Retention of Learning: Student-led Classrooms or Traditional Classrooms?

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Abstract

Looking for ways to increase retention of concepts taught in your classroom? Have you wondered what inquiry learning is all about? Inquiry learning is a style of teaching in which students discover methods for solving problems instead of being told how to solve the problem. Information is stored for longer periods of time because it has a deeper, more meaningful connection to us. Inquiry learning can provide the meaning for concepts so students' brains will store the information. Seventh grade students were given the task to develop a formula for trapezoids. By working cooperatively in groups, students created a formula they could use for calculating the area of a trapezoid. Students were given the area formulas for rectangles, parallelograms, triangles, and circles by traditional teaching methods. Data was collected to compare the retention of all the formulas over a period of seven weeks. Results from this research indicate there was a strong retention of the trapezoid formula compared to some of the formulas taught by traditional means. The retention of the more difficult trapezoid formula indicates the use of inquiry learning improved the students' ability to remember the formula.

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Introduction

What is the Pythagorean Theorem? Can you name a situation in which you would use the Pythagorean Theorem to solve a problem? If you cannot answer either of those questions, you are probably not alone. Part of the reason formulas and theorems may not be easily recalled is because it may not have had any meaning for you. Teachers tend to teach in the same way they were taught, which was sitting in a desk listening to the instructor in the front of the room disseminating information to them. The problem with that type of teaching is it lacks an ability to be stored in the brain. “Information is most likely to get stored if it makes sense and has meaning” (Sousa, 2006, p. 48). In order for the information to make sense, students need to be actively involved in their learning. This means teachers need students to question ideas, search for answers, and analyze the answer to see if it makes sense. Student-led learning follows these general guidelines.

Purpose of the Study

The purpose of this study is to find out if retention of learning is higher when learning by a student-led lesson or through a traditional teacher-led lesson. This research project is being conducted because the researcher wants to find out from which method of instruction students will retain information longer. The question the research is attempting to answer is which type of teaching will lead to higher retention of the concept: student-led or teacher-led lessons.

The goal for teachers is to have their students retain concepts and to apply those concepts to situations. This study will help reinforce which type of teaching will lead to a higher retention rate of concepts. If teachers want their students to retain information, the information needs to be able to make a connection to previous knowledge. Current research encourages the use of student-led instruction so students can make more sense of the information which should lead to an increase in retention. The stronger the connection, the more likely students will remember the information since the brain can only store information that has a stronger, deeper meaning to the person. The more actively involved students are in the learning process, the more likely the information will be retained; hopefully for longer periods of time.

Setting

This study will be conducted in a small town in rural South Dakota. The participants in the research project are in the seventh grade. This is their first year in junior high, and as a result, students have never been exposed to this researcher's methods of instruction. All the seventh graders are taught math in one classroom at the same time of day. There is one teacher for all the seventh grade math classes so the teaching methods will not change due to different instructors.

Definitions

Throughout this paper there will be references to different teaching or learning types along with other unfamiliar terminology. It is beneficial to first become aware of the vocabulary words associated with this study. The major terms are defined below.

- Student-led learning is a process of learning information in which the students ask questions of one another while they assist each other as peers in discussing the method used to acquire the answers to those questions. Students are allowed to work with one another in a student-centered environment.

- Teacher-led learning is currently the most popular form of teaching students. This method involves the teacher holding all the information and sharing it with the students over time.
- Inquiry learning is another term for student-led learning. It requires students to inquire about the question and discover an answer for it.
- Area is the amount of square units needed to cover a two-dimensional figure.

Limitations

This study provides more information on the correlation between retention of the area concepts over time and the type of teaching used while learning those concepts. This study does not compare the teaching of math concepts other than area with the retention of different concepts.

One factor that can affect the validity of the results is previous exposure to formulas. Students have already been exposed to finding area of rectangles prior to seventh grade. Because they have previous knowledge and the concept has been reinforced over time, most students should be able to recall the area for rectangles. Area of rectangles are included just as a baseline measure of retention prior to the teaching of any other formulas.

The time allotted for each formula lesson to be taught will be the same. The tests that will be given over the course of the study will include the same type of problems on each test. The chapter test will have two problems for each type of area formula. The pre-test and post-tests will only have one problem for each type of area formula.

During the instruction of the area formulas, students will be exposed to songs that they will hear for all the formulas. This may lead to some skewing of the data since the songs may influence the retention because it allows for a deeper connection in the brain. However, since all the area formulas have songs for them, the effects for all of them will be equal.

Some students naturally remember formulas better than other students. This is one factor that cannot be accounted for. The way the brain learns and stores the information is different for every student so this could be something that might affect the results. The way to counteract that effect is to give a post-test three weeks after the chapter test and another post-test two weeks after that to help determine whether students memorized the formulas or truly learned them. The rationale for this is because over a longer periods of time, without reinforcement of the concept, the students who have a better memory for formulas should encounter some difficulty if the formula was memorized only.

Another factor that may affect the project is the length of the study. Because this study is being completed over a six-week time frame, the results may turn out differently over a longer period of time. The only way to find out would be to have tests over longer periods of time but the time constraints of this project limit the length of the research.

Along with the length of the study, the fact that only one lesson is an inquiry type lesson may skew the results of the project. It might have been beneficial to use the inquiry lessons for an entire concept like area and then use traditional lessons. The only downfall of that is it would require the use of a two-year research project which is beyond the time constraints. The other problem with the use of a two-year project is it would be comparing different student scores.

Since this is a small group of students being used in the project, the same project may not produce the same results in a large population of students. In a smaller setting, the facilitator has more time to give to each group. In a larger population of students, the amount of time spent with the facilitator asking questions would be limited.

The hardest factor to control is the students themselves. The best learning occurs when students are rested, well-fed, and come to school in a good mood. Most of these are outside of the researcher's control. One way to combat these factors is to encourage students to get plenty of sleep and eat good meals throughout the research project.

Significance of the Study

This study is significant for any teacher who is attempting to increase retention of concepts in their classroom. There is information in this project which can be applied to a different content area. However, math instructors will find this project more relevant to their content area. Administrators might find this beneficial in using it as a source of information. They could use it as a basis for teachers to begin the questioning process of how to increase learning and retention in their own classroom.

The biggest significance may be for the researcher herself. This study will add more knowledge towards improving learning for students. The researcher will utilize the knowledge gained from this project in order to create a learning rich environment for all students.

Organization of the Study

In Chapter Two, appropriate literature related to the problem just described will be examined. In Chapter Three, the research methodology selected to respond to the problem will be delineated. In Chapter Four, the data will be presented and analyzed. The study will conclude with Chapter Five, which will include a summary of conclusions drawn from the data presented in Chapter Four.

Summary

In summary, this project will analyze the effects of student-led lessons versus teacher-led lessons to the retention of the concepts. The most recent literature gives an indication that student-led learning will lead to longer retention. This is because students are taking a more active role in their learning process which should result in a more meaningful connection to the information. The purpose for this paper is to find out if a connection exists between the type of learning used and the retention of the concepts.

This project involves seventh graders from a rural town in South Dakota. Students will be exposed to traditional teacher-led lessons and to a student-led inquiry type lesson. Students will find the area of two-dimensional figures utilizing different types of lessons and be administered tests over a period of time in order to make a connection between the type of lessons used and the retention of the formulas.

There are many factors that will limit the results of the project. Some of those factors are previous knowledge of formulas, the length of lessons, the time constraints of this survey, the size of the class, and the students themselves. Although teachers can maintain some control with things that happen inside the four walls of their classroom, they cannot control what happens prior to class or at home.

The significance of this study may influence how teachers present lessons. All teachers want students to remember what was taught in previous weeks or years, yet most students struggle with retaining that information. The biggest influence should be on the researcher as it will influence how teaching takes place in her classroom after the project is completed. There has been a journey of how to enhance student learning, and if this project provides another opportunity for that, then it benefits future students. The literature relating to this project will follow in Chapter Two.

Literature Review

Learning is defined as "the acquisition of knowledge or skills through experience, practice, or study, or by being taught" (Wikipedia, 2011, para. 1). This definition encompasses a wide range of what learning could be like or where it takes place. What comes to mind when someone hears the word learning? For most, it may be the thought of a classroom since learning is most often connected to schools. However, learning is "a continual and effortless process" that happens every day (Smith, 1998, p. 12). Most people may say learning takes place when someone is teaching or providing the information to others, but learning is as simple as finding the answer to an unknown question.

The most easily recalled concepts are those which have a personal connection for people. "Information is most likely to get stored if it makes sense and has meaning" (Sousa, 2006, p. 48). The brain encounters numerous activities in just one day. It has to decide what information is important enough to remember and what can be discarded. Stored information occurs when the brain decides the information will be needed for future use. "Schema theory holds that information, if it is to be retained, must be categorized with something already stored in memory" (Carr, 1988, para. 11). This means information needs to be connected to previous learning in order to be retained. The original concept retained has to be one that has a personal meaning and/or made sense at the time. If the information coming in did not make sense, it will not be stored. If the original information is not stored, other vital information will have nothing to connect to.

Even though learning takes place every day, learning and retention does not always take place together. Students are exposed to new information multiple times throughout a day and are expected to remember that information the next day. Teachers become frustrated when the information is not easily recalled. In order to combat this frustration, most teachers search for a way to improve a student's retention but fail to succeed. Part of the problem may be a need for changing instruction style. Teachers need to find a way to make the information meaningful to students so it lasts longer. One way to do this is through inquiry learning.

Inquiry learning is when students are allowed to take the front seat and steer their learning instead of listening to the teacher instruct them. Students play a more active role in their learning by becoming involved participants during class. Teachers usually provide the class with a starting question and encourage students to work together for an answer. In this system, teachers will have more of a facilitator role.

So how will changing teaching instruction improve retention for students in a mathematics classroom? What is inquiry learning and how is it different than teacher-led learning? The purpose of this literature review is to review the findings of literature on using student-led learning along with teacher-led learning in order to see if either way will improve retention of material for students.

Frank Smith wrote in *The Book of Learning & Forgetting*,

> The official theory, which regards learning as work and forgetting as inevitable, is primarily concerned with memorization, the effort to store away one thing after another. The classic kind of learning, on the other hand, is growth. It is growth of the mind analogous in every way to the growth of the body. (1998, p. 12)

This quote reinforces the concept that teaching in the traditional way with memorization is going to lead to forgetting. There is no real connection to information so the brain decides it is something that can be forgotten. Even though teachers are expecting information to be retained for long periods of time, material will be lost because the expectation to memorize facts is still the main goal for most classrooms.

