students from first period, eight students from second period, seventeen students from third period, and ten students from seventh period indicated they preferred the technology
enhanced calculator method. Four students from first period, two students from second period, four students from third period, and twelve students from seventh period indicated they preferred the construction method. Overall, out of the 65 surveys collected, 66% of the students preferred the technology enhanced calculator method to the 34% who preferred the construction method.

Question two asked the students why they like the method they indicated in the first question. For those students who preferred the calculator method, their responses indicated that “it was good to see the lines move and the different angle measure,” and that they “didn’t have to do anything but look at the board.” For those students who preferred the construction method, their responses indicated that they “liked to use the tools,” and “it was fun to construct.”

Question three asked the students what they liked about the method they chose. For those students who preferred the calculator method, their responses indicated that they “got to see what the calculator everyday could do.” For those students who preferred the construction method, their responses indicated that they “could see that no matter what two lines anyone drew, the relationships were still there, and we just drew them!”

Question four asked the students what they did not like about the other method of instruction. For those students who had indicated that they preferred the calculator method, they did not choose the construction method “because it was too hard to make” and “I hate compasses.” For those students who had indicated that they preferred the construction method, they did not choose the calculator method “because I didn’t get it” and “I didn’t get to do it.”
Question five asked the students which method they would be able to reproduce on their own. Overall, all students indicated that they would be better able to try the construction method. The main reason was because they were not taught how to use the program on the calculator.

Question six asked the students if they would prefer both methods to help them learn the concept or just one. Student responses were varied. Some students felt “no, after we made the construction, we didn’t need the calculator.” A few students felt “probably just the construction method, but I would like to learn how to use that program, it looked fun.”

Question seven asked the students if they would like to see more technology used in the classroom and indicate if they knew of any technology they would like to try. Almost all of the students indicated that they would like to use more technology in class. Comments such as “it would be so much more fun to play with computers and still learn math” were handed in. In response to what types of technology they would like, only one or two students were able to mention any other modes of technology. The students mentioned the Promethean Board they use in their accounting class with another teacher in the building.
Discussion

It was thought that the differences between the results of the traditional instruction and the technology enhanced instruction would be significant, but they were not. If anything, the results from this experiment gave way to many conjectures to lead future research regarding technology enhanced geometry instruction. The outcomes from the observations, quizzes, and surveys will be discussed and the relevance of the experiment will be evaluated.

The results from the quiz of the students in the first iteration were monotonous. Second period and third period participated in the first iteration of the experiment which had the students learn the concept of parallel lines being cut by a transversal through hands on constructions. Second period’s class average was 90% and they scored a class average of 86.5% on the quiz. This showed a decrease in understanding of the material that they had learned. Third period’s class average was a 93% and they scored a class average of 92.3% on the quiz. The difference in class average was not significant enough to make a conclusion.

Due to research performed on technology enhanced instruction, the results from those students who participated in the second iteration, who were instructed using technology to help them understand the concept of parallel lines being cut by a transversal, should have performed at a higher level of understanding (National Council of Teacher’s of Mathematics, 2000). First and seventh period participated in the second iteration of the lesson in which the graphing calculator was used to enhance the lesson to help students learn the material. First period’s class average was 88% and they scored a class average of 87.1% on the quiz. Seventh period’s class average was 89% and they
scored a class average of 90.6% on the quiz. First period's results indicated that they stayed pretty close to their class average indicating that they performed consistently with their performance level in Geometry the rest of the year. Seventh period's results indicated that they outperformed their class average by increasing their average almost two percent. This shows that the students performed better on this quiz than their performance in geometry through the year thus far. This result goes along with what Angelo and Woosley (2007) found that technology in the classroom helps students build knowledge.

Those students who had received traditional instruction with constructions showed a decreased class average on the assessment. This result could indicate that traditional instruction did not help the students understand the concept, but rather it just taught them a skill of how to construct parallel lines cut by a transversal and measure with a protractor to find items that were equal. Furthermore, this decreased class average could indicate that the student's in second and third period were not kinesthetic learners. Perhaps, the hands on activity of constructing the parallel lines did not help them learn regarding their learning styles.

