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The Effects of Activity-based and Inquiry-based Teaching Methods on Student Attitude and Perception Toward Geometry

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The Effects of Activity-based and Inquiry-based Teaching Methods on Student Attitude and Perception Toward Geometry

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ABSTRACT

This quantitative action research project evaluated high school students' attitude and perceptions toward geometry before and after two units that were taught. The first unit was taught using a more traditional style of teaching while the second method incorporated activity-based and inquiry-based lessons into a traditional method of teaching. The students were surveyed by using a modified version of Bauer's (2008) Attitude Toward the Subject of Chemistry Inventory. The survey was changed to focus on the students' attitudes and perceptions toward geometry. Survey scores in the subscales: interest and utility, anxiety, intellectual accessibility, fear and emotional satisfaction were compared through statistical analysis of mean, standard deviation, and t-test. Students' attitudes and perceptions were not significantly different between the two units that were taught. The results of the survey were inconclusive and showed that there needs to be continued research.

CHAPTER 1

INTRODUCTION

Introduction

There is a disconnect between how math is used in the real world and how math is taught in schools, which could be a major cause for students to develop a fear or dislike for math. Mathematicians have been discovering new ideas and concepts about mathematics for thousands of years. They discovered these new ideas by exploring the patterns of the world and then used math to explain why these patterns happened. However, the students in many classrooms are not given this chance to see the patterns, therefore, they do not see math as an exploratory subject. Students are often forced to memorize many rules, properties and procedures which is how they perceive the subject of math (Boaler, 2016). Many students who fear or dislike math often comment to teachers that learning math is pointless because it won't be used outside of the classroom anyway. Comments like these have become very concerning as many students are losing interest in math and are not pursuing mathematical careers. The U.S. Department of Education (2014) found that in 2014 only 16% of seniors in high school who were proficient in math also choose a career or major that dealt with math. Students seem to have become less interested in math or have come to have negative attitude toward the subject and some experts believe that it is because of how math is taught in schools (Boaler, 2016; C. Wolfram, 2010).

As technology has advanced, how people look at solving a math problem has changed right along with it. In the past, students needed to be good at calculations and knowing procedures in order to be able to do math. Now, most students can use an app to take a picture or type any equation and it will give them the solution to the equation. According to C. Wolfram (2010) and S. Wolfram (2010) programs like Wolfram Alpha allow students to type in an equation into the online program and it will calculate the answers, the steps that were used to get the answer, and other important information about the problem. Programs like these are convenient for high school students because the programs can do tedious computations in seconds, whereas a mathematician doing them by hand could take a few minutes to hours to compute (C. Wolfram, 2010; S. Wolfram, 2010). These programs raise questions on the effectiveness

of traditional teaching methods in the math classroom. These questions are not easy to answer because most experts will say that it is going to depend on the group of students that are being taught (Gil-Domenech & Berbegal-Mirabent, 2013; Guce, 2018; Kuo et al., 2020; Noreen & Rana, 2019). Teachers need to be able to determine the types of learning methods that will benefit different types of learners and incorporate different teaching methods into their classes. This way more students can be reached by giving them a chance to explore math more often so they can see how people outside of the classroom might use their skills in the real world. The researcher used this study to look at how incorporating activity-based and inquiry-based teaching methods helped to create more positive perceptions from students and allow them to explore more topics in math.

Brief Literature Review

Math education has become disconnected from how it is used by people in the real world. Mathematicians are not the only people who rely on math every day for their jobs. According to C. Wolfram (2010), "geologists, engineers, biologists, and all sorts of other people use math to create models and simulation to solve problems" (1:19). People in the real-world use math to investigate and explore problems around them whereas students are taught rules and procedure to solve abstract problems. Students are constantly being tested on these rules and procedures creating the idea that math is only a performance-based subject where students learn a concept and then are tested to see how much they remember (Boaler, 2016). This disconnection is causing students to feel as though math were unimportant because it is not relevant in their daily lives. However, this is untrue as C. Wolfram states that, "math is very popular, just not in education" (1:28).

Another cause for students to dislike math is that they are taught using a traditional style of teaching that does not allow students to explore the ideas they see interesting. It has been the researcher's experience that most students sit passively in their desk while the teacher leads all of the discussion with little student input during this time. Incorporating different teaching styles that incorporate more student-lead lessons will allow for more student exploration and give student more input while learning math. Activity-based teaching allows student to use activities to explore concepts and help them try to bridge to

abstract concepts using concrete representations (Noreen & Rana, 2019). Studies have shown that activity-based learning has the possibility to positively increase student interest, engagement, learning and cognitive knowledge (Celik, 2018; Noreen & Rana, 2019). Students who are taught using traditional methods are usually listening to the teacher reason through most of the content without students doing much of the thinking. Inquiry-based teaching allows for students to do more of the reasoning because they are pushed to explore concepts, ask their own questions and share their ideas (Ellingson, 2020). For an inquiry-based lesson, students ask their own questions and explore them using any resources they have to try and answer those questions. They can also work with a partner or in small groups where they discuss their ideas together and try to answer the questions they have come up with. Students who were taught using inquiry-based teaching showed positive increases in student attitude, behavior, expectations and value of learning (Kim, 2006; Kuo et al., 2020).

One major idea in both activity-based teaching and inquiry-based teaching that is not often included with traditional teaching methods is student discussion. Student discussion is important as it allows students to develop ideas together and increase knowledge of the subject by using each other to reason through situations. Kosko (2012) described mathematical discussion as students describing, explaining, defending, and justifying their ideas with another student. When students are allowed to discuss concepts, they have the opportunity to explore them, talk about them and build deeper understandings about the concepts from other students. Rather than the primary source of information, the teacher could be more of a conversation facilitator allowing students to take more control to develop the ideas they find more interesting.

Statement of the Problem

The research problem for this study was that student perceptions and attitudes toward math have been declining causing many students to become disengaged in class. The researcher was interested to see if incorporating activity-based and inquiry-based lessons along with continued direct teaching would increase positive student perceptions and attitudes toward geometry class. He wanted to give students more opportunities to build up their own mathematical understanding rather than being taught using only

direct instruction and look at the overall impacts on student perception, student attitude, and student engagement in class. The researcher collected this information by using surveys that students took before and after two units that were taught using two different methods. This research helped to determine if incorporating activity-based and inquiry-based lesson into a traditional classroom would help build more positive attitudes and perceptions about math for students.

Purpose of the Study

The purpose of this study was to see how incorporating activity-based and inquiry-based lessons with a traditional teaching style would affect student attitudes and perceptions toward learning geometry. In the math department at the researcher's high school, teachers noticed that students had become less interested about learning math and many students had become disengaged in class. Comparing the two different ways of teaching gave the researcher insight on whether or not adding these two methods of teaching would help create more positive attitudes and perceptions for students in geometry. Students who fear or dislike math typically do not choose a career or major that includes a lot of math even if they are proficient in the subject (US Department of Education, 2014). By incorporating these methods used in the study, the researcher made changes to his teaching practice that helped increase student interest in math.

Research Question

How will a hybrid teaching method consisting of activity-based, inquiry-based, and traditional-based teaching methods affect a student's attitude and perception toward learning geometry?

Definition of Variables

The following are the variables of study:

Variable A: The independent variable for this study was the type of teaching method used for the study. During the study, the first unit was taught using a traditional style teaching method to get a base reading for the students' attitude and perception toward geometry. The second unit was taught by incorporating activity-based and inquiry-based lessons into the traditional teaching method to see how students' attitudes and perceptions changed toward geometry.

Variable B: The dependent variable for this study was the students' attitude and perception toward geometry during the two units that were taught in using the two different teaching methods.

Significance of the Study

This study was significant because by understanding how different types of teaching methods affected students' attitudes and perceptions helped the researcher use the results from the study to make improvements in his teaching practices. Students learning math usually don't have much exposure to other teaching methods, but implementing new teaching methods that affect students in positive ways can help decrease their possible fears of math and even increase their interest and knowledge in math (Gil-Domenech & Berbegal-Mirabent, 2013). By completing this study, students were exposed to two different types of teaching methods that are not normally used in their typical math class. The knowledge that the study provided will allow the researcher to use more of the methods that affected the students in a positive way. The potential benefits of continuing to use these other methods can be shared with other math teachers that the researcher collaborates with including his current colleagues who are struggling with similar students who have become disengaged in their classrooms as well.

Research Ethics

Permission and IRB Approval

In order to conduct this study, the researcher sought MSUM's Institutional Review Board (IRB) approval to ensure the ethical conduct of research involving human subjects (Fraenkel et al., 2019) (see Appendix A). Likewise, authorization to conduct this study was given from the school district where the research project took place (see Appendix F).