Traditional classrooms are classrooms in which most of the instruction comes from the teacher. Teachers stand in the front of the room giving out all the information while students are expected to sit in their desks listening with an expectation to remember what is spoken. Students have an attention span for a limited amount of time and expecting them to sit for fifty or sixty minutes is unreasonable.

> Learning is not a spectator sport. Students do not learn much just by sitting in class listening to teachers, memorizing pre-packaged assignments, and spitting out answers. They must talk about what they are learning, write about it, relate it to past experiences, apply it to their daily lives. They must make what they learn part of themselves. (Bonwell, 2000, p. 4)

Teachers must find a way to have students interact more with the lesson being taught if true understanding and retention is the goal. By incorporating writing, student interaction, and applying it to their everyday life, students in those classrooms will have the opportunity to remember more about ideas and concepts taught to them throughout their education.

This process of incorporating interaction among students with the hope of increased retention, along with the ability to problem-solve situations has many terms: student-led classrooms, inquiry learning, classic learning, discovery learning, and constructivist classrooms just to name a few. "Inquiry is defined as 'seeking for truth, information, or knowledge – seeking information by questioning" (Exline, 2004, para. 2). Inquiry learning is problem solving a situation by seeking more information about it. When introduced to some new concept, we want to know more about it in order to connect it to previous knowledge in some way. That process occurs without conscious effort. People develop inquiry learning at birth and continue it every day. Traditional classrooms are teaching in a style that is contradictory to the way students learn outside of the classroom. Classic or inquiry learning is longer lasting because it connects learning with a meaning for students. If teaching methods could be altered to do more inquiry in the classroom, the learning should have longer lasting effects.

To change teaching styles means teachers must learn to teach differently than they were taught. For decades, teachers have been the ones who have all the knowledge and their job was to disseminate the information to students sitting nicely in their desks. “Most of us have sat and listened to teachers lecture at us year after year, so we naturally think that’s what teaching is all about” (Kohn, 1999, p. 62). Yet there is something missing over the last twenty or so years from students who have been graduating from high schools all over the country. “Traditional learning focuses more on LEARNING ABOUT THINGS, while inquiry learning focuses more on LEARNING THINGS!” (Exline, 2004, para. 7). It was acceptable for a long period of time for people to memorize facts and be able to repeat those back to people, and because access to quicker information was not always available, people relied on their memory. In today’s technology-driven world, information is available sooner and people can find the information instead of relying just on their memory.

> Education is not preparing students for a world that is static and fixed. Rather, education must prepare learners to cope with changes that will increase in complexity throughout their lives and many of which cannot be foreseen at this time. (Exline, 2004, para. 1)

Living in the 21st century allows for more available technology to be used at a moment's notice. Students need to be able to survive in an ever-changing world, which means students have to be able to problem solve when placed in different situations. Ultimately, students will be solving problems tomorrow that did not exist today.

> What I am saying is if we want kids to be thinkers, we have to encourage (and help) them to think—and that means spending most of their time in most subjects on questions that don't lend themselves to single-word answers that are either right or wrong. (Kohn, 1999, p. 57)

The basics are not nearly as important as they were twenty or thirty years ago. Information available through the Internet allows for a faster, more efficient way to learn about things. Students need to be able to decide how to go about solving a problem or where to look. There is so much technology readily available that teachers need to provide the tools necessary for them to know where to look instead of knowing just facts.

The best reason for why inquiry learning should be used as a teaching method is that it allows students the necessary tools for an ever-changing world. "Inquiry implies emphasis on the development of inquiry skills and the nurturing of inquiring attitudes or habits of mind that will enable individuals to continue the quest for knowledge throughout life" (Exline, 2004, para.7). As stated previously, the world students will be entering is not a static and fixed world. Students need to be able to find answers to questions and the ability to know where to look in order to help find the answer. "Becoming a teacher who helps students to search rather than follow is challenging and, in many ways, frightening" (Brooks & Brooks, 1999, p. 102). So how do teachers transition from a traditional classroom to using inquiry learning as a teaching style?

Teachers will have to learn to ask questions that will lead students down a path instead of telling them which path to take to find the answer. Teachers already know that in asking questions, they will discover the varying levels of student performance. Sometimes, they just do not ask the right question in the right way. "Constructivist teachers seek to ask one big question, to give the students time to think about it, and to lead them to the resources to answer it" (Brooks & Brooks, 1999, p. 39). Teachers will need to spend more time interacting among other teachers and researching what works best in order to change teaching styles. "Hence, when we examine skilled questioning (or instruction of any kind), it is essential to learn from those teachers who understand how to engage a wide community of learners" (Wolf, 1987, p. 2). Utilizing other teachers who already use inquiry learning should advance the learning curve for teachers who are changing styles of instruction. Wolf also stated that most questions in a classroom are very low-level, short questions that do not involve a lot of thinking (1987).

Wolf suggests there are five major types of questions that give a greater range of questioning than did Benjamin Bloom's taxonomy. Those five types are: (a) inference questions, (b) interpretation questions, (c) transfer questions, (d) questions about hypothesis, and (e) reflective questions (1987). Using the different levels of questioning allows the teacher to challenge all students regardless of skill or thinking abilities throughout the learning process. Understanding the different type of questions to ask will enable a teacher to go beyond yes/no questions in order to get students to delve farther into the learning process.

Inference questions require teachers to ask questions that go beyond a one-word answer. These types of questions ask students to make inferences about what they see, hear, or believe. It challenges the students to think beyond just knowing facts and to fill in what is missing from a scenario. Students are asked to come to a conclusion based on reasoning and facts. They have to be able to back up what they are thinking which requires more thought behind the answer instead of just recalling facts.

Interpretation questions take the learning or thought process another step further. It requires students to be able to understand consequences of information or ideas. For example, asking a student to look at a picture or graph and interpret what is shown requires students to put forth more effort instead of just a one word answer. It could go a step further and asks the students to be able to decide what would happen if something was missing or added to the picture. Students need to be able to explain or demonstrate the meaning behind what they decided.

Transfer questioning should ask students to take their knowledge and apply it to a new scenario. It encourages students to use previous knowledge and apply it to a different topic. For example, in math, students may have been studying the circumference of circles. They could take that knowledge and apply it to the size of a colony of fungus in order to give a description of the amount of fungi growing. Students are taking knowledge from one classroom into another. When curriculums can cross over to one another, students are more likely to give true meaning to the concept or idea.

Questions about a hypothesis involve students being able to make a prediction of an outcome and then actually prove how the outcome could be found. This type of questioning requires students to expand on their existing knowledge and create outcomes based on what they already know. The outcomes may vary between students depending on their pre-existing knowledge and how they interpret the ideas.

The last type of questions, reflective questioning, require students to reflect about their individual thinking. These questions will reinforce the conclusion reached by students. The answers to the questions will reinforce the learning that took place. It could also cause a student to question whether he or she is right or wrong and investigate more independently. It makes the learning more meaningful.

The reason teachers need to be able to ask quality questions of students is to "invite students to experience the world's richness, empower them to ask their own questions and seek their own answers, and challenge them to understand the world's complexity" (Brooks & Brooks, 1999, p. 5). The process of getting students to problem-solve involves teaching them to ask good questions, or inquire, about things around them. In essence, it is inquiry learning at its finest.

What will inquiry learning look like? Inquiry learning will encourage more student interaction in the classroom. This may lead to a louder, more chaotic classroom because of student interaction, yet teachers will need to monitor the progress of each group. The following list was first published by Synergy Learning so teachers would know what inquiry learning looks like when in practice:

- Students will look forward to learning.
- They will collaborate and work cooperatively with teacher and peers.
- They are more confident in learning, demonstrate a willingness to modify ideas and take calculated risks, and display appropriate skepticism.
- They exhibit curiosity and ponder observations.
- They confer with classmates and teacher about observations and questions.

- They use questions that lead them to activities generating further questions or ideas.
- They value and apply questions as an important part of learning.
- They make connections to previous ideas.
- They design ways to try out their ideas, not always expecting to be told what to do.
- They sort information and decide what is important.
- They express ideas in a variety of ways, including journals, drawing, reports, graphing, and so forth.
- They listen, speak, and write about learning activities with parents, teacher, and peers.
- They recognize and report their strengths and weaknesses.
- They reflect on their learning with their teacher and their peers.

(1995, p. 13)

After reading what inquiry learning should look like, a common theme throughout the list was students working together, questioning each other, and working with the teacher. This type of interaction is sometimes called cooperative learning. Cooperative learning is a concept that has been around for a while and is used as one method of teaching students. Inquiry learning works best in conjunction with cooperative learning. "Cooperative learning activities encourage students to engage in the type of discourse about concepts and problem solving that moves them away from rote learning strategies and toward more meaningful learning strategies" (Towns, 1998, para. 9). After all, the quest teachers are on is one in which students are asked to make more meaningful connections with the concepts they are being taught.

Cooperative learning has been shown to lead to increased positive attitudes, higher self-esteem, empathy for peers, and higher achievement (Towns, 1998). Even though those benefits were not intended for cooperative learning, they are outcomes that must be met for students to be risk takers and ask good questions of each other for inquiry learning to work. The reason why collaborative learning works is that:

- Individual students may get stuck on a problem and give up, whereas groups of students tend to keep going,
- Students become exposed to alternative problem-solving strategies,
- Students are much less fearful of generating and answering questions among themselves than individually and directly to the instructor in class,
- And as McKeachie says, students learn best what they teach.

(McKeachie, 1998, para. 6)

There is a place for traditional learning to take place and one for inquiry learning to take place. There has to be a middle ground between the two in order to keep students engaged and moving forward. One case study found on the comparison of a traditional classroom learning calculus to an inquiry-based classroom there was no correlation to students doing better in an inquiry-based classroom than a traditional classroom. Students were given tests weeks after the course was taught in order to make any connections with retention and teaching styles. The tests indicated both classes retained about the same amount of information. However when asked to be able to explain how they found they answers, one student in the traditional course stated,

"…you focus so much on just doing the problems that I didn't really think about what it meant" (Garner & Garner, 2001, p. 177). It was pointed out in the case study all too often teachers want students who can replicate what was seen or illustrated for them. Students in the inquiry-based classroom could explain what they were finding and how it was relevant. So even though the test scores did not indicate an improvement in one group to the other, the evaluators did feel students in the inquiry-based classroom had a stronger understanding and connection of how to go about solving the problem.