Overall, the quiz produced little results. The change in performance of the two iterations was not as significant as expected. According to literature on technology enhanced instruction, students who have the benefit of technology with the Geometry curriculum should show improvement in understanding with the ability to see the geometric concepts and with the opportunity to explore the concept more visually (Witt, 2003; Angelo & Woosley, 2007). This result was not evident. Students who participated in the second iteration where technology was used in instruction, showed improvement
but only in one of the classes that was part of the iteration. This lack of significant results leaves the question if the quiz itself has faults. Perhaps, the quiz was not aligned with what was taught in the class. The quiz assessed whether the students could identify the relationships of the angles that the parallel lines being cut by the transversal formed.

Perhaps an assessment to have the students construct and explain the relationships would have measured the students' ability to demonstrate what was taught in class.

The lack of significant results on technology helping students better understand the concept from the quiz, leads one to look for understanding through other measures, such as observation. If results do not appear in measurable evaluations, perhaps results of technology helping students will be observable.

Teacher observations can lead to an incredible insight into how the students are performing during the lesson. Observations assess during the learning instead of after the learning has occurred like quizzes. Comparing the two classes and how they performed during the different types of instruction will help with future research possibilities.

Students who were taught using the construction method were seen to have more aha moments. The students exhibited excitement when they would discover a relationship when they were measuring their angles and comparing them to the person next to them. Students were also seen to get frustrated with using the tools. Their frustrations were clarified with their responses in the survey that they completed. Students who were taught using the graphing calculator and the dynamic geometry software of Cabri Jr. were able to recognize the relationships and therefore propel the lesson at a quicker pace than the other iteration’s classes. The possible reason for students in the second iteration to move at a quicker pace is most likely due to their lack of participation in the lesson. The
students in the second iteration were just asked to observe and make conjectures.

Students in the first iteration of the lesson were asked to actually make the concept and then observe relationships that existed due to their construction. After both iterations, it seemed that one iteration did not help the students over the other. It seems that a combination of both iterations would be beneficial to understanding the concept in full.

Student surveys also provided some insight into how the students perceived their learning of the material. Since the students filled out the surveys after they received both methods of instruction, the results allow the researcher to see connections between observations of students learning as well as the students' scores on their quizzes. More students indicated that they preferred the calculator method of instruction. Following the identification of the type of instruction preferred, when asked why they preferred that instruction, they indicated that they wanted to "play on the calculator." The students did not indicate that they preferred the calculator because it allowed them to see the relationships better than the construction did, but because they wanted to play with the technology. This confession aligns itself with the literature on integrating technology into instruction with the fear that technology will just be an entertainment factor and in fact not help with the students’ ability to understand and comprehend what is being taught (Olson & Clough, 2001). Students also indicated that they liked the calculator method, because "we didn’t have to do anything." When students were asked which method would help them with their test, the students wholeheartedly admitted that the construction method would have helped them. This difference between their preference of learning and what the students themselves actually acknowledge to what would have helped them on the assessment indicates that the students might want to take the more
entertaining method of instruction but recognize that having fun does not always mean they will learn the material better. The students exhibiting an interest in technology and wanting more technology integrated into their learning of geometry shows that the teacher should not turn a blind eye to integrating technology into their daily lesson, but rather find a way that the technology and the content can be enhanced and enriched instead of just being dumbed down and more fun.

With the inconsistencies of quiz scores, observations and student surveys to find a true method of instruction, traditional or technology enhanced, that will benefit understanding of geometric principles, one has to look at the experiment itself to see what could be modified to achieve significant results. The experiment dealt with two periods of Geometry receiving two types of instruction of the same concept. Although, the periods were selected based on class average and size, learning style and students in special education should have been included in the division of classes. From student surveys and teacher observation, it was noted that students did not like the construction method due to the method not helping their learning, but rather it was frustrating to them or difficult to perform. These students' learning styles should have been evaluated to see if that was the reason the task was frustrating. Furthermore, the length of the experiment was too short to see any long term benefits or detriments of the technology enhanced instruction. Additionally, only one lesson was modified to include technology enhanced instruction instead of a whole chapter. If it was possible to instruct students for a whole year with technology enhanced instruction and students with traditional instruction without potential harm to their education, it would be beneficial to the results of the experiment.
The experiment itself is not the only part of the research that could be modified. The teacher in the technology enhanced lesson did not have the students actually make the construction on their calculator, but rather explained the construction. Students never participated in the technology portion of the enhanced lesson. Students should have been taught how to use the dynamic geometry software so they could use it for their future lessons and understand the technology generated construction. This fault has been shown to be a fault of integrating technology into instruction due to the lack of knowledge and actual use of technology into the lesson (Otero et. al, 2005).
Conclusion