Informed Consent

Protection of human subjects participating in research will be assured. Participant minors will be informed of the purpose of the study via the Method of Assent (see Appendix B) that the researcher will read to participants before the beginning of the study. Participants will be aware that this study is conducted as part of the researcher's master degree program and that it will benefit his teaching practice. Informed consent means that the parents of participants have been fully informed of the purpose and

procedures of the study for which consent is sought and that parents understood and agreed, in writing, to their child participating in the study (Fraenkel et al., 2019). Confidentiality will be protected through the use of anonymous surveys that do not use any identifying information. The choice to participate or withdraw at any time will be outlined both verbally and in writing.

Limitations

The study was conducted by surveying the students who were willing to participate. The results were used to inform possible teaching practices that could be used in the future. The results for the study using a small population size of 47 students who were in the researcher's classes may or may not give an accurate picture as to how future students may be affected by the same type of study. More research will have to be done in order to see if the results would be replicated using a larger sample or by continuing to use a similar study that conclude the same results. Another major limitation is that the researcher had knowledge about how to implement activity-based learning and inquiry-based learning, but was not fully trained and had little experience actually using these types of teaching methods. This may have affected how much of a change was seen in the students' attitudes and perceptions toward learning geometry. The researcher could get training in the implementation of activity-based and inquiry-based learning and see how much this would affect the previous results.

Conclusions

Many students have negative attitudes and perceptions toward math and it has affected their ability to learn. There are many reasons that students have developed these negative attitudes and perceptions toward math, one being that some experts believe that math education has become disconnected from how people in the real world use it. Students are often taught with traditional methods causing the teacher to be the main source of information and students the passive learners. Whereas people using math in the real world are the source of information as they explore the concepts around them. By using other teaching methods such as activity-based learning and inquiry-based learning, teachers can give students more time to explore like people in the real world do when using math. By exploring, students can try to relate abstract concepts using concrete representations, create their own

ideas, and even defend and justify those ideas. Student discussion is another type of activity that is typically incorporated into activity-based and inquiry-based teaching methods and is a major part in allowing students to defend and justify their reasoning with other students. Research has shown that allowing students to do these types of activities can positively increase student interest and student learning in math and other subjects. The goal for this study was to see if incorporating activity-based and inquiry-based teaching methods into a traditional style of teaching would impact students' attitudes and perceptions toward learning geometry. The following chapter is a literature review that includes causes for students' dislike of math, the impacts of activity-based and inquiry-based teaching styles, and how student discussion can impact students as well.

CHAPTER 2

LITERATURE REVIEW

Introduction

The purpose of this study was to see how teaching students with a hybrid method consisting of activity-based, inquiry-based, and traditional-based teaching methods affected students' attitudes and perceptions about learning geometry. Many teachers can likely relate to hearing students question when or how will they would ever use the information they learned in the classroom in the real world. It has been the researchers experience that when students viewed math as unimportant, they were more likely to become disengaged during class and their attitude toward the subject became negative. If teachers allow this to happen from elementary school through high school, students' motivation and engagement in math may slowly decline as the students age (Jansen et al., 2018). As student motivation and engagement drops, so does the ability to learn, as motivation and engagement play a major role in a student's ability to learn math (Guce, 2018).

Body of the Review

Context

According to experts like Boaler (2016) and C. Wolfram (2010), math education needs a change. They believe that traditional teacher-centered classrooms need to become more open student-centered classrooms. An important part to learning math is to be able to make an argument from evidence, prove or disprove the argument, and change the argument when needed (DeJarnette & Gonzalez, 2013). A majority of math students do not get the opportunity to explore math in this way because many students are taught using a more traditional style of teaching. This method typically has the teacher providing all of the information with little student input. The students are given all the information they will need for the test and expected to practice procedural skills for mastery. According to Boaler (2016), if a student and a mathematician who uses math daily were asked to give a description of math they would get two completely different answers. "A student will usually say it is a subject of calculations, procedures or a set of rules, whereas the mathematician will say it is the study of patterns" (Boaler, 2016, p. 22). This

makes math one of the only subjects with this type of disconnection between the student point of view and expert point of view (Boaler, 2016). It seems as though this disconnect has also caused fewer students to pursue a career in mathematics because it was found that high school seniors who were proficient in math and interested in a career dealing with math was only 16% in the United States (US Department of Education, 2014). Math continues to change in how it is used in society today and people are no longer looking at students who can compute or do calculations. There are apps and programs that can do most of those calculations and procedures instead of doing them by hand. Teachers want students who think about what they are learning and figure out a way to solve a problem even if it has nothing to do with math. Students need to be given opportunities to manipulate objects or do hands-on learning as with activity-based learning (Boaler, 2016; Hattie et al., 2017). Students should have the skills to think through a problem and have the ability to fix their own thinking if they made a wrong assumption. Inquiry-based learning helps to build up student communication skills so they can have the ability to discuss their ideas and even help correct a wrong assumption with a new point of view from a classmate. The literature reviewed has many possible answers as to why students tend to fear or hate math. It also covered a few different teaching methods that may affect students' attitudes and perceptions about the subject. It is for this reason, the researcher decided to look at the effects the hybrid teaching style had on his geometry students.

Disconnection of Mathematics

As previously described, math is the one subject in schools that seems to have a disconnect between students and the people who work in the field. According to some experts, they believe this disconnect is created by the way math is being taught versus how it is used in the real world (Boaler, 2016; C. Wolfram, 2010; Hattie et al., 2017). "Students spend thousands of hours in classrooms learning sets of procedures and rules that they may never use, in their lives or their work" (Boaler, 2016, p.27). Conrad Wolfram (2010) talked about how students work the problems, but don't have a true understanding about how to do math. At this point, math is now a performance subject instead of a subject in which students can investigate and learn. The traditional style of teaching works against human

nature as humans are naturally curious about different subjects, but when students are not given the chance to explore they lose that sense of curiosity. Other than having to memorize all the rules and procedures, another part of math that seems to cause negative student thoughts is the amount of testing that comes with it. Boaler (2016) stated that the testing culture of the United States is more pervasive in math than any other subject (p. 21). Students are tested constantly in math classrooms whereas with other subject they may do reports or presentations instead of a test to show their understanding. Many teachers even give students a test sometime during the first week of school just to see what they remembered over the summer from the previous school year. The tests continue throughout the entire year, where students are getting quizzed and tested for almost every unit that is taught. Finally, most states require a state-wide assessment so again another test for students to take in math. This could be a major reason that students have started to dislike math, they are not given a chance to actually explore and they are asked to memorize and be tested on rules and procedures many of them may not use after they graduate high school.

Even though the explanations remain unidentified, students are still disengaged and change is still needed. One of the major findings was that many parents and educators felt that students should learn math the exact same way that they did, through memorizing facts, formulas and procedures that were practiced over and over (National Counsel of Mathematics Teachers, 2014). This could make change a little more difficult until teachers get support from the community around them. However, the literature showed that a change is needed to help students' learning and create more positive attitudes about math.

Methods of teaching (Traditional, Activity-Based and Inquiry-Based)

Students are often disengaged in math classrooms because there is little to be curious about. Most educators that use a traditional teaching method lecture on the content to explicitly teach the materials that students need to learn. The basic format for most traditional math classes is teach a lesson give homework for the entirety of the unit with a few days where students are quizzed or tested on the material presented. There is not much time built in for investigation in the traditional method, but teachers still need student engagement to make class time productive. Jansen et al. (2019) defined engagement as the interactive

relationship between the student and the subject matter being taught. Students are not getting the interactive relationship part to help with their engagement, they are only being taught the subject matter. The traditional teaching method is not a solution to help students develop a curiosity for math as it does not allow them to explore or be curious. However, it does have a time and place as to when it should be used for student learning. If teachers want students to have the chance to interact with the subject matter they need to give them a chance to investigate some of the material they learn. This was why the researcher was interested in adding in activity-based learning and inquiry-based learning to his teaching to see how it affected his students.