In math classes, there are two types of knowledge: procedural and conceptual. Procedure knowledge is an understanding of the rules for completing mathematical tasks, including the use of symbolic language. Conceptual knowledge is an understanding of mathematical ideas, including reasons why algorithms work and when they should be applied. "Both types of learning are important to competency in mathematics, and linking the two helps to create the kind of networked information that is better retained" (Garner & Garner, 2001, p. 167). This indicates a need for both traditional and inquiry-based classrooms.

Another indication of why inquiry-based learning should not be used solely by itself is because "the classroom is too unstructured" (Anders, 2009, para. 8). Garner and Garner during the research commented,

> The ideas mentioned earlier for teaching reform applied calculus, at least in this case, were no more effective in general than traditional teaching ideas as measured by this test. Yet the knowledge of calculus retained by students in the reform course was clearly different from that of students in the traditional course. (2001, p. 178)

This also reinforces that inquiry-based classrooms enable students to find a "why" behind all of their questions.

Charles Bonwell says there are six commonly mentioned obstacles to using active learning strategies. They are:

A. You cannot cover as much course content in the time available;
B. Devising active learning strategies takes too much pre-class preparation;
C. Large class sizes prevents implementation of active learning strategies;
D. Most instructors think of themselves as being good lecturers;
E. There is a lack of materials or equipment needed to support active learning approaches;
F. Students resist non-lecture approaches.

(2000, p. 4)

This list contains common complaints from teachers who resist using inquiry learning as one of their teaching methods. The most valid point made from the list is the amount of pre-class preparation. This is a concern for any teacher making the switch from traditional teaching to using inquiry based learning. However, the change in teaching style does not need to be one that uses inquiry learning every day, nor immediately. The transition can be slow so as to gain confidence and understanding for the teacher.

In summary, students learn better when they are actively involved in the teaching process. Inquiry learning encourages students to developing strategies for solving situations and allows them to develop ways to solve new problems each day. "Students should be taught to think logically, analyze and compare, question and evaluate" and inquiry learning does just that

(Carr, 1988, para. 9). Traditional teacher-led classrooms require memorization and students who can memorize do well in that environment. The problem for this research is to compare inquiry learning with traditional teaching to see if there is any improvement in retention for students.

This problem has been researched before and the results show the retention for students might not be any better for either situation. However, through research, students are more able to give justification or reasons for their answers and how the mathematics work. This is because students were given the opportunity to search for an answer and could explain how they got their answer versus students who are merely told to repeat the same process someone else showed them. In one case study, although the test scores did not illustrate a better retention of material taught, it did indicate students in the inquiry classroom understood the reasons behind the work (Garner & Garner, 2001). This would support the fact that inquiry learning allows students to make a better connection on why things work the way they do.

This topic has been researched numerous times in the college setting but there is limited information about it for elementary or middle school classrooms. The research for this project should provide students with a stronger understanding of how things work in a junior high math classroom.

Questioning the environment around us is a form of inquiry learning. The quest to understand how or why something works is what makes people create new inventions. "We are all responsible for our own learning…Teachers do this by encouraging self-initiated inquiry, providing the materials and supplies appropriate for the learning tasks, and sensitively mediating teacher/student and student/student interactions" (Brooks & Brooks, 1999, p. 49). Teachers can provide students with opportunities to become life-long learners who know how to solve problems and work with others. The methodology of how this project will be implemented is delineated in Chapter Three.

Methods

Introduction

Students are more likely to remember information that has meaning to them versus information that is just given to them. If students are actively engaged in their learning, they are more likely to retain the information. Students who are expected to memorize facts and knowledge struggle to recall information as time goes on since the brain must pick and choose what to remember. The project is attempting to determine if a connection between a student-led lesson will be retained longer than a teacher-led lesson. This section will delve into the steps needed to implement this project along with the population used for this research.

Restatement of the Problem

Will a student-led lesson lead to longer retention than a teacher-led lesson? Even though learning takes place every day, learning and retention do not always take place simultaneously. Students are exposed to new information multiple times throughout a day and are expected to remember that information the next day. Most teachers search for a way to improve a student's retention but fail to succeed. Part of the problem may be a need for changing instruction style. Teachers need to find a way to make the information more meaningful to students so it lasts longer. One way to do this is through inquiry learning.

Inquiry learning is when students are allowed to take the front seat and steer their learning instead of listening to the teacher instruct them. Students play a more active role in their learning by becoming involved participants during class. Teachers usually provide the class with a starting question and encourage students to work together for an answer. In this system, teachers will have more of a facilitator role.

Research Methodology

Inquiry learning is a process used by people every day to answer questions. Throughout life people learn to inquire about the world around them. Yet in a classroom, learning is treated as a one-way avenue of information from the teacher to the student. This project allows students the opportunity to inquire about the procedures of math problems and answer those questions using materials and resources around them. The students will be given different simple figures for which they must find the area. The formulas for rectangles, parallelograms, triangles, and circles will be taught in a traditional setting. The students will use inquiry learning in order to discover the formula for trapezoids. The results for this project will be compared in order to find a connection, if one exists, between the retention of the formulas found by the student-led learning versus traditional teacher-led learning.

Subjects

The students participating in this project live in a small rural area of South Dakota. The students are all in the seventh grade and have only been taught by this teacher for a few months. This section will identify what type of students make up the study both within the entire county down to the specific class being used for the study.

Population. Students from this study live in Haakon County, which is 1827 square miles in area. Haakon County is primarily composed of ranchers and farmers. Haakon County contains three towns: Midland, Milesville, and Philip. Philip is the biggest and is located halfway between Pierre and Rapid City. Haakon County itself has 1937 residents of which 714 are located in the town of Philip. The community consists of approximately 46% male and 54% female inhabitants, with a median age of approximately 42 years. The median age is higher than the state average for South Dakota and the population of the community has declined by 19% from 2000 to 2009.

The socioeconomic status of Haakon County varies, but in 2009, the median household income was $40, 447. The average household in the city of Philip is comprised of two or more persons with a combined median income of approximately $44,000. The ethnic composition of the area is composed primarily of white persons, as of 2010, 94.7% of county residents were placed in this category while 1.9% of residents reported American Indian or Alaskan Native ethnicity. For the population of persons over the age of 25, 86% have a high school diploma yet only 21% of those same people hold a bachelor's degree. In comparison to the state average, Haakon County is relatively close to the same percentages of people. Of the advanced degrees held by community members, 22% have obtained an Associate Degree, 15% have obtained a Bachelor Degree, and 3% have obtained a Masters or Doctoral Degree.

The common industries of the community consist of manufacturing, health care, and agriculture while other businesses work in conjunction with and support these areas of commerce. Of the industry in this community, 40% is the manufacture, transportation, and warehousing of metal fabricating solutions, 31% is healthcare and social assistance, and 17% is agriculturally based.

Sample. The students involved in this study will be seventh graders in the junior high. These students are between the ages of 12 and 13. This class is being selected because the researcher has never taught these students prior to this year. There are 19 students in the seventh grade class but only 18 will participate in the study since the other student receives math instruction in a one-on-one classroom. There are nine females and nine males in the math class of which all are Caucasian. Most of the students live in town or drive less than five miles to town. However, there are four students who drive more than 20 miles to school every day.

Design

Students learn better when they make a personal connection to the material. In this project, students will be taught math lessons utilizing two different methods. The first method is the traditional way of teaching students. It will involve students being given information directly from the teacher. During these lessons, the researcher will present the information with some question as to why certain things exist in the formula. For example, the teacher will ask why the triangle formula contains the number one-half in it. The researcher will expand on this information to deepen a connection as to how the triangle formula is derived from the parallelogram formula.

The second method is to allow students to discover the formula for area through interaction with other students and manipulatives. Students will be divided into pairs and given two different cut-outs of trapezoid shapes (Appendix A). Students will use coordinate grid paper (Appendix B) to cover the trapezoid in order to find out how many square units is needed to cover the trapezoid. Covering the trapezoid is the same as finding the area of the figure. Students will work together to find a way to measure the area of the trapezoid and create a formula to use for all trapezoids.

Instrumentation. Students will be evaluated in a variety of ways. The data collection includes a pre-test prior to the introduction of lessons, a chapter test, two post-tests, and a survey about the instructional methods. The data collection includes quantitative and qualitative information which will be compiled before and after the lessons are taught.

Pre-test. Students will take a pre-test (Appendix C) over finding area of simple figures prior to introduction of the material. The pre-test will be used as a baseline measurement for all students.

Content. The focus will be to gain insight of any prior knowledge students have for finding area of simple figures. Students will be informed that the pre-test is not a graded assignment, merely a tool to see what exposure the students have had to finding area of figures. The emphasis will be on students making an effort to come up with an answer along with giving an explanation as to what they were thinking and why they choose those steps.

Format. The pre-test will contain five problems. The five problems will be a picture of a rectangle, trapezoid, parallelogram, triangle, and circle in which students have to calculate the area of the shape. Students will be allowed time in class to find the area for each of the figures. Students will be given access to calculators in order to alleviate mathematical errors. Along with finding the area, students will need to write a reason or justification as to why they worked the problem in the manner they did. The researcher will record the type of problems that were correct or incorrect along with analyzing why problems were incorrect.

Chapter test. Students will take a chapter test (Appendix D) over finding area of simple figures after the lessons have been taught on area of simple figures. The chapter test will be compared to the results from the pretest.

Content. The focus of the chapter test is to measure the percent of correct answers and determine whether or not a correlation exists between the lessons and formulas that were teacher led versus being student-led lessons. The researcher will look at the chapter test and compare the results to the pre-test. The researcher will be looking to see if students were able to answer a high percentage of the area problems with the lesson that was student-led. The researcher will record the type of problems that were correct or incorrect along with analyzing why problems were incorrect.

Format. The chapter test will contain ten problems composed of one rectangle, two trapezoids, two parallelograms, two triangles, two circles, and a vocabulary definition of area. Two figures are given in order to check for consistency in understanding. Students will be allowed to use calculators in order to lessen the chance of mathematical errors. The researcher will record the type of problems that were correct or incorrect along with analyzing why problems were incorrect.