Integrating technology into high school classroom instruction has shown to be beneficial when it is integrated correctly. It is not so much technology itself being the fault when the integration of technology into instruction fails. Sometimes the fault could lie in the teacher and their knowledge and understanding of the technology, along with the intricacies of the concepts that they are teaching. Other factors of the instruction such as the lesson itself and the technology available contribute to the faults of the integration as well. Further research on the matter of whether technology enhanced lessons are more beneficial than traditional lessons in the subject of geometry needs to be completed. To guide additional research on this topic one should further evaluate the technology integrated lessons with a different type of technology other than a graphing calculator with dynamic geometry software. The use of an interactive whiteboard in addition to graphing calculator use as well as more lessons with technology integration would be an example of such an alternate experiment.
References


Appendix A

Assessment

Name: ____________________________ Date: __________

1. Draw two parallel lines cut by a transversal.

2. Label your angles #1-8 in #1.

3. Identify all pairs of:
   - Alternate Interior Angles
   - Alternate Exterior Angles
   - Corresponding Angles
   - Consecutive Interior Angles

4. Fill in the blanks. (° or + = 180°)
   a. Alternate Interior Angles are ________.
   b. Alternate Exterior Angles are ________.
   c. Consecutive Interior Angles ________.
   d. Corresponding Angles ________.
5. Draw skew lines.

6. Draw lines intersected by a transversal.
   Label $\hat{z}$'s #1-8.

7. Identify the following pairs of $\hat{z}$'s (all pairs):
   Vertical Angles
   Linear pairs

8. Vertical Angles are ________.  

9. Linear pairs ________.  

Fill in the blank. ($\cong$ or $\pm = 180^\circ$)
Appendix B

Technology in Geometry Survey

Directions: Answer all questions honestly. Be as descriptive as possible.

1. (Circle One) Which method of instruction did you like?
   - Calculator Method
   - Construction Method

2. Why did you like this method?

3. What did you like about this method (try to be specific)?

4. What did you not like about the other method?

5. Which method do you think you will be able reproduce on your own?

6. Which method do you think helped you take your test?

7. Would you prefer both methods to help you learn a concept or just one?

8. Would you like to see more types of technology used in class other than the calculator?

Do you have any ideas of what you would like to see?
Appendix C

Letter to the Participants

WATKINS GLEN HIGH SCHOOL
301 TWELFTH STREET, WATKINS GLEN, NEW YORK 14891
PHONE (607) 535-3210  FAX (607) 535-3262

DAVID WARREN
PRINCIPAL

NANCY LOUGHLIN
GUIDANCE COUNSELOR

October 21, 2007

Dear Parents/Guardians,

I currently teach your students Geometry. I am completing my master’s degree in math, science and technology at St. John Fisher College. As a part of my graduate coursework, I will be conducting a study in which technology is incorporated into the lesson. The study is to see if incorporating technology in the Geometry classroom is beneficial to the student’s learning, if it detracts from the student’s learning, or if it has no effect on the student’s learning. Although this study is small, I am hoping to also get some anonymous input from the students of whether or not the use of the technology was enjoyable for them and to get some personal input on their education.

The students are aware of this study. The students will receive the normal instruction of the concept parallel lines cut by a transversal, but they will receive it in two forms. The students’ academic learning will not be negatively affected. I will only see the data that is recorded from this study. After the study is done, all data will be discarded. The results of this study will not be published. The results of this study will only be shared with my graduate class as part of my master’s thesis.

If there is any concern, please contact myself at (607) 535-3210 extension 7580. This study is approved through the Institutional Review Board at St. John Fisher.

Thank you.

Sincerely,

Andrea Morganti
Appendix D

Consent Form

St. John Fisher College
INFORMED CONSENT FORM

Title of study: Traditional Versus Technology Enhanced Teaching in the Geometry Classroom

Name(s) of researcher(s): Andrea Morganti
Faculty Supervisor: Dr. Dianne Barrett
Phone for further information: (585) 385 - 8366

Purpose of study:
Recently, schools have been purchasing computer programs and other forms of technology to use for academic purposes. This study is designed to address whether the use of technology in the Geometry classroom enhances or detracts from the student's ability to understand the concepts and skills that are presented before them.