For activity-based learning, students are actively involved in hands-on or technology-based experiences that allow them to try and relate abstract ideas with concrete observations (Noreen & Rana, 2019). Pairing traditional learning and activity-based learning will allow student to learn some of the content directly and then have the chance to investigate other content using the previously learned concepts. It was shown that there is a positive impact on developing student cognitive skills when activity-based learning is used at the elementary level (Noreen & Rana, 2019). Bos (2009) discovered that when interactive math object formats are used in technology student achievement can improve. Celik (2018) studied the effects of activity-based learning on 6th grade math students and found that activity-based learning positively affected performance, attitude and interests toward the class. So, activity-based teaching had the possibility to positively affect student achievement and student attitude toward math whether it was a hands-on activity or an online activity. Technology-based activities can enhance student discovery and learning. However, teachers need to watch out for the apps and programs that have students do procedural type work as those are no different than having students do a worksheet (Attard & Northcote, 2011). Many teachers would consider apps that take this approach to be drill and kill apps because they are having students continually work on the same procedure over and over until students master the concept. Attard and Northcote (2011) explained that if technology is to be used for activities it should be used as a tool to support the teaching or learning of the material. The technology should allow students to manipulate or give insight into abstract concepts without having them do the same thing over

and over. The activities used in the classroom should allow students to reason and make sense of the content that is being learned (DeJarnette & Gonzalez, 2013). Students need the chance to become actively involved in their learning and activity-based learning is one way that could get students more engaged in class and help positively affect their attitudes toward math.

Inquiry-based learning is a method of teaching that emphasized the student's role in the learning process, where students are encouraged to explore the content, ask questions, and share ideas (Ellingson, 2020). The students are interacting with the content by asking questions and exploring which may or may not have an activity involved with it. Kuo et al. (2020) found that for middle school students who were learning science, using inquiry-based learning improved their behavior, expectations and value of learning. Another study showed that ninth grade students taught with inquiry-based teaching improved student attitude toward math (Kim, 2006). The two studies showed that inquiry-based learning could have a positive effect on students' learning whether they are learning math or science. Inquiry-based learning can be used in many ways. Students can work individually, in pairs, in groups, or even as a whole class. As long as students are exploring and asking questions about the content without a lot of direct instruction from the teacher they are using inquiry-based learning. Students can also express their ideas in different ways such as verbally, using technology that allows students to share ideas, or by journaling about their learning. Guce (2018) found that the implementation of journaling improved the attitude of the students toward math in two ways: (1) likeability of the subject and (2) willingness to engage in math activities. Journaling is a way for students to process what they have learned and allows them a safe place to put their thoughts until they are ready to share with the class. Students need the chance to think about their learning in a different way than just being told how to do it by a teacher and inquiry-based learning has the ability to improve students' attitude and perception toward geometry.

Teachers have many methods that they can use to teach their students, but many of the methods fall into three different categories as explained by Colman and Walkoe (2020). The three types of lessons that can be used for teaching are: (1) teacher-lead direct instruction (2) teacher-lead exploration and (3) students-lead exploration. Teacher-lead direct instruction is a lesson where the teacher directly teaches the

concepts. Teacher-lead exploration is where the teacher is exploring with the students and giving them questions to prompt what the students should be exploring. Finally, student-lead exploration is where students are asking themselves questions to prompt their exploration. Students need all three types of lessons to help learn math as sometimes they need the direct instruction from the teacher or maybe they may need help from the teacher when exploring more complex situations. Even when using the other two types of lessons Coleman and Walkoe (2020) found that student-led exploration is the most effective on student learning and engagement. The more control a student has to explore individually and build up their own ideas about the concepts in math the better the student learning can be. Gil-Domenech and Berbegal-Mirabent (2019) talked about how using student-centered methods of teaching where students learn knowledge by applying it does not discourage the use of lecture, but when combined they are found to be more effective when used correctly. According to Sahin and Ozpinar (2020), "students who preferred student-centered classrooms, stated that they chose these methods because they allow for students self-learning and retentive learning, increase interest in the course, improve students' communication skills and support peer learning" (p. 91). By blending these methods together students will have more of a variety of methods to learn from since all three methods have strengths and weakness, but when combined they could benefit the teacher instruction. Students that have a limited experience with the different methods of teaching need to be exposed to more ways of learning to help rid students of the fear of math as well as boost their interest and knowledge (Gil-Domenech & Berbegal-Mirabent, 2019).

Student Discussion

A common theme that was brought up in the literature review was student discourse and the benefits it presented to student learning. Kosko (2012) found that when students are exposed to daily discussion it can generally predict higher levels of achievement in math. Mathematical discussion involves students describing, explaining, defending and justifying their ideas about math (Kosko, 2012). Student discussions help add onto what students are already doing during activity-based and inquiry-based learning. By incorporating the discussion piece, the students are asked to defend or justify their idea

with a partner or in a group. Hattie et al. (2017) found that student learning benefitted from having activity-based lessons for students to engage in as it gave them a chance to develop their thinking and reasoning before having their discussions. Students should develop their own ideas and by incorporating student discussion into activity-based learning or even inquiry-based learning they have a chance to explore and talk about what they found. This would give students a chance to not only be able to develop ideas, but also be able to share those ideas with others. Hodge and Walther (2017) believed that as students become better at discussing their ideas they will eventually become a resource for themselves and for their classmates to be able to bounce ideas around. The more students can communicate their ideas the more time they can help each other deepen their learning and understanding of the concepts. The discussions with each other are important because students develop their understanding of mathematical concepts by attempting to communicate them with someone else (DeJarnette & Gonzalez, 2013). It was also found by Russo and Minas (2020) that students liked learning math when they had the freedom to collaborate with their peers. From the research, it would seem that pairing the chosen teaching methods with student discussion should have a positive impact on the students in some form.

As previously mentioned, student discussion sounds to be a great way to get students involved in their learning and give them a chance to take charge of their learning. However, teachers need to create a positive environment where students feel safe to express their thinking. Kosko (2012) said that one important part of student discussion is for the teacher to "create a positive atmosphere lacking social penalties for incorrect answers" (p. 115). Once teachers have this type of environment they can act more as a facilitator rather than the main source of discussion which helps create a true student-centered classroom. Buchheister et al. (2019) explained that the students' voice is the most important part of the discussion process. The students need to be the ones who are communicating their ideas and thinking through the content as that is the only way to keep the student voice present in the classroom. The teacher needs to facilitate the process and ask probing questions to help the students when they get stuck on an idea or concept. Hodge and Walther (2017) talked about four important practices to develop discussion in math:

> 1. Use more open tasks that allow students to reason and make sense of; 2. Use think, pair, revoice/compare which is a modification of think-pair-share; 3. Offer students three different ways to participate in the conversation; 4. Define what it means to contribute to the conversation so students know what is expected of them. (p. 432)

Creating an open environment for students to share, along with the types of tasks that encourage student discussion and engagement, has the protentional to benefit the students' attitudes and perceptions toward geometry.

Theoretical Framework

The focus of this study was put on students' attitudes and perceptions toward geometry while implementing a new teaching method. Students have their own beliefs about subjects in school and it has been the researcher's experience that students tend to have negative attitudes and perceptions about geometry or math in general. The cognitive dissonance theory was used to help guide the research. The theory focuses on students keeping their thoughts and behaviors in equilibrium (Burns, 2006). Therefore, if students believe that they dislike math then their behaviors will represent that belief. However, teachers can challenge those original thoughts by introducing a valid point of view that will cause a person to rethink their beliefs, resulting in disequilibrium between their thoughts and behaviors (Burns, 2006). Using this theory, it was attempted to challenge students' negative attitudes and perceptions about geometry or math in general by introducing new teaching methods. The methods have been shown to help create positive effects on students' attitudes and perceptions toward math which gave the researcher a valid reason to try incorporate them into his teaching.

Research Question

How will a hybrid teaching method consisting of activity-based, inquiry-based, and traditional-based teaching methods affect a student's attitude and perception toward learning geometry?

Conclusions

This chapter looked at why students have become disconnected from math and a few ways that teachers can adjust their teaching methods to try and create more positive attitudes and perceptions

towards math. One of the main issues that the literature presented was that students are disengaged from the teaching methods that are being used in most math classrooms. Students are not given the opportunities to explore and relate to how math is used in the real world. It was found that using activity-based and inquiry-based teaching methods have the potential to positivity impact the students' attitudes and perceptions toward math. Thus, using activity-based and inquiry-based methods with traditional learning will give students more chances to explore the subject of math in a student-centered approach rather than the traditional teacher-centered approach. Student discussion was also found to be a very important part of activity-based and inquiry-based learning as students learn by attempting to communicate the concepts they have learned. From the research, these three teaching methods along with mathematical discourse could help positively change students' attitudes and perceptions toward math as well as increase students learning and achievement. The following chapter will go into detail about the methodology that was used to carry out the action research.

CHAPTER 3

METHODS

Introduction

Students' attitudes and perceptions toward learning math have become more negative in recent years and a common phrase that gets used by students is: When will this ever get used outside of school? When a student gets these types of attitudes and perceptions, how well the student learns a subject can be affected as their attitude plays a major role in learning any subject (Guce, 2018). In order to enjoy their time in the classroom, students need to have positive experiences and that is not usually the case when it comes to traditional styles of teaching. Students are often asked to sit in their desks quietly while the teacher presents the content with little student involvement. And more specific to math, students are also asked to work problems that use a specific process or rule over and over until they have it mastered. This leaves a disconnect between what learning math is like and how math is actually used outside of the classroom. Math has become a performance subject instead of a subject about looking for patterns and discovering ideas that explain those patterns (Boaler, 2016).