Survey. The students will be provided with a survey (Appendix E) after all the lessons have been taught. The survey will be given and turned in the day after the chapter test.

Content. The focus of the survey is to obtain the student's perspective of the different instructional methods. The survey will allow the students to voice their opinion for which instructional method had more meaning to them.

Format. The format of the survey will be a Likert scale. Students will rank the order of the formulas from easiest to hardest for recalling the formula. Students will indicate their understanding of each formula as "Great", "Okay" or "Not so Hot". They will use the same choices to indicate their ability to remember the formula.

Pilot-test procedures. The survey will be test piloted by two professional instructors along with two eighth grade math students for clarity and ease of understanding the questions. This pilot will be completed prior to giving the survey to the seventh grade math students. The survey will be changed to ensure students understand the directions.

Post-test. Students will take two different post-tests. The first post-test (Appendix F) will be given three weeks after the chapter test. The second post-test (Appendix G) will be given two weeks later or five weeks after the initial chapter test.

Content. The focus of the post-tests is to evaluate the long term understanding and retention of area formulas. The post-tests will be checked for accuracy of the area for those simple figures. The researcher will compare the results of the test to the pre-tests and chapter tests in order to determine if any connection exists. The researcher will record the type of problems that were correct or incorrect along with analyzing why problems were incorrect.

Format. The post-tests will contain five problems for finding area similar to the beginning pretest given prior. Students will use calculators on these post-tests to avoid calculation errors. Students will also write a justification as to why they worked each problem in the manner they did. The researcher will record the type of problems that were correct or incorrect. The researcher will compare the problems to the type of instructional methods utilized in learning the formulas.

Materials and equipment. The researcher will need two cutouts of the different trapezoids. There will be two different types of trapezoids so students can apply their formula to a second unknown trapezoid's area. Students will also have rulers and scissors made available in order to cut the extra trapezoid shapes they already know the formulas for. Some groups may not need to cut their trapezoid as they may be more visual learners who can dissect the shape by just seeing it. Other groups may have to cut the trapezoids in order to see the shapes.

Procedures

Data collection includes the results of a pre-test, chapter test, post-tests and the survey. Data collection and analysis of the data is delineated below.

Data collection procedures. The researcher will seek the approval of the high school administration prior to beginning the project. Student-led learning requires students to work cooperatively with one another. Students may need to be taught this process, so beginning on the first day of school, students will be given activities that require students to interact with each other. Students will have activities that will develop communication skills with one another along with learning to respect someone else's opinions. The researcher will model appropriate questioning and reasoning examples throughout the first quarter of school. Once the researcher feels confident in the students' ability to communicate with one another, along with self-confidence to voice their own opinions, the introduction of area formulas will begin.

The researcher will give a pre-test prior to the introduction of any formulas to obtain a baseline knowledge of their exposure to two-dimensional figures. The pre-test will contain one problem for each simple figure. The results of the pre-test will remain with the researcher throughout the experiment. The formulas for rectangles will be discussed in the classroom on the first day of area formulas. The researcher will give sufficient class time for students to discuss their own thoughts and opinions on how to find the area of rectangles. Within this same lesson, students will be introduced to the concept that rectangles are parallelograms, which will mean using the same formula to find its area. On the second day of the actual project, the researcher will introduce the concept of finding area for triangles. Students will be given sufficient class time to understand how the formula for triangles and parallelograms are connected to each other. The third day will require introduction to finding the area of circles. All three of these days will involve the researcher giving the information while students take down the information which is a traditional math lesson. On the fourth day, students will use the cutouts of trapezoids along with rulers, scissors, and grid paper printed on transparencies in order to discover the area formula for themselves. Students will be placed into pairs so they can work cooperatively and give their own thoughts throughout the activity. Each formula will be given an equal amount of classroom time and each lesson will have the same number of problems assigned to find area.

Once the students have practiced the different area formulas and the researcher is confident of everyone's ability in finding area, the students will take a chapter test over finding area. The chapter test will contain two problems for parallelograms, triangles, trapezoids, and circles while the rectangle will be represented by one problem. The researcher will keep a copy of this test to use for comparison of results. The day after the chapter test, the students will be asked to answer a survey in which they must rank the understanding of the concept along with ranking which formula was the easiest to recall.

Three weeks after the chapter test is given, students will complete a post-test over the same formulas. The test will be used to compare results from the pre-test and the chapter test. The researcher will give another post-test five weeks after the chapter test. Each post-test will contain one problem for each area formula. All of this information will be kept in order to compare the formulas and the retention of the concepts.

The timeline for this project will begin with pre-test given on November 23 and the chapter test will be given on November 30. The post-tests will be given on January 3 and again on January 17. The entire project from pre-test to the last post-test will take 25 class days.

Data analysis procedures. In order to answer the research question, the data will need to be compiled and analyzed. The test scores will be recorded in a table and placed into a bar graph in order to better understand the results. The breakdown for each lesson taught will be correlated with the questions answered correctly on each tests. The researcher will compare the pre-test, chapter test, and post-test scores so decisions can be made about the retention of area formulas. The answers to the students' survey will be analyzed in order to gain the students' perception of their own retention.

Summary

In summary, this project is comparing a student-led lesson with that of traditional teaching in an attempt to make a connection for the retention of area concepts. The students are from a rural area in western South Dakota where most of the students reside out of town. The students are seventh graders who attend the same math class during the same period.

The design of the project will utilize tests and a survey in order to gather data. The students will take four different tests. The first test, a pre-test, is used as a baseline for student's knowledge. The second test is a chapter test given after all the formulas have been taught and practiced by the students which should indicate the learning of the formulas. The last two tests are post-tests which will help determine the retention of the concepts so a comparison can be made to the type of lesson taught and if it impacted their retention of it. Students will complete a survey which will allow the students the chance to voice their opinion of the type of lessons taught and which formula they felt was more beneficial to them.

The data collected will be arranged graphically so the research can be analyzed and correlations made between the lessons taught and the retention of that concept. The information collected along with results will be explained in detail in Chapter Four.

Results

Introduction

In this chapter, the results of the study will be given. The students were given a variety of instruments in order for the researcher to compare the results in an attempt to answer the question that began this process. The instruments varied in type from pre-test to post-test to a survey. The data was collected over eight weeks, or 25 class periods. The researcher has created graphical analysis of the data when appropriate. The results are written in narrative form along with explanations of what the results indicated. The results will be used to make recommendations on how this study will impact education in Chapter Five.

Findings and Results

The researcher will provide the information received from the five instruments used in this project. The five instruments' (pre-test, chapter test, survey, and two post-tests) results are delineated below. The results are available in both narrative and graphical form.

Pre-test. The first instrument used in the study was a pre-test over the area of the five different figures: rectangle, parallelogram, triangle, trapezoid, and circle. The data came from a test that contained five figures in which the students were asked to find the area, which are shown in Figure 1. For the rectangle, eight of the 18 students could calculate the area correctly. Four of the ten students that had incorrect answers attempted to find the perimeter of the figure. Only one student of the class calculated the area of a triangle and trapezoid correctly. His reasoning for how he found the area of the triangle was because it was half of a rectangle so he found the area as if it were a rectangle and then divided it by two. He solved the trapezoid by separating the trapezoid into a triangle and rectangle. No student calculated the area of the parallelogram or circle correctly.

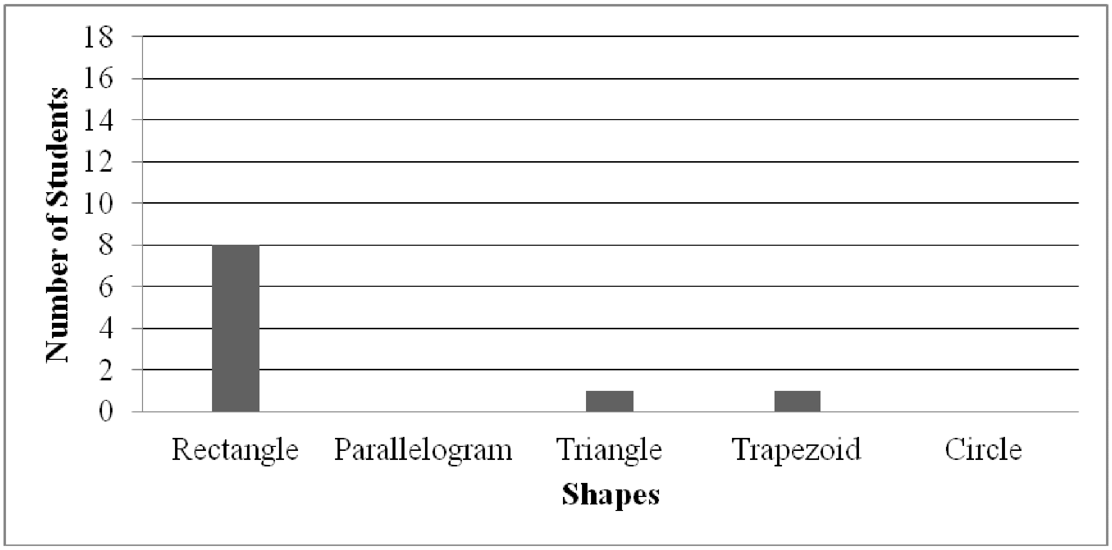

Figure 1. Number of students out of 18 who calculated the area of each shape correctly.

Chapter test. The second instrument used for the study was a chapter test. The chapter test contained nine problems; one rectangle and two of the other figures. As shown in Figure 2, all 18 students correctly found the area of the rectangle along with the parallelogram while 16 students calculated the area of triangles correctly. Sixteen students correctly found the area of the circle while 15 students calculated the area of a trapezoid correctly.