Approval of study: This study has been reviewed and approved by the St. John Fisher College Institutional Review Board (IRB).

Place of study: Watkins Glen High School, Watkins Glen, NY 14891
Length of participation: 3 days

Risks and benefits: The expected risks and benefits of participation in this study are explained below:
There are no risks associated with this study. The students will have no change to their usual classroom activities. The students will receive instruction with and without the use of technology. All students will receive both types of instruction to make sure that there is no loss of understanding the material of the chapter. The results of this study will help determine whether the incorporation of technology into the Geometry classroom will help your student understand the geometric concepts and skills better or if the use of technology detracts from that understanding.

Method for protecting confidentiality/privacy:
During the course of this study, student names will not be used. I will be the only person to have access to the data. The results of this study will be presented to my graduate class, they will not be published. The students will be filling out a survey anonymously. When the study is completed, all data will be destroyed.

Your rights: As the parent/guardian of a research participant, you have the right to:
1. Have the purpose of the study, and the expected risks and benefits fully explained to you before you choose to allow your minor child to participate.

2. Withdraw from participation at any time without penalty.

3. Refuse to answer a particular question without penalty.

4. Be informed of appropriate alternative procedures or courses of treatment, if any, that might be advantageous to you or your minor child.

5. Be informed of the results of the study.

I, the parent or guardian of ____________________________, a minor _____ years of age, consent to his/her participation in the above-named study. I have received a copy of this form.

Print name (Parent/Guardian) ____________________________ Signature ____________________________

Date ____________________________

Print name (Investigator) ____________________________ Signature ____________________________

Date ____________________________

If you have any further questions regarding this study, please contact the Andrea Morganti at (607) 535-3210. If you or your child experiences emotional or physical discomfort due to participation in this study, contact the Office of Academic Affairs at 385-8034 or the Wellness Center at 385-8280 for appropriate referrals.
Parallel Lines and Transversals

Whenever two lines are crossed by a transversal, the following types of angles are formed:
1. 
2. 
3. 
4. 

When two parallel lines are crossed by a transversal, the following properties occur with the angles formed:
1. Corresponding Angles are congruent.
2. Alternate Interior Angles are congruent.
3. Consecutive Interior Angles are supplementary
4. Alternate Exterior Angles are congruent.

There are theorems that have been proven to be true for these types of angles formed when two parallel lines are cut by a transversal.
1. Corresponding Angles Postulate
   - If two parallel lines are cut by a transversal, then the pairs of corresponding angles are congruent.
2. Alternate Interior Angles Theorem
   - If two parallel lines are cut by a transversal, then the pairs of alternate interior angles are congruent.
3. Consecutive Interior Angles Theorem
   - If two parallel lines are cut by a transversal, then the pairs of consecutive interior angles are supplementary.
4. Alternate Exterior Angles Theorem
   - If two parallel lines are cut by a transversal, then the pairs of alternate exterior angles are congruent.

Practice:
Practice with Proofs:

Given: \( p \parallel q \)
Prove: \(<1 \text{ and } <2 \text{ are supplementary}

<table>
<thead>
<tr>
<th>Statements</th>
<th>Reasons</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>1. Given</td>
</tr>
<tr>
<td>2. (&lt;1 \equiv &lt;3 )</td>
<td>2.</td>
</tr>
<tr>
<td>3.</td>
<td>3. Definition of congruent angles</td>
</tr>
<tr>
<td>4.</td>
<td>4. Definition of linear pair</td>
</tr>
<tr>
<td>5. ( m&lt;3 + m&lt;2 = 180^\circ )</td>
<td>5.</td>
</tr>
<tr>
<td>6.</td>
<td>6. Substitution</td>
</tr>
<tr>
<td>7. (&lt;1 \text{ and } &lt;2 \text{ are supplementary} )</td>
<td>7.</td>
</tr>
</tbody>
</table>
1. Corresponding angles occupy corresponding positions

2. Alternate interior angles

3. Alternate exterior angles

4. Consecutive interior angles

5. 2 pairs of corresponding angles

6. 2 pairs of alternate interior angles

7. 2 pairs of alternate exterior angles

8. 2 pairs of same-side interior angles