The researcher was interested in investigating if changing up his teaching style would help create more time for students to explore math and help increase positive student attitudes and perceptions. The study looked at whether incorporating activity-based and inquiry-based lessons into a traditional style of teaching would help student learning and create more positive attitudes and perceptions toward learning geometry. To do this, the researcher chose two different units to focus on and changed up his teaching style while using a longitudinal survey that asked students to place themselves on a scale from 1 to 7 between two opposing adjectives (see Appendix C). The data that was collected was all quantitative data about the students' attitudes and perceptions about learning geometry. For the first unit, students were taught using a more traditional method of teaching that the researcher had used for his first five years of teaching. The second unit was taught by incorporating more activity-based and inquiry-based lessons into the unit to see if student attitudes and perceptions about learning geometry had changed. For the study, the researcher only had access to the students who attended his local high school and were enrolled in his

geometry courses. The sample was limited a little more when a few of the students opted to not participate in the surveys.

Research Question

How will a hybrid teaching method consisting of activity-based, inquiry-based, and traditional-based teaching methods affect a student's attitude and perception toward learning geometry?

Research Design

The research was an action research study utilizing a quantitative approach in which the results of the study will be used to determine if activity-based and inquiry-based lessons helped affect students' attitudes and perceptions toward geometry. The study used a longitudinal survey to focus on the students' attitudes and perceptions toward geometry by using a survey that had students place themselves between two opposing adjectives on a scale of 1 to 7. A longitudinal survey collects information at different times in order to look at changes over time (Fraenkel et al., 2019). The researcher chose a longitudinal survey because it gives statistical results in a timely manner allowing him to get more results to compare so that his classes don't fall behind. According to Gaille (2020), surveys give researchers a way to collect and compare data quickly and give a straightforward way to analyze and visualize data. The number scale was also used to make analysis of the data more accessible for Google Sheets. All students in both classes received the same teaching method for each unit. In order to see how attitudes and perceptions changed, the researcher taught two units using two different methods. The first unit was the control unit where the researcher taught using the more traditional method that he had been using for his first five years of teaching. The second unit was the experiment method where the researcher incorporated activity-based and inquiry-based lessons into the unit. The students were surveyed before and after both units to see how their views may have changed over time or during the units. A longitudinal survey using a panel study was used because the researcher wanted to look at how the same students' feelings changed over time. A panel study uses the same population for the surveys that are given at different times (Fraenkel et al., 2019) This method was picked so that the researcher had a larger sample to collect data since splitting his two classes into a controlled and an experimental group would have made his sample smaller. The

researcher also didn't have control of who was in each class which would have made it more difficult to have evenly split his classes based on criteria such as ability, gender, or other possible criteria making the groups comparable.

Setting

This study took place in a high school geometry classroom that was located in a rural town of northern Minnesota. The population of the town was right around 700 people living within the city limits, but many people lived in the country as the town was mainly know for agriculture. There are a lot of family farms in the area and many of the students either lived or worked on those farms after school and in the summer months. The other main source of work in the town was a telecommunication service provider that offered many jobs to the community. Residents who did not farm or work in the telecommunications provider had to drive to larger cities for their careers.

The district was comprised of only one building that contained all students from kindergarten through twelfth grade and was made up of approximately 450 students in those grades. The size of each grade varied anywhere from 25 to 50 students per graduating class. For staff, the school had two teachers per grade in the elementary and two teachers for core subjects in the high school. The band, choir, and art teachers were split between elementary and high school for their classes. The high school also had a business education teacher, a half time family and consumer science teacher, a half time Spanish teacher, and three special education teachers. The racial/ethnicity break down for the school was 0.2% Hispanic or Latino, 0.2% American Indian or Alaskan Native, 0.2% Asian, 0.2% Black or African American, 93.1% White, and 6% two or more races (Minnesota Report Card, 2021). Based on these percentages and the size of the student population, there was not much for diversity in terms of race or ethnicity. The student body had no English learners, 20.1% were receiving special education services, and 36.8% received free or reduced lunches (Minnesota Report Card, 2021).

Participants

The participants of this study were all sophomores with the exception of one freshman that were enrolled in the researcher's two geometry classes during the 2021 – 2022 school year. Students were in

their first semester of the course and all students had been in the researcher's class during the 2020 – 2021 school year for math. The demographics of the two classes together were approximately 56% female to 44% male. As for race/ethnicity, the two classes were made up of 34 White students, 1 Black or African American student, and 1 Asian American student. Ages of the students ranged from 14 to 16 years of age and approximately 13.9% of them received special education services. Family structures for the students were as follows: three students went between divorced parents who are not remarried, three students had parents who were divorced and at least one parent was remarried, four lived with only one parent, 1 student lived with a grandparent, and the remaining 25 students lived with both of their married parents.

Sampling

Participants for the study were selected through a convenience sample. A convenience sampling uses participants who are easily available to the researcher (Fraenkel et al., 2019). The researcher selected his students because they were enrolled in his geometry classes during the 2021 – 2022 school year. The students were given the option if they wanted to participate in the study so not all students were surveyed from the researcher classes.

Instrumentation

The tool that was used in this research was a modified version of the Attitude toward the Subject of Chemistry Inventory which was created by Bauer (2008). The original survey was created to be used with chemistry students and asked them to place themselves between the two endpoints of opposing adjectives on a seven-point scale. The words on this survey were not chemistry specific so the researcher modified the very beginning and changed the word chemistry to geometry. This means that students were asked to look at the two adjectives and place themselves somewhere between them based on how they felt about geometry. The survey was given during class time through a Google Form and took the students approximately fifteen minutes to complete. A copy of the paper version of the survey can be found in Appendix C. The questions that students saw during their survey were all posed as the question that is shown in Appendix D. The only difference was that the adjectives were changed for each question.

According to Bauer (2008) the twenty items on the survey can be broken into five different parts that consist of three factors (Interest and Utility, Anxiety, and Intellectual Accessibility) and two items (Fear and Emotional Satisfaction). Items 2, 3, 6, 12, and 15 from the survey addressed how the student felt about the geometry's ability to be utilized and interesting. The items 8, 13, 16, 19, and 20 addressed how geometry caused different levels of anxiety in students. Items 1, 4, 5, 9, and 10 addressed how accessible geometry was for the students. Item 18 measured the students' fear of geometry and items 7, 11, 14, and 17 addressed how emotionally satisfied students felt while learning geometry (Koehler, 2021). The three sets of factors were created by Bauer (2008) as the adjectives formed certain patterns that had clear distinctions from one another and are found to be independent from each other. The survey was found to have a reliability coefficient close to 0.7 or above when being used to see how general chemistry, study group leaders, and chemistry majors felt about the subject of chemistry (Bauer, 2008).

Data Collection

The data was collected from the three surveys students had to take during the process of the study. The survey was distributed using a Google Form that students had access to through their Google Classroom page. The responses were transferred to Google Sheets for the analysis part of the research. The data from the surveys was all in numerical form and the scores were all setup so that when the data was analyzed the researcher knew that the higher the score meant the more positive the attitude or perception toward geometry. The reverse was also true where the lower the score revealed a more negative attitude or perception toward geometry with a score of 4 being directly in the middle.

Data Analysis

The raw data from the surveys were transferred to a Google Sheet, with each response in numerical form. Before the data was analyzed, any responses that were incomplete were removed from the data set. All items in the survey were set up where the higher scores showed a more positive attitude or perception toward geometry and the low scores showed a more negative attitude or perception toward geometry with the middle score for each item being 4. Using the Google Sheet, the mean score and standard deviation were calculated for each item on the survey. The items were then grouped into the

three factors and two items that were defined by Bauer (2008). The mean score for each factor and item were also found. The three sets of data from each survey were then analyzed to see if there was a significant change in the students' attitudes and perceptions toward geometry by comparing changes of data from the two different units. After comparing the data from the three surveys, the results were represented on a graph showing how the means changed throughout the two units.

Research Question and System Alignment

Table 1 provides a description of the alignment between the study Research Question and the methods used in this study to ensure that all variables of study have been accounted for adequately.