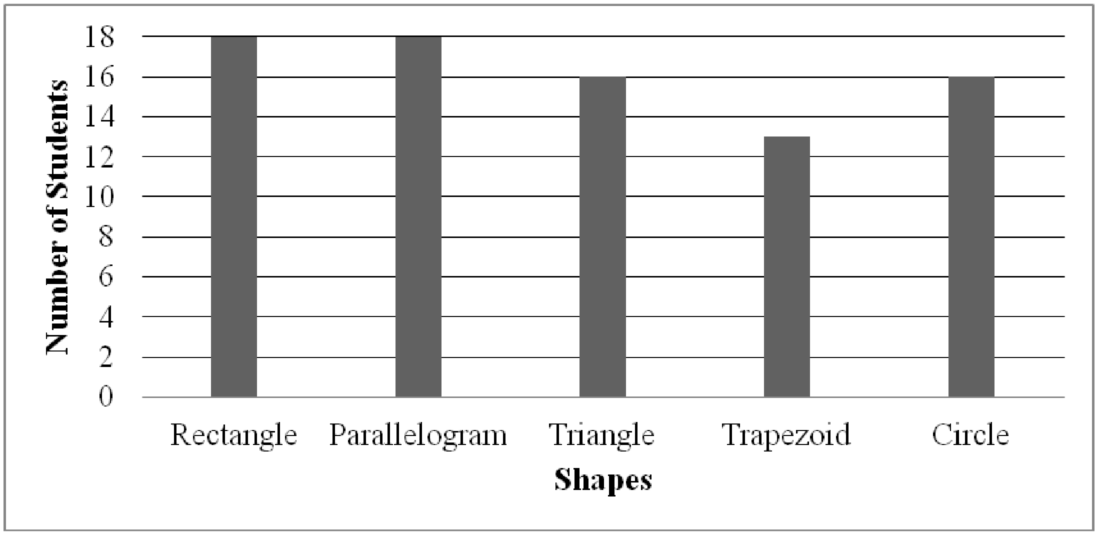

Figure 2. Number of students out of 18 who calculated the area of each shape correctly.

The two students who calculated the area of a triangle incorrectly did not use one-half in their formula. For the circle, one of the students had a computation error on one of the circles and another student forgot to square the radius on one of her circles. For the trapezoid, one student multiplied the bases together instead of adding the bases. Two students had incorrect answers for both trapezoids. They had the formula written correctly, but made calculation errors when solving for the area on both trapezoids. There was not enough work shown in order to determine exactly where the mistake occurred.

There were a total of nine questions answered incorrectly on the chapter test. Four of those nine were a result of not having the correct formula for the figure. The other five incorrect problems were computational errors.

Survey. The next instrument used was a student survey completed during the class period after the chapter test. On the survey, students ranked their understanding of the formulas for each shape. The ranking of the survey contained only three choices for them to rank. The three choices were "*great*", "*okay*", and '"n*ot so hot*". Thirteen of the students felt "*great*" about the understanding for the formula used with parallelograms and rectangles while five students felt "*okay*". For the triangle formula, 12 students felt "*great*" while six felt "*okay*". Seven students felt "*great"* about understanding the trapezoid and 11 of them marked "*okay*". Fourteen students felt "*great"* about understanding the formula for the circle and only four marked "*okay*". No student marked "*not so hot"* for any formula.

The second question the students answered, was about how well they could remember the formulas. Sixteen students marked they could remember the triangle formula "*great"* while 15 of them marked "*great"* about remembering the circle formula and 13 selected they could remember the parallelogram formula "*great*". Only seven students felt "*great"* about remembering the formula for a trapezoid. The remainder of the students marked they were "*okay"* with remembering the formulas. No student marked "*not so hot"* in remembering the formulas.

The next question asked students to rank their most preferred lesson to least preferred lesson when learning the formulas. Half of the students chose parallelogram as the most liked lesson, but triangles received five votes while circles received four. The least liked lesson was overwhelmingly the trapezoid lesson with 16 students choosing that lesson. One student chose the triangle lesson and another chose the circle lesson as their least liked lesson. When the students had to give justification as to why they chose each, the students said the parallelogram, triangle, and circle lessons were easiest to learn and fun. The reason the students chose the trapezoid lesson for the least liked was because it was a harder formula with more steps, which took more time.

The next question asked the students to put in order the formulas they felt were easiest to remember to hardest to remember. The majority of the students chose parallelograms. Ten students chose parallelograms, five chose circles, and three chose triangles. In regards to the hardest formula to remember, one student chose circles, one student chose triangles, and 16 students chose trapezoids.

The last question asked the students to list what helped them remember the formulas throughout the chapter. As stated previously in Chapter Three, the students listened to songs for each formula and listened to the songs on the day they learned the lesson, and again throughout other days of class before the chapter test. Nine students said the songs helped them remember the formulas. Two students said the repetition of working the problems helped them remember. Two students said they remembered the formulas from studying and using them every day. Five students had no response for anything specifically helping them remember the formulas.

Post-test #1. The fourth instrument used was a post-test given three weeks after the initial chapter test. This test contained one problem for each shape. Students were asked to give a reason as to how they chose to work the problem. All of the students gave the formula for their justification on working the problem the way they did.

As shown in Figure 3, 17 of 18 students calculated the area of rectangle correctly while 14 calculated the parallelogram's area correctly. Seventeen of the 18 students found the area of a circle correctly and all 18 students calculated the area of the trapezoid accurately. The trapezoid lesson was the lesson taught through student-led learning. Students justified they knew which formula to use because they recognized the figure since it contained two parallel bases.

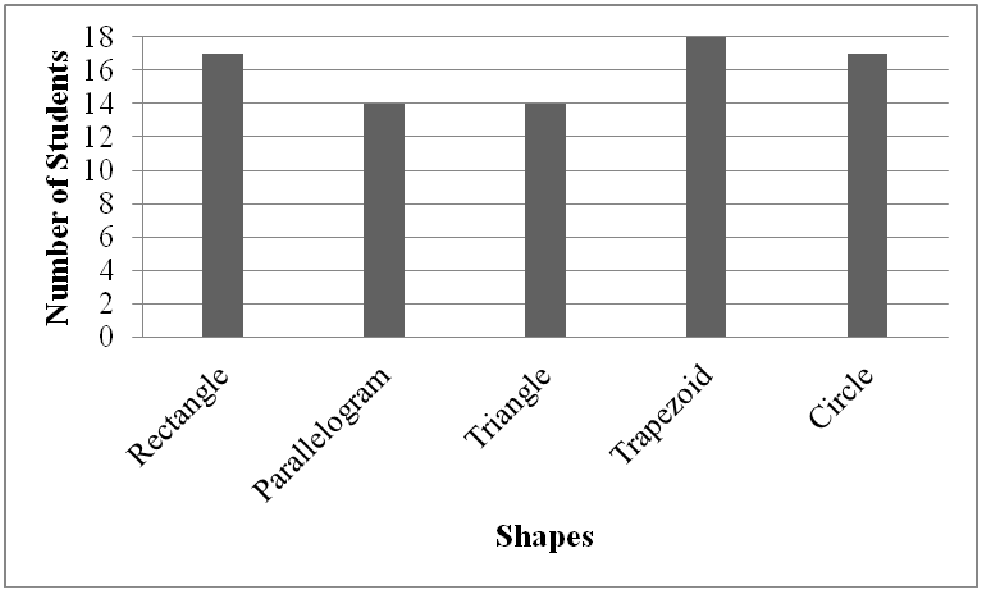

Figure 3. Number of students out of 18 who calculated the area of each shape correctly.

The student who missed the rectangle made a calculation error with the numbers used. For the parallelogram, three of the four students had calculation errors in their problem. There was one student who used an incorrect formula. The student who had the wrong calculation for the circle used the diameter instead of the radius, but in his justification he wrote down the correct formula.

Eight students had at least one question marked wrong. Of the eight, four students had the correct formula and justification for the figures but made a calculation error. Six of the eight students missed only one problem while the other two students missed two problems. Five of the ten problems counted wrong were a result of computation errors and not retention of the formula. Those five problems all had the formula written correctly but the students made an error when solving the problem.

Post-test #2. The last instrument used was a post-test given five weeks after the initial chapter test. This post-test contained one problem for each shape just like the other post-test.

Students had to write a reason for why they chose to work the problem the way they did. All of the students used the formula as their justification for working the problem in the manner chosen.

As shown in Figure 4, all 18 students found the area correctly for the rectangle and parallelogram. Seventeen of the 18 students used the correct formula and found the area correctly for the triangle. When finding the area of the circle, 15 of the 18 students found it correctly. The trapezoid lesson, which was the student-led lesson, was found accurately by 14 out of the 18 students.

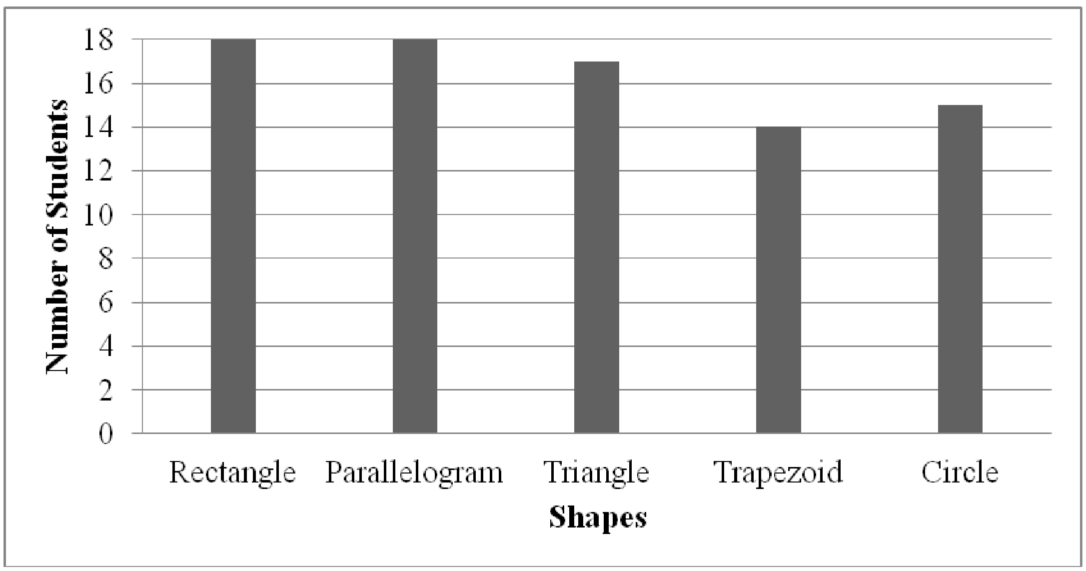

Figure 4. Number of students out of 18 who calculated the area of each shape correctly.

The student who answered the triangle area incorrectly did not use one-half in her formula. The three students who inaccurately found the area of the circle made mistakes such as cutting the radius in half, multiplying the radius by two instead of squaring it, and not squaring the radius at all. All three students wrote the formula for their justification which was written correctly.