Table 1

Research Question Alignment

Research Question	Variables	Design	Instrument	Validity & Reliability	Technique (e.g., interview)	Source
RQ1	IV: Teaching method, either traditional method or activity-based and inquiry-based methods incorporated into a traditional method DV: Students' attitudes and perceptions toward geometry.	Quantitative Action Research – Longitudinal Survey	Attitude toward the Subject of Geometry Inventory (Modified version of the ACSI that was created by Christopher Bauer, 2018)	The ACSI was shown to assess student attitudes separate from performance by Bauer (2008). The Validity and Reliability should not change when changing the main focus from chemistry to geometry as the opposing adjectives are not changed.	Longitudinal survey where student complete three surveys one before and after both units that were being taught.	Bauer (2008); Fraenkel (2019)

Procedures

The research part of the study took approximately six weeks to complete as there were two full units to cover in this time frame. The surveys were administered about three weeks apart. To begin the study, the students were asked to take the first of three surveys in class and all students were given at least fifteen minutes to complete the survey before starting the first unit. The unit was taught over a three-week period using a traditional style of teaching before the first unit test was taken by the students in the two classes. The second survey was then administered to all students after they all had a chance to finish the unit test. The second unit was taught by using the hybrid model that incorporated activity-based and inquiry-based lessons into the unit and only utilized traditional methods when necessary. For example, one lesson that was used during this unit had students manipulate parallel lines that were being cut by a transversal using GeoGebra. Students were asked to describe what they noticed about the angle pairs that had been covered in a previous lesson. After students had a chance to look at them individually, they got with a partner and compared what each of them had noticed for each set of angle pairs. Finally, as a class, they combined and solidified the concepts that were covered where the researcher facilitated the conversation and helped students come up with common terminology to be used by all students. The unit lasted about three weeks and when the unit was done the second unit test was taken by students. The final survey was then given to students and the data from the third and last survey were recorded into a Google Sheet for analysis. At the end of the six weeks, the researcher analyzed the data and looked at how the data changed over the three surveys given to the students in the study. The data from the surveys was graphed to show any changes in their mean scores. The researcher also looked at how much the data changed between the first two surveys and the last two surveys to see if there was more or less growth that came from the two different teaching methods.

Ethical Considerations

The study was conducted with no intentions on harming any students and safety along with confidentiality were of high priority for the researcher. The research was only conducted after the researcher had notified parents and students of the purpose of the study and he had received consent from

the students who would be a part of the study. Students and parents were able to decline to be a part of the research and were able to exit the study at any time during the process with no consequences. The use of activity-based and inquiry-based lessons did not pose a concern for students' safety as the researcher created an environment that was open for all students to share and learn together. All responses from the surveys were anonymous where no student names were attached to the surveys. This way no surveys could be traced back to any students.

Conclusions

The focus of this study was to use a longitudinal survey to see if students' attitudes and perceptions about geometry changed by teaching two lessons with two different teaching styles. The first unit was taught using a traditional method and the second unit was taught by incorporating activity-based and inquiry-based lessons with a traditional method. The sample was a convenience sample that consisted of the students who were enrolled in the researcher's geometry classes during the 2021 – 2022 school year. The researcher used a modified version of the Attitude toward the Subject of Chemistry Inventory where he changed the word chemistry to geometry and used this survey to collect the data on how students felt about geometry. The mean scores were analyzed for each item on the survey along with the changes that happened between each survey. The next chapter will present the results of the study.

Chapter 4

DATA ANALYSIS AND INTERPRETATION

Through quantitative methods, the study looked at how students' attitudes and perspectives changed toward geometry while using a more traditional teaching method as well as an activity-based and inquiry-based teaching style. A student's attitude or perspective of any subject is an important aspect of teaching (Guce, 2018). The researcher had many students who felt like geometry or even math in general was unimportant, which was what prompted the study. The purpose of the study was to see if a different teaching style may have a positive effect on the students' attitudes and perspectives about geometry. The following chapter presents a summary of the data collected through a quantitative survey. The data are presented in tabular and graphical formats.

Research Question

How will a hybrid teaching method consisting of activity-based, inquiry-based, and traditional-based teaching methods affect a student's attitude and perception toward learning geometry?

Data Collection

The study was an action research study that used a quantitative approach with a survey administered three times throughout the process. Survey data were collected through the use of an online survey administered through Google Forms. Students were given access to the survey through the Google Classroom that students were enrolled in for the high school course. The students were asked to complete the three surveys during class time and were given approximately fifteen minutes to answer the questions.

During the action research project, all students who participated with the surveys were attending school full time with none of them out due to Covid-19 issues. There were four students who were gone for school activities during the last survey which caused the number of students to drop as they were students who had decided to participate in the research. Table 4.1 shows the number of students that were sampled from, as well as the number of students that participated in each survey and had complete results. The number of students who participated went up and down due to students not having their paperwork in on time due to Covid-19 absences, but all students were present during the survey portion of the research.

Table 4.1

Student Sample and Retention Data

Description:	Number of Students:
Students enrolled in high school geometry	38
Students who completed the first survey	21
Students who completed the second survey	24
Students who completed the third survey	19

The action research study took place in a rural school district in northern Minnesota. The participants from the study were all students enrolled in the researcher's high school geometry class during the 2021-2022 school year. The students were all in their first quarter of the course and had the researcher for a previous class except for the one foreign exchange student who decided to participate in the study as well. Students that participated in the study were approximately 70% female and 30% male. All students who participated in the study identified as White or Caucasian. The ages of participates were either 15 or 16 and were primarily sophomores in high school with the exception of one freshman who transferred in to the district.

Results

RQ 1: How will a hybrid teaching method consisting of activity-based, inquiry-based, and traditional-based teaching methods affect a student's attitude and perceptions toward learning geometry?

The survey scores were broken down into five subscales, where the scores for multiple questions that were related to a similar theme were combined to show an overall score for that particular subscale. The student data for each subscale were then averaged to find the means for the entire class. The mean scores for each subscale were converted to percentages and can be seen in Table 4.2. Mean scores for each subscale were also compared through a paired t-test.

The statistical assumptions were examined to determine if the t-test was an effective tool for comparing the means for each of the subscales. The survey was a Likert-scale, so the researcher

determined a score for each individual survey that was submitted and found that each of the three sets of surveys administered followed a normal distribution. The standard deviations are approximately equal for each subscale score, but are unknown for the population. The surveys were also a simple random sample of the students' responses which made the t-test an appropriate measurement to determine if mean scores had a significant change after each unit was taught to students.

Table 4.2

Statistical Values for all three Surveys

Subscale	1st Survey Mean (%)	2nd Survey Mean (%)	3rd Survey Mean (%)	Change in Mean from 1st to 2nd Survey (%)	Change in Mean from 2nd to 3rd Survey (%)
Interest and Utility	69.4 (20.6)	66.1 (20.3)	67.5 (20.7)	-3.3	1.6
Anxiety	61.1 (21.7)	59.5 (23.5)	59.2 (20.2)	-1.6	-0.3
Intellectual Accessibility	66.4 (19.9)	63.9 (22.6)	63.5 (23.4)	-2.5	-0.4
Fear	79.6 (22.8)	77.4 (19.7)	75.9 (23.4)	-2.2	-1.5
Emotional Satisfaction	65.8 (21.4)	62.4 (21.8)	66.2 (21.6)	-3.4	3.8

Note. Standard deviations are presented in parentheses.

Figure 4.1 shows the mean scores as percentages broken down into subscales and compared between the three sets of surveys that were administered to students. The largest change that occurred after the first unit was taught was in emotional satisfaction, where the mean score decreased by 3.4%. The mean scores for the other four subscales also decreased after the first unit was taught, interest and utility decreased by 3.3%, anxiety decreased by 1.6%, intellectual accessibility decreased by 2.5%, and fear decreased by 2.2%.

The largest change that occurred after the second unit was taught was in emotional satisfaction as well, except this time the mean score increased by 3.8%. Interest and utility also increased by 1.6% after

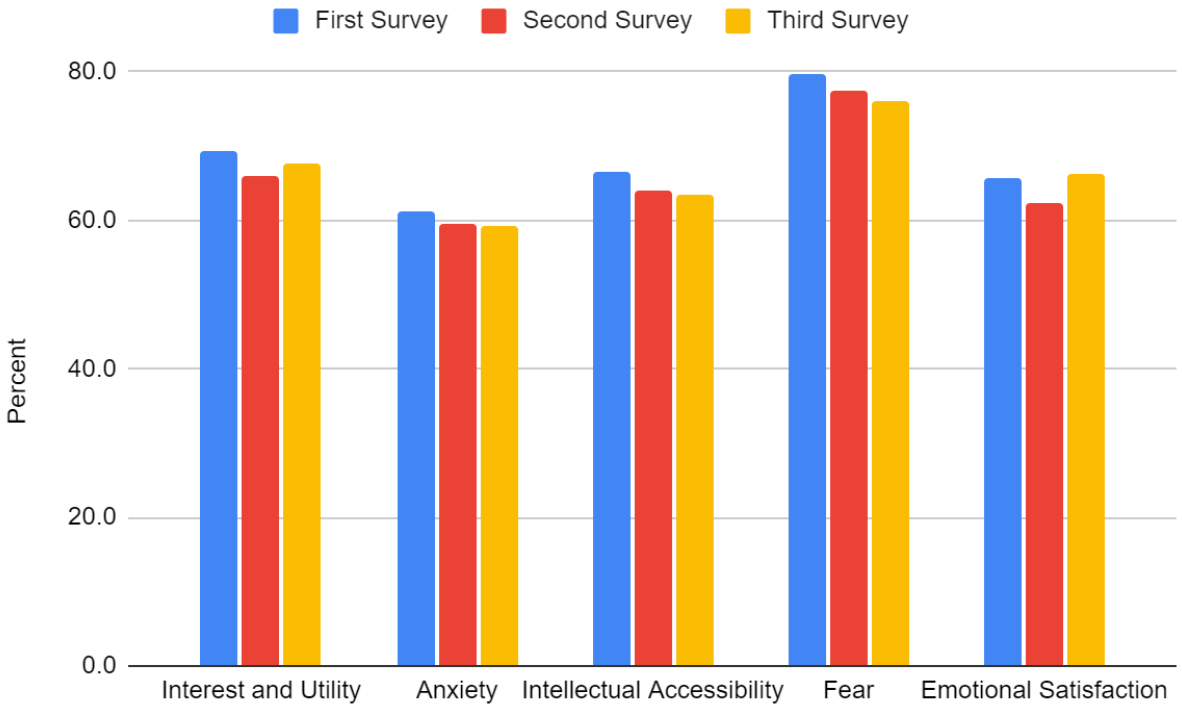
the second unit was taught. The remaining three subscales continued to decrease as follows, anxiety (-0.3%), intellectual accessibility (-0.4%), and fear (-1.5%).

Even with the changes that can be seen in the mean scores for all subscales, statistical analysis from the t-test shows that there was no significant change at $p < .05$ in mean scores in any of the subscales. There was a 3.3% decrease in the mean score for interest and utility between the first survey ($M = 69.4,\ SD = 20.6$) and the second survey ($M = 66.1,\ SD = 20.3$), but between the second survey ($M = 66.1,\ SD = 20.3$) and the third survey ($M = 67.5,\ SD = 20.7$) there was a 1.6% increase in the mean score. Using the t-test, these changes in mean scores for interest and utility were found to be insignificant with the results $t(20) = 0.9054,\ p = 0.1203$ for the first change in mean score, and $t(18) = 0.3949,\ p = 0.6976$ for the second change in mean score. There was a decrease of 1.6% in the mean score for anxiety between the first survey ($M = 61.1,\ SD = 21.7$) and the second survey ($M = 59.5,\ SD = 23.5$) as well as 0.3% decrease between the second survey ($M = 59.5,\ SD = 23.5$) and the third survey ($M = 59.2,\ SD = 20.2$). Using the t-test, these changes in mean scores for anxiety were found to be insignificant with the results $t(20) = 0.5509,\ p = 0.6067$ for the first change and $t(18) = 0.9278,\ p = 0.3658$ for the second change in mean scores. There was a decrease of 2.5% in the mean score for intellectual accessibility between the first survey ($M = 66.4,\ SD = 19.9$) and the second survey ($M = 63.9,\ SD = 22.6$), as well as 0.4% decrease between the second survey ($M = 63.9,\ SD = 22.6$) and the third survey ($M = 63.5\ SD = 23.4$). Using the t-test, these changes in mean scores for intellectual accessibility were found to be insignificant with the results $t(20) = 0.7102,\ p = 0.3892$ for the first change and $t(18) = 0.8816,\ p = 0.3896$ for the second change in mean scores. There was a decrease of 2.2% in the mean score for fear between the first survey ($M = 79.6,\ SD = 22.8$) and the second survey ($M = 77.4,\ SD = 19.7$), as well as 1.5% decrease between the second survey ($M = 77.4,\ SD = 19.7$) and the third survey ($M = 75.9,\ SD = 23.4$). Using the t-test, these changes in mean scores for fear were found to be insignificant with the results $t(20) = 0.4743,\ p = 0.7292$ for the first change and $t(18) = 0.8274,\ p = 0.4188$ for the second change in mean scores. There was a 3.4% decrease in

the mean score for emotional satisfaction between the first survey ($M = 65.8,\ SD = 21.8$) and the second survey ($M = 62.4,\ SD = 21.8$), but between the second survey ($M = 62.4,\ SD = 21.8$) and the third survey ($M = 66.2,\ SD = 21.6$) there was a 3.8% increase in the mean score. Using the t-test, these changes in mean scores for emotional satisfaction were found to be insignificant with the results $t(20) = 0.7793,\ p = 0.2840$ for the first change in mean score and $t(18) = 0.2537,\ p = 0.8026$ for the second change in mean score.

Figure 4.1

Mean Percentage Scores for the all three Surveys



Note. Mean percentage scores for the three surveys for each subscale are presented.

Data Analysis

The overall data for the study shows that the answer to the research question: how will a hybrid teaching method consisting of activity-based, inquiry-based, and traditional-based teaching methods affect a student's attitude and perceptions toward learning geometry is complicated. The data showed that the students' attitude and perception about geometry were not significantly affected in the five subscales

that the survey questions were broken into according to Koehler (2021). The lack of significant change in the mean scores for the second unit taught showed that the teaching style used in the second unit did not have a negative influence on the students' attitudes and perceptions about geometry.

According to Celik (2018), Kim (2006), and Kuo et al. (2020) activity-based and inquiry-based teaching could potentially increase a student's attitude or perception about mathematics or science. The results from this study varied as the mean scores for interest and utility and emotional satisfaction decreased when using the more traditional style of teaching and increased when the hybrid teaching style was used. These were not significant changes, but do show the potential to increase students' attitudes and perceptions about geometry. The subscales for anxiety and intellectual accessibility decreased by 1.6% and 2.5% respectively for the more traditional style of teaching, but only decreased by 0.3% and 0.4% respectively when using the hybrid teaching style. Even with these not being significant changes, the students' attitudes and perceptions about geometry did not decrease as much. Finally, the mean scores for fear decreased by 2.2% for the traditional style of teaching and 1.5% for the hybrid style of teaching. The units that students were learning about had a few lessons about creating proofs where students were less confident and felt they were not capable of doing the proofs without assistance. This researcher is not sure if this observation did or did not affect the students' fear mean score or any of the other subscale mean scores that were looked at.

The results of the study did not show a significant change in students' attitudes and perceptions, which may have been caused by the shortness of the study. Due to the study needing to be done in a shorter time frame, a longer study may have shown more accurate results as students could have had more time with each type of teaching style over different units. The study may have been more accurate of the students' attitudes and perceptions if it was done over a longer period of time. It would be beneficial to survey students over a semester where each quarter used a different teaching style or even over a year where each semester used a different teaching style.

Recommendations for Future Research

The study was done in a single small town school district and the researcher understands that the results of his action research has limitations in regards to how much can be generalized from them. This is due to the size of the study and the limited samples that were used for the research. To get more generalizable results, the study would have to be done with a much larger sample size, as well as include other school districts that are more diverse in population size and use schools from different areas across the region, state or even the country.

If the research were to be repeated, the researcher would increase the length of the study to see if it affects the students' attitudes and perceptions. It would be productive to see if the content of the units taught had any effect on how little the mean scores changed as the different teaching styles were used. By creating a longer study, the units would vary in difficulty, and students would have more time to experience the hybrid style of teaching before taking the third survey. Adding a qualitative portion to the study may have allowed the researcher to get more personal insight from the students who participated in the survey. This could help determine if the surveys are a true picture of how the students feel about geometry or even math in general. The researcher would also look at academic achievement as part of the study. In his experience, the students seemed to have a better grasp of the content from the unit that was taught using the hybrid style of teaching, but there was not data to back this up. Looking at scores from previous years and comparing them to the current year being taught to see if this has had an academic affect would be a future step for this research.

Conclusion

The results of the study through the survey showed that students' attitudes and perceptions were not significantly changed through the hybrid style of teaching where activity-based and inquiry-based lessons were used. There were some trends that showed that traditional styles of teaching may be decreasing attitudes and perceptions for all five subscales used. The results also showed that they hybrid style of teaching slowed the negative attitudes and perceptions for some subscales, but did increase two of the subscales in a positive direction.