Of the four students who inaccurately found the area of the trapezoid, three of them had the wrong formula written. One of them did not use the height in the formula while two other students forgot one-half in their formula. The fourth student had a computation error when they multiplied the numbers together.

Eight problems out of all the problems on the second post-test were answered incorrectly. Four of those incorrect problems were calculation errors made by the students, but all of those students had written the formula down correctly. The other four incorrect answers had incorrect formulas written for the shapes.

The retention of the formulas was the main focus of the project. The researcher had kept the tests given throughout the project in order to look at the justification given by students for solving the problems. All of the students wrote the formula for their justification. Figure 5, shown below, has the results for the number of students who could recall the formula correctly. All 18 students remembered the formula for rectangles accurately for the chapter test, and both post-tests. Comparing that to the parallelogram, 18 students could recall the formula on the chapter test while 17 students answered it correctly on the first post-test and 18 students correctly identified it on the second post-test. For the circle, 16 students recalled the formula correctly on the chapter test and then it dropped down to 14 on the first post-test. The second post-test had an increase back to 17 students recalling the formula correctly. There was only one student who consistently used the wrong formula for the triangle. Sixteen students accurately remembered the trapezoid formula on the chapter test while all 18 students had the correct formula for the first post-test and then it dropped to 15 students on the second post-test. The circle was the only shape in which all 18 students could retain the formula for each test. There were students who had computation errors as they worked those problems but every student could accurately recall the formula.

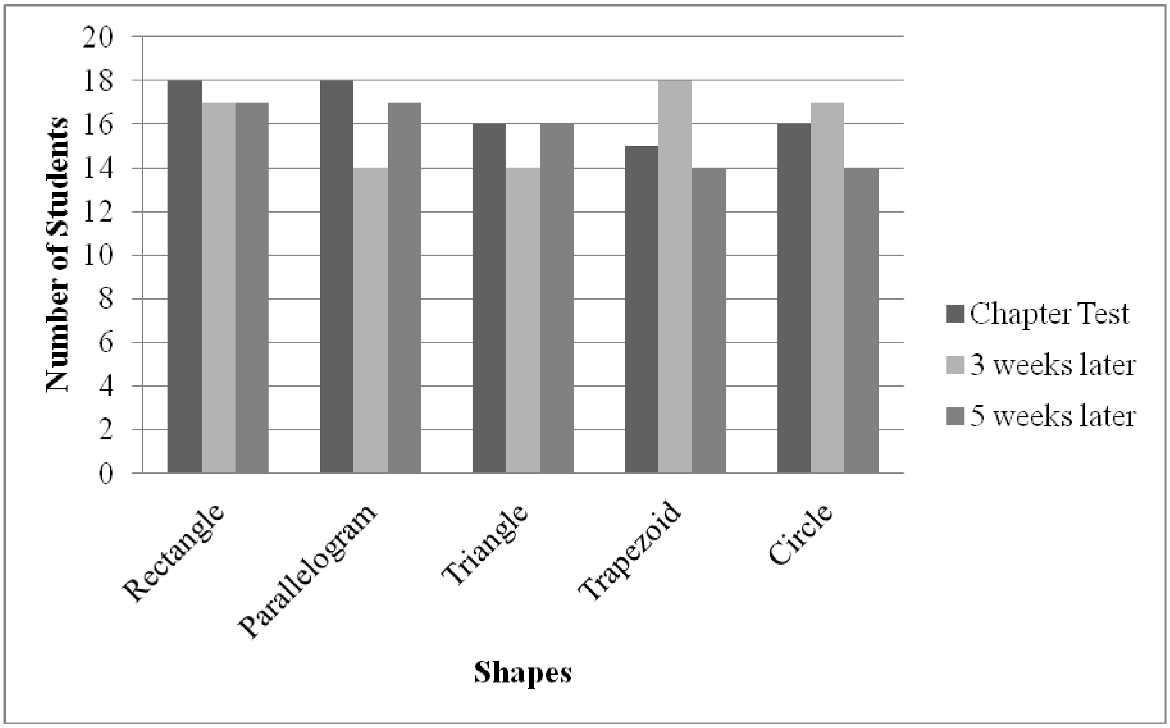

Figure 5. Number of students out of the 18 who correctly remembered the formula of each figure.

Summary

In summary, the pre-test given indicated the students had no previous knowledge or retention for finding the area of parallelograms, triangles, trapezoids, or circles. The students had been exposed to the formula for finding area of rectangles in previous years, yet only eight of the 18 students remembered how to solve them correctly.

The results of the chapter test indicated the students had a strong memory of the formulas, but this was shortly after learning and practicing the formulas. Out of the 162 problems total on all the chapter tests, only nine problems had incorrect area answers. Of those nine, four of those incorrect answers had the wrong formula written for finding the area.

The students indicated on the survey that the parallelogram formula was easiest to remember while the trapezoid was hardest. The students indicated they understood all the lessons for area.

Post-test #1 indicated students retained the information as all 18 students calculated the trapezoid's area correctly and 17 of them were correct with the circle's and rectangle's area. Fourteen of the students calculated the area for the parallelogram and triangle correctly. Five of the ten questions answered incorrectly were a result of computation errors because the formulas were written correctly.

Post-test #2 indicated students still retained the formula for rectangles and parallelograms, while seventeen students remembered the formula accurately for the triangle. Based on the formula written for their justification, all 18 students remembered the formula; yet three of them had a computation error, so only 15 students had the correct answer. Fourteen of the 18 students found the area correctly for the trapezoid yet truly 15 of them had remembered the formula accurately. The three other students did not have the correct formula so they did not calculate it correctly.

When comparing the formula written for the chapter test and both post-tests, the majority of students could recall almost all the formulas. The triangle and trapezoid formulas seem to be the formulas the students have trouble remembering. However, all 18 students did recall the trapezoid formula, the student-led lesson, accurately on the first post-test. The only formulas accurately retained throughout the project were the rectangle, which was taught in previous years, and the circle. This was the first experience for all of the students in learning the circle formula.

The researcher will use the data collected throughout this project and compare it to the body of research literature in order to determine which method of instruction helped the students retain the formulas better. Correlations between the lessons taught and the retention of those concepts, will be made in the next chapter. The synthesis of data collected, along with an explanation as to how this research fits into a classroom, will be made in Chapter Five.

Discussion

Introduction

The purpose of this chapter is to summarize the entire project along with providing recommendations of how this research will impact the future. The project began with a desire to understand what type of lessons students would retain information from better: a student-led lesson or a traditional teacher-led lesson. The search for this answer began with a review of literature already written about the different types of teaching and learning. Throughout this chapter, a review of the entire project will take place along with how this research impacts the future of education.

Summary of Study

Learning takes place every day in classrooms around the world. Every teacher desires students to retain information taught in the classroom over long periods of time. The fact is the brain decides what to keep for long-term retention. “Information is most likely to get stored if it makes sense and has meaning” (Sousa, 2006, p. 48). The brain encounters numerous activities in just one day. It has to decide what information is important enough to remember and what can be discarded. Information that is perceived to be important is retained. This perception of importance is connected to how often the material is repeated, or if it can be connected to prior knowledge; the more often repeated, the more likely it will be remembered. If the information can be connected to some previous knowledge already gained, then the new information can link to the old information and be stored easier. Information is also stored if there is a deep, personal connection to the individual. Getting the brain to decide the information is important enough to be remembered is the goal of every educator.

I wanted my students to retain information for longer periods of time so while searching for a topic, I found information about student-led learning versus teacher-led learning. My project was to decide which type of lesson would lead to better retention of the problem. The concept being taught was finding area of two-dimensional shapes. I taught the lessons for calculating the area of a rectangle, parallelogram, triangle, and circle. The students led the learning, or discovery, of the formula for trapezoids, which is generally the hardest formula to remember. The students were given a pre-test, chapter test, survey, and two post-tests starting November 23 until January 17.

Summary of the Findings and Conclusions

I chose to do this project because I wanted students to retain their knowledge for longer periods of time. I know retention is linked to having a deeper connection of the material in the brain. Looking through all of the data, there was an increase of students' retention of the formulas for all shapes. The students had been exposed to finding the area of a rectangle for at least two years, yet only eight students could calculate it correctly before the lesson was re-taught this year. Throughout the rest of the tests, the rectangle was the only figure all the students calculated the area correctly.

Students had a strong retention for the parallelogram's formula, the first lesson taught by traditional means, as indicated by the results. The students were given the opportunity to cut and rearrange a parallelogram into a rectangular shape. All of the students remembered the formula and calculated it correctly for the chapter test and post-test #2. On the first post-test, four students had the wrong answer but three of those students had the formula correct. They had the wrong answer as a result of a calculation error.

The triangle and circle were the other two lessons taught by traditional teacher methods. Most students were retaining those formulas. On the chapter test, two of the students had the formula wrong for triangles. On the first post-test, four students had the wrong formula while one student had the wrong formula on the second post-test. All of the students had forgotten to use one-half in their formula for a triangle.

In years past, previous students have struggled with remembering the circle's formula. I have found a unique song and dance for finding the area of a circle which the students were allowed to watch and dance to in class. This activity may have helped create a deeper connection in the students' brains because they were using multiple methods of modality for instruction. On the chapter test, two students had the wrong answer but only one of them had the formula wrong. On the first post-test, all eighteen students had the right formula but one student used the diameter instead of the radius. On the second post-test, all the students again had the right formula but three students had incorrect calculations. I encourage my students to do as much mental math as they can in their heads and as a result of that, some students made errors in their multiplication. The fact all eighteen students could remember the formula correctly though does indicate they must have had a better retention of the circle formula.

The student-led lesson for the trapezoid's area does provide some correlation to retention of information. In previous years, students struggled with remembering the formula because it has more steps and more operations in the formula. On the survey, most students felt it was the hardest formula to remember. I had a discussion with the class to find out why they felt it was hardest and they said they felt it was hardest because it had more steps or parts to remember for it. Students in years' past struggled with finding the area of a trapezoid but this year it seemed to be more students understood the reason behind why there are two different bases in the formula along with one-half. The fact that only two and three students struggled remembering the formula for the chapter test and second post-test, respectively, does indicate the students had a better understanding of the formula. It is also important to note that students generally struggle with both circle and trapezoid formulas because the students have to do multiple lines of work. This group of students used cooperative learning when learning all of the formulas which may have helped them with retention of the formulas.

The repetition of the tests may have also improved the retention of the formulas. Research supports the fact that the more the information is tested, the more likely the brain is to retain it. The students were given four tests over the same material which may have influenced the brain to remember these concepts because they were repeated numerous times.

Traditional classrooms have students sitting in desks and performing rote memorization of concepts. “Most of us have sat and listened to teachers lecture at us year after year, so we naturally think that’s what teaching is all about” (Kohn, 1999, p. 62). In previous years, I have taught concepts in this manner only to be frustrated when students do not recall the information weeks or months later. The trapezoid formula is developed by using the area of a rectangle and the area of a triangle. In previous years, my students have struggled remembering what is contained in the formula. This year, most of my students could remember the formula. “Information is most likely to get stored if it makes sense and has meaning” (Sousa, 2006, p. 48). By using an inquiry method for teaching the trapezoid area formula, my students were able to connect the new shape of a trapezoid as a rectangle and triangle shape.

Students were also developing their problem solving ability while discovering the formula. “Inquiry implies emphasis on the development of inquiry skills and the nurturing of inquiring attitudes or habits of mind that will enable individuals to continue the quest for knowledge throughout life” (Exline, 2004, para. 7). Students need to be able to find answers to questions and the ability to know where to look in order to find the answer. The students had to use critical thinking skills in order to come up with a formula that would give the correct mathematical answer. Teachers need to provide the tools necessary for students to know where to look or how to problem solve situations.

The biggest obstacle for me to overcome in this project was to decide how to use inquiry learning as a teacher. I had not used inquiry as a method for instruction prior to this project. Teachers have to learn to ask different questions in order to lead students down a path instead of telling them which path to take to find the answer. Sometimes, they just do not ask the right question in the right way. “Constructivist teachers seek to ask one big question, to give the students time to think about it, and to lead them to the resources to answer it” (Brooks & Brooks, 1999, p. 39). One way to assist teachers who are interested in using inquiry learning is to spend time interacting among other teachers and researching what works best in order to change teaching styles. “Hence, when we examine skilled questioning (or instruction of any kind), it is essential to learn from those teachers who understand how to engage a wide community of learners” (Wolf, 1987, p. 2). Utilizing other teachers who already use inquiry learning should advance the learning curve for teachers who are changing styles of instruction.

Wolf also stated that most questions in a classroom are very low-level, short questions that do not involve a lot of thinking (1987). I had to think about what type of questions to ask in order to drive the learning in the right direction instead of giving the students the road. This one lesson was the most nerve-racking for me to develop since my first year of teaching. After the lesson was taught, I was excited about the future lessons I will teach using inquiry methods. It was inspiring to watch the students work feverishly on developing the formula. There was a high level of excitement among the students to work the numbers correctly for the answer. Once one of the groups came up with a possible method they believed worked, the rest of the groups worked through it and then attempted to discredit the formula. By attempting to discredit the formula, those groups only created further support of the method.

It was during the discovery process for the trapezoid formula that the seventh graders strengthened their cooperative learning skills. "Traditional learning focuses more on LEARNING ABOUT THINGS, while inquiry learning focuses more on LEARNING THINGS!" (Exline, 2004, para. 7). After watching firsthand the collaborative effort of a group working towards creating a formula, I do believe there is merit in creating lessons where students can develop a deeper understanding of why things work the way they do in math. Something happened during the student-led lesson that cannot be replicated by a teacher just giving the formula to the students. The students began to communicate better with each other about their ideas on how to solve problems. Meeker students began to have a personal opinion as to why or how they would work the problem they thought would work. Students began to value each other's opinion and took the time to try different methods based on what their group members suggested. Prior to this lesson, most students would wait to follow the more confident math students whenever it involved sharing ideas or other activities in class.

All of these things are some of the unintended benefits of cooperative learning. Even knowing these factors should happen with cooperative learning, it was eye-opening to see it firsthand and to watch it develop in my classroom. Prior to this experience, I did not always understand the benefit of cooperative learning. After watching my students become better group members, I will continue to use cooperative learning methods as one of my methods for teaching concepts.

Recommendations

The recommendations for how this research impacts education is written next. The recommendations on how this project will impact current practice are delineated below along with how it will impact future research.

Recommendations for practice. The impact of this research is that it can be applied in a variety of atmospheres in order to improve retention. It can improve retention of material in the classroom all the way to the workplace. One way is to allow people to work together to come to conclusions about problems. By allowing people to work closely with one another, opportunities are being created for people to improve their speaking skills, their critical thinking skills, and to truly work together as a team to overcome obstacles. By allowing students to work together, they are being encouraged to think through their ideas and can bounce ideas off of each other. Throughout the sharing process, the students will discover a method for solving. By discussing methods they are trying, the students are making a deeper connection to the material which means it should be stored longer.

Another way to improve retention is by allowing people to get the answer by different means. If we encourage people to discover a method of solving, it will have a more meaningful connection in the brain which will in turn mean it is more likely to be stored. So if we want people to remember material for longer periods of time, we need to give them chances to create their own path for solving.

A final recommendation for improving retention is to retest the information often. The more the information is repeated, then the brain will associate that information as needed often. The more the brain has to have it for recall, the better or stronger the connection will be in the brain for that information. Even though this was not the focus of the project, it has to be identified as something that did impact the students' retention.

One area of concern for most teachers is how to create or build lessons in which students can discover or use inquiry learning for the concepts. I have found some information on the Internet in order to provide some activities for discovery but most teachers are left to find their own activities. I think by networking with other teachers and attending conferences, less experienced teachers can find great resources in order to incorporate inquiry learning into their classroom.

Recommendations for future research. This research will have long lasting effects. As more teachers learn how to incorporate discovery learning into their classroom teaching, it should improve retention of material. If students are allowed to make deeper connections to information so it can be easily recalled, the students will be able to solve higher level thinking problems.

There are recommendations I would make on this topic for future research. They are:

- Would running the project for a longer period of time create different results? This project was short in nature so if the time frame was extended for months, or even a year longer, the results may be different.
- Does a different subject area create different results? This was done with a seventh grade math class. Could the retention of science concepts be applied in a similar manner in order to obtain the same results?
- Since only one lesson was taught with inquiry learning, would having the students discover the formulas for all of the figures improve the retention?
- This project only dealt with area formulas of shapes. Could the same type of results be gained by using other math concepts taught through inquiry learning?
- Would a bigger class size provide the same results? The data collected was from a class size of only eighteen which is smaller than some class sizes.

Implications

This research project has provided evidence supporting the use of inquiry learning in order to improve retention of materials. As more testing is being required from the state and nation, students are being expected to remember more information previously taught earlier in the year or from previous years. If the students were to make deeper, more meaningful connections about the information, the information would be retained longer. If students can retain the information for longer periods of time, it would impact the tests in a positive manner. By using inquiry learning, teachers would be creating opportunities for learning in which students would be able to make a better connection of the material.

Throughout all of life, people have used inquiry in order to find out information about the world. Babies learn about the world through inquiry. Elementary students come to school with a desire to learn. They inquire about all different kinds of information. By the time students are in middle school and high school, some students have lost that desire to inquire about things in their life. This could be a result of how lessons are taught by teachers in the upper elementary, middle school, and high school classrooms. By using inquiry learning when teaching students, it might re-instill the student's natural inquiry to learn. As students began to inquire more about the world around them, along with information they are learning in the classroom, one would think all of the knowledge gained would have a deeper connection in the brain which would mean better retention of information. This is what all educators desire for their students.

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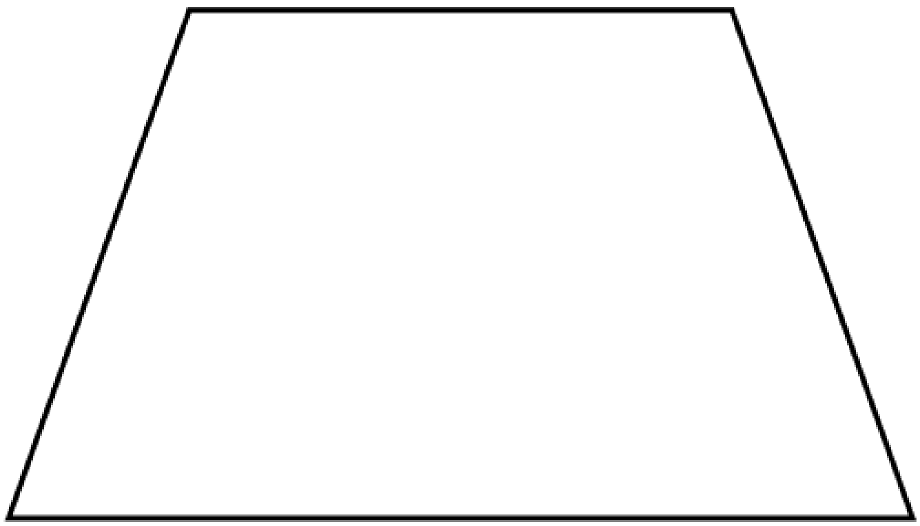
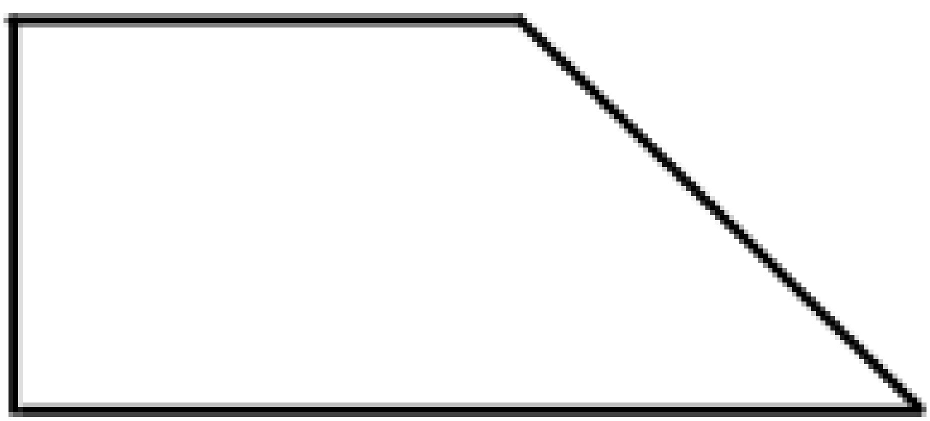
Appendix A