Chapter 5

IMPLICATIONS FOR PRACTICE

The process of this study has given the researcher the opportunity to reflect on his teaching methods, more specifically how they may affect the students' attitudes and perceptions about geometry. The study showed there was no significant change in mean scores for the students' attitudes and perceptions about geometry. The following chapter will discuss how the information gained from the research will be used to benefit the researcher's classroom, students, co-workers and other math teachers.

Action Plan

Researching how the hybrid teaching methods affects a student's attitude and perceptions toward learning geometry has been very relevant to the researcher's teaching. He has been struggling with how students perceive math inside and outside of school. Many students feel that math has become less important over the years, and by the time they get to his classes in high school they feel that they don't need to learn it anymore. The results showed that the change in mean scores for all the subscales may have been insignificant to prove that the change was enough to be important, but the trends in the changes made in the data seemed as if the hybrid teaching style slowed the negative attitudes and perceptions. Due to this, the researcher is planning on continuing to use lessons that implement activity-based and inquiry-based lessons into his classroom. The students seemed to respond well to the activities, and appeared as though they have become more active in the lectures using their own inquiries. The activities could be used to help introduce new concepts during units, giving students a chance to build up some of their own inquiries, and as a class the ideas can become cemented. This will allow more time for students to explore in math class and less time where the teacher is the center of the lesson.

Another way that this study will be useful for the researcher is through awareness and evaluation for student attitude and perception. Even though the research did not provide a strong argument for how incorporating activity-based and inquiry-based lessons into the curriculum affects students' attitudes and perceptions, it did give the researcher a way to assess it for students. The survey will also continue to be used as tool to determine how students feel about the different classes the researcher teaches. However,

the survey will be used to determine the year-long change in students' attitudes and perceptions versus only looking at one quarter. On top of extending the time frame for the surveys, the researcher plans to continue looking into incorporating more activity-based and inquiry-based lessons into his teaching. This will help his teaching toolbox grow, and it will give students time to explore math more often while in class. In order to accomplish this, the researcher plans to resume going to a math network that is offered to any teacher, teaching in the region. The network often talks about the shift from traditional teaching to a more student centered style of teaching. Teachers often bring in different ideas of how educators can incorporate different projects, lessons, or activities that allow students to do more inquiry and less note taking. The researcher will also look into any online resources that could be incorporated into classes, and allow students to interact with online math manipulatives that could help create raise students interest in different concepts.

Plan for Sharing

In the researcher's district, there are two people who are 7^{th} – 12^{th} grade math teachers, both of whom try to incorporate different teaching styles into their classroom. The results will first be shared with the other teacher in the district before being shared with other teachers who would be interested in the results of the survey. The researcher would like to discuss the effectiveness of the hybrid teaching style and how it may affect students' attitudes and perceptions. The research found through the literature review expresses how using different teaching styles can be effective in improving student attitude and perspective toward the subject, but due to uncertainty, they should be careful with the information. The information from the studies can be somewhat generalized, but it may not always be successful in all situations that it is applied to. This presentation can give teachers a chance to discuss changes that could be made to curriculum, helping incorporate different types of lessons that could potentially increase positive student attitudes and perceptions at a young age. As a reminder, Jansson et al. (2018) talked about how students' attitudes and perceptions toward math tend to decrease as they age. Therefore, it is important to help find a way to keep students positive about the subject they learn, especially math.

It is important for students to have positive attitudes and perceptions toward any subject they are learning about, and if changing up teaching styles helps to establish that, then it is important to share. The results from this research will also be shared with the network the researcher is a part of where he will discuss the effectiveness of the hybrid teaching style and how it could affect the students' attitudes and perceptions about math. The information that was found during the research part of the of the study would also be presented to the network along with the precautions that were presented to the teachers as well.

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Appendix A

IRB Approval

Institutional Review Board

MINNESOTA STATE UNIVERSITY MOORHEAD

DATE:	September 20, 2021
TO:	Tiffany Bockelmann, Ed.D Wade Hukriede
FROM:	Lisa Karch, Chair Minnesota State University Moorhead IRB
ACTION:	**APPROVED**
PROJECT TITLE:	[1807229-1] The Effects of Activity-based and Inquiry-based Teaching Methods on Student Attitude and Perception Toward Geometry
SUBMISSION TYPE:	New Project
APPROVAL DATE:	September 20, 2021
EXPIRATION DATE:	September 20, 2022
REVIEW TYPE:	Exempt Review

Thank you for your submission of New Project materials for this project. The Minnesota State University Moorhead IRB has APPROVED your submission. This approval is based on an appropriate risk/benefit ratio and a project design wherein the risks have been minimized. All research must be conducted in accordance with this approved submission.

This submission has received Exempt Review based on the applicable federal regulation.

Please remember that informed consent is a process beginning with a description of the project and insurance of participant understanding followed by a signed consent form. Informed consent must continue throughout the project via a dialogue between the researcher and research participant. Federal regulations require that each participant receives a copy of the consent document.

Please note that any revision to previously approved materials must be approved by this committee prior to initiation. Please use the appropriate revision forms for this procedure.

All UNANTICIPATED PROBLEMS involving risks to subjects or others and SERIOUS and UNEXPECTED adverse events must be reported promptly to the Minnesota State University Moorhead IRB. Please use the appropriate reporting forms for this procedure. All FDA and sponsor reporting requirements should also be followed.

All NON-COMPLIANCE issues or COMPLAINTS regarding this project must be reported promptly to the Minnesota State University Moorhead IRB.

This project has been determined to be a project. Based on the risks, this project requires continuing review by this committee on an annual basis. Please use the appropriate forms for this procedure. Your documentation for continuing review must be received with sufficient time for review and continued approval before the expiration date of .

- 1 -

Please note that all research records must be retained for a minimum of three years after the completion of the project.

If you have any questions, please contact the Minnesota State University Moorhead IRB. Please include your project title and reference number in all correspondence with this committee.

This letter has been issued in accordance with all applicable regulations, and a copy is retained within Minnesota State University Moorhead's records.

Appendix B

Consent Letter

MINNESOTA STATE UNIVERSITY
MOORHEAD

218.477.2217 T
218.477.2561 F

9/20/2021

200 1st Street NW
Sebeka MN 56477

Dear Parent or Guardian,

Your child has been invited to participate in a study to see how student attitudes and perceptions toward geometry may be affected by using activity-based and inquiry-based lessons along with traditional teaching.

Your child was chosen because he/she is enrolled in my regular geometry class this fall. If you decide to participate please understand that your child will be asked to complete three surveys asking about their attitude toward geometry. All students, regardless of participation in the research study, will be a part of the activity-based and inquiry-based lessons. However, only those involved in the study will be asked to complete the surveys. Student participation in the study will involve no risk to the students, and is not required. Participation in the surveys will not affect their grade in anyway.

Principal Amie Westberg has granted me permission to conduct this study. However, since this information is being used to help me complete my master's degree at Minnesota State University Moorhead, I need to have parental consent to use this information in my final paper that I am required to do as part of my degree. If I didn't need this information to complete my master's degree, I would be conducting this same type of research in my normal everyday lessons. If you sign this form, you are giving me consent to use the information that I gather from the surveys. All information that is used will be confidential, no names will be used. Please also note, that your child can choose not to participate at any point during the study without any consequences.

Please get in touch at any time with questions about this study. You may contact Mr. Wade Hukriede at 218-837-5101 ext. 175 or email whukriede@g.sebeka.k12.mn.us or Principal Investigator Dr. Tiffany Bockelmann at 218-780-0757, or email tiffany.bockelmann@mnstate.edu. Any questions about your rights may be directed to Dr. Lisa I. Karch, Chair of the MSUM Institutional Review Board, at 218-477-2699 or by email at irb@mnstate.edu.