Trapezoid Shapes

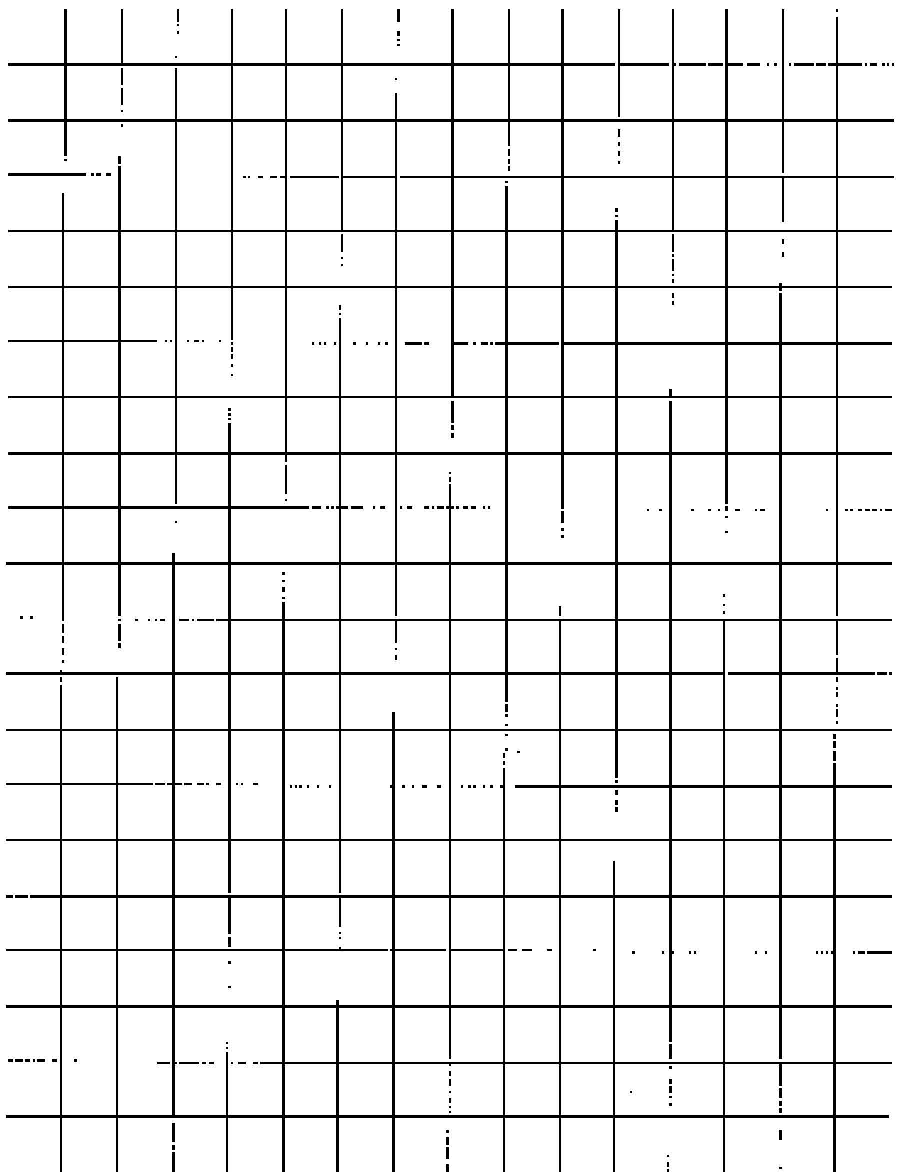




Appendix B

Grid Paper

Centimeter Grid Paper



Appendix C

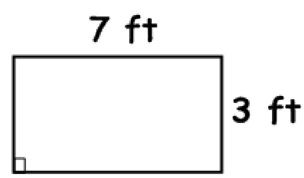
Pre-test

NAME ____________________

Chapter 11 Test

Find the area of each figure.
Write a reason or justification as to how you found the area. In other words, why did you work the problem in the manner you choose?

1.



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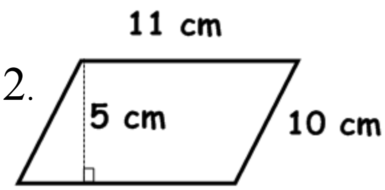

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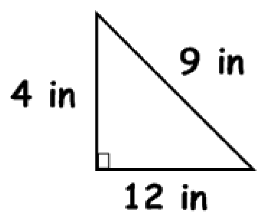

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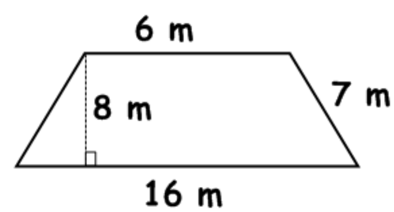

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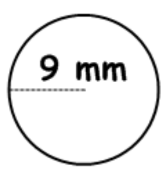


Appendix D

Chapter Test

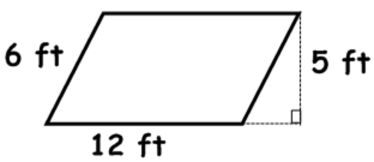
NAME ____________________

Chapter 11 Test

SHOW AS MUCH WORK AS POSSIBLE!!! 2 points for work

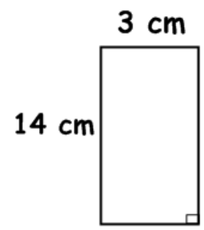
Find the area of each parallelogram. Round to the nearest tenth if necessary. 2 points each

1.



2.

3.



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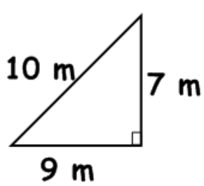

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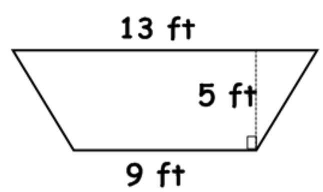

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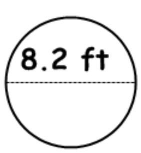

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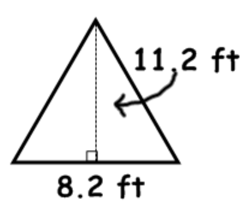

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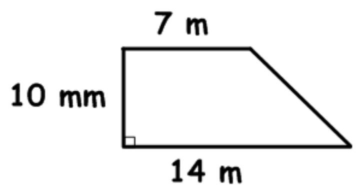

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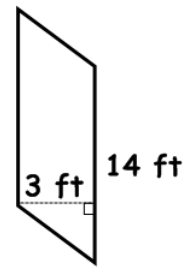


Vocabulary. Define in complete sentences.

10. Area—____

____

Appendix E

Student Survey

Name________________________

Survey of Area formula lessons

Please read each question and give an honest answer.

1. **Rank your understanding of each area formula**. Place a check mark or X in the column you feel best describes your understanding of the formula.

AREA OF	GREAT	OKAY	NOT SO HOT
Parallelograms			
Triangles			
Trapezoids			
Circles			

2. **How well do you feel you remember the formulas for area?** Place a check mark or X in the column you feel best describes each.

AREA OF	GREAT	OKAY	NOT SO HOT
Parallelograms			
Triangles			
Trapezoids			
Circles			

3. **Think about the lessons used to teach each area formula.** Put the lessons in order of which lesson you preferred most to the one you preferred the least. There were 4 lessons (parallelograms, triangles, trapezoids, and circles).

Most preferred lesson	
Least liked lesson	

4. Why did you enjoy the lesson you chose for most preferred?

5. Why did you not enjoy the lesson you chose for least preferred?

6. **Think about all the formulas**. Put the figure names in order by which formula you think is easiest to remember down to which you think is hardest to remember. Please give a reason as to why you found one easier or harder than another. There are 4 figures (parallelograms, triangles, trapezoids, and circles).

	Shape formula	**Reason why**
Easiest to remember		
Hardest to remember		

7. What do you think helped you remember the area formulas? (You can list more than one)

Appendix F

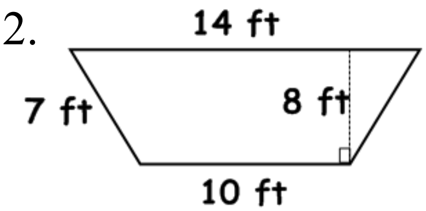
Post-test #1

NAME ____________________

Chapter 11 Post-test

Find the area of each figure.
Write a reason or justification as to how you found the area. In other words, why did you work the problem in the manner you choose?

1.


2.


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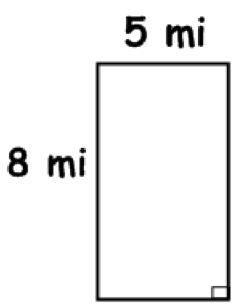

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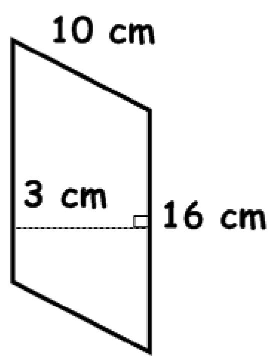

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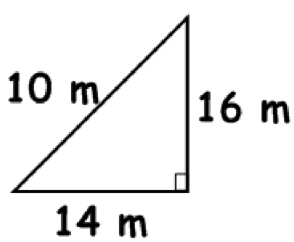


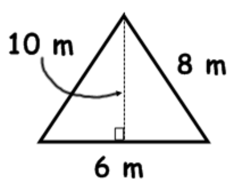
Appendix G

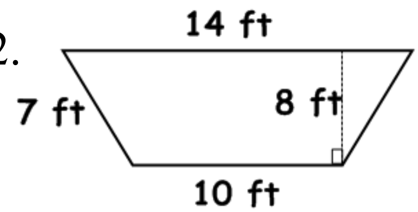
Post-test #2

NAME ____________________

Chapter 11 Post-test

Find the area of each figure.
Write a reason or justification as to how you found the area. In other words, why did you work the problem in the manner you choose?

1. 

2. 

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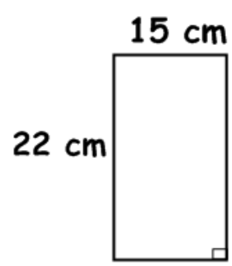
4. 

5.