You will be offered a copy of this form to keep. You are deciding whether or not to participate. Your signature indicates that you have read the information provided above and have decided to participate. You may withdraw at any time without any penalties after signing this form should you choose to discontinue your child's participation in this study.

mnstate.edu | 1104 Seventh Avenue South • Moorhead, Minnesota 56563

MINNESOTA STATE UNIVERSITY
MOORHEAD

218.477.2217 T
218.477.2561 F

Signature of Parent or Guardian _____ Date _____

Signature of Investigator _____ Date _____

mnstate.edu

1104 Seventh Avenue South • Moorhead, Minnesota 56563

Appendix C

Survey Questions

The following survey is a modified version of the Attitude to Subject of Chemistry Inventory by Christopher F. Bauer of the University of New Hampshire. (the word chemistry was changed to geometry)

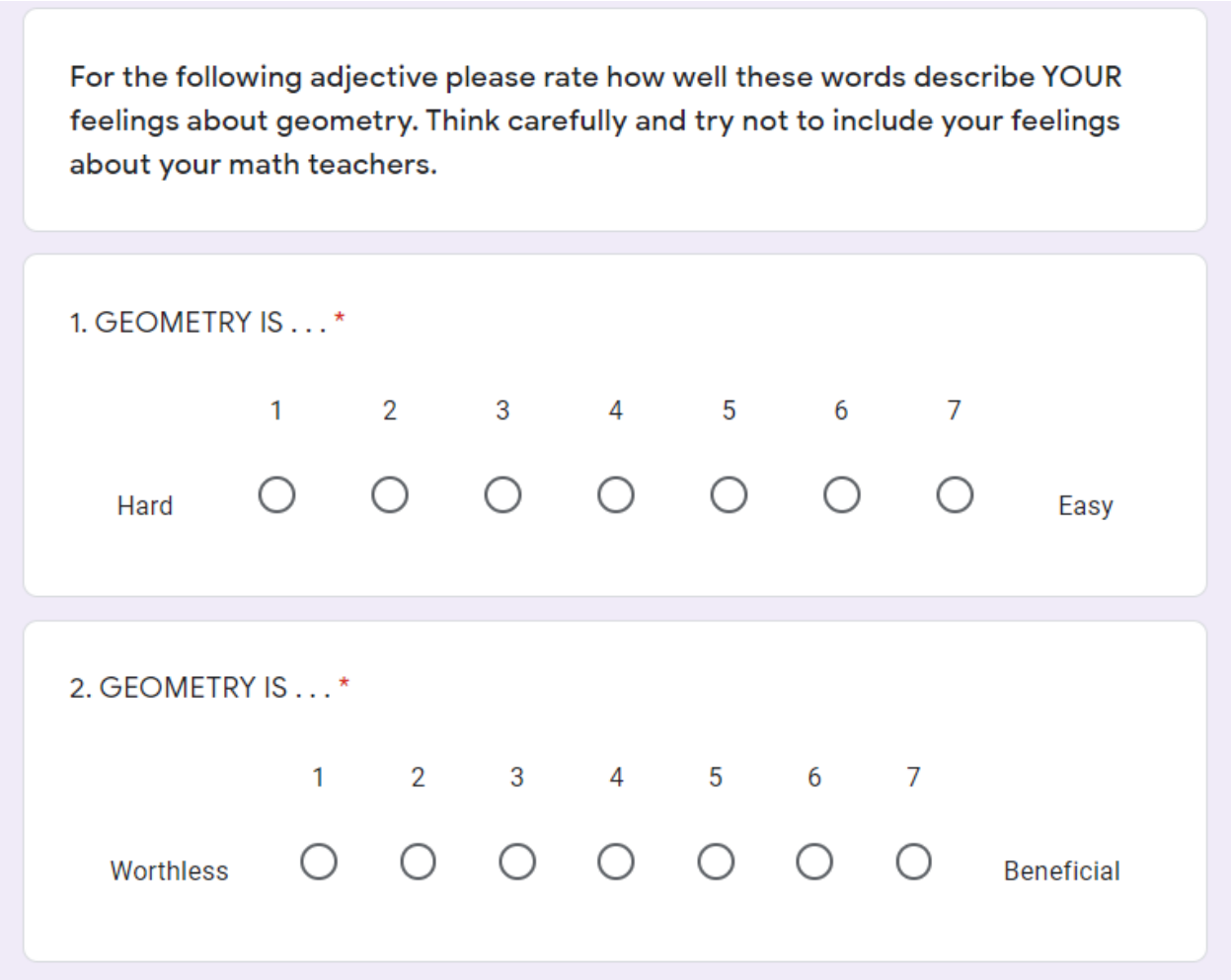
A list of opposing words appears below. Rate how well these words describe your feelings about **geometry**. Think carefully and **try not to include** your feelings toward math teachers or math course. For each line, chose a position between the two words that describes **exactly how you feel**. Mark that number here or on the standard answers sheet. The middle position (4) is if you are undecided or have no feelings related to the terms on that line.

GEOMETRY IS

1. Hard	|_ 1 _|_ 2 _|_ 3 _|_ 4 _|_ 5 _|_ 6 _|_ 7 _|	Easy
2. Worthless	|_ 1 _|_ 2 _|_ 3 _|_ 4 _|_ 5 _|_ 6 _|_ 7 _|	Beneficial
3. Boring	|_ 1 _|_ 2 _|_ 3 _|_ 4 _|_ 5 _|_ 6 _|_ 7 _|	Exciting
4. Complicated	|_ 1 _|_ 2 _|_ 3 _|_ 4 _|_ 5 _|_ 6 _|_ 7 _|	Simple
5. Confusing	|_ 1 _|_ 2 _|_ 3 _|_ 4 _|_ 5 _|_ 6 _|_ 7 _|	Clear
6. Bad	|_ 1 _|_ 2 _|_ 3 _|_ 4 _|_ 5 _|_ 6 _|_ 7 _|	Good
7. Frustrating	|_ 1 _|_ 2 _|_ 3 _|_ 4 _|_ 5 _|_ 6 _|_ 7 _|	Satisfying
8. Scary	|_ 1 _|_ 2 _|_ 3 _|_ 4 _|_ 5 _|_ 6 _|_ 7 _|	Fun
9. Incomprehensive	|_ 1 _|_ 2 _|_ 3 _|_ 4 _|_ 5 _|_ 6 _|_ 7 _|	Comprehensible
10. Not Challenging	|_ 1 _|_ 2 _|_ 3 _|_ 4 _|_ 5 _|_ 6 _|_ 7 _|	Challenging
11. Unpleasant	|_ 1 _|_ 2 _|_ 3 _|_ 4 _|_ 5 _|_ 6 _|_ 7 _|	Pleasant
12. Dull	|_ 1 _|_ 2 _|_ 3 _|_ 4 _|_ 5 _|_ 6 _|_ 7 _|	Interesting
13. Disgusting	|_ 1 _|_ 2 _|_ 3 _|_ 4 _|_ 5 _|_ 6 _|_ 7 _|	Attractive
14. Uncomfortable	|_ 1 _|_ 2 _|_ 3 _|_ 4 _|_ 5 _|_ 6 _|_ 7 _|	Comfortable
15. Useless	|_ 1 _|_ 2 _|_ 3 _|_ 4 _|_ 5 _|_ 6 _|_ 7 _|	Worthwhile
16. Work	|_ 1 _|_ 2 _|_ 3 _|_ 4 _|_ 5 _|_ 6 _|_ 7 _|	Play
17. Chaotic	|_ 1 _|_ 2 _|_ 3 _|_ 4 _|_ 5 _|_ 6 _|_ 7 _|	Organized
18. Dangerous	|_ 1 _|_ 2 _|_ 3 _|_ 4 _|_ 5 _|_ 6 _|_ 7 _|	Safe
19. Tense	|_ 1 _|_ 2 _|_ 3 _|_ 4 _|_ 5 _|_ 6 _|_ 7 _|	Relaxed
20. Insecure	|_ 1 _|_ 2 _|_ 3 _|_ 4 _|_ 5 _|_ 6 _|_ 7 _|	Secure

Appendix D

Sample of questions from Google Form Survey



Appendix E

CITI Program Certificate

CITI PROGRAM

Completion Date 23-May-2021
Expiration Date 22-May-2024
Record ID 42620849

This is to certify that:

Wade Hukriede

Has completed the following CITI Program course:

Not valid for renewal of certification through CME.

Social & Behavioral Research - Basic/Refresher
(Curriculum Group)
Social & Behavioral Research
(Course Learner Group)
1 - Basic Course
(Stage)

Under requirements set by:

Minnesota State University Moorhead

CITI
Collaborative Institutional Training Initiative

Verify at www.citiprogram.org/verify/?wfcaa4b76-ae61-4e65-9e21-2714af849afa-42620849

Appendix F

District Approval

SEBEKA PUBLIC SCHOOL

David G. Fjeldheim—Superintendent
Amie Westberg - K-12 Principal
Rachel Kern - K-12 Counselor
Jon Lillquist - Activities Director

Independent School District 820
200 1st Street NW
P.O. Box 249
Sebeka, MN 56477
218-837-5101

September 8th, 2021

To whom it may concern,

This letter is to grant Wade Hukriede permission to conduct an action research study at Sebeka High School during the 2021-2022 school year. I understand that this study poses no risk to those persons involved or to the Sebeka Public School District. I also understand that all information received will be kept confidential and will only be used for purposes of this study.

Sincerely,

Amie Westberg
K-12 Principal