What is the Effect of Content Area Literacy on Mathematics Achievement?

Elizabeth Adam

St. John Fisher College

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The use of literacy strategies in the mathematics classroom has become an area of interest in recent years. Many researchers believe that there is a connection between the literacy and mathematics content. This study will examine the effect of the use of literacy strategies in a seventh grade mathematics classroom. The study was implemented in a rural district in which reading achievement is poor. Research has shown that students who perform poorly in reading tend to perform lower in other content areas. The No Child Left Behind Act has influenced states to increase standards. New York State introduced new standards for mathematics for the 2005-2006 school year. Along with new standards, the state is also implementing a state assessment for grades 3-8. I am a seventh grade mathematics teacher and was looking for ways to increase my student's achievement and knowledge retention. In researching ways to improve mathematics achievement, I found many literacy strategies that I would be able to implement into my classroom. The research showed that the use of literacy in the mathematics classroom increased student achievement and motivation. I wanted to implement the strategies in my classroom and study the effect on my student's achievement. Many of my students struggle in mathematics and I would like to find ways to help increase student achievement. Many assessments require students to digest a large amount of information that can be very difficult. It has been said “the language of mathematics is comparable to a foreign language; math is a combination of symbol, numbers and words” (Beliveau, 2001, p. 2). I would like to find ways to incorporate literacy strategies that have been proven to work. This study will focus on the implementation of proven literacy strategies.

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What is the Effect of Content Area Literacy on Mathematics Achievement?

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literacy strategies that have been proven to work. This study will focus on the implementation of proven literacy strategies.
Content Area Literacy 7

Review of the literature

Content area literacy is a growing area of research in educational reform. This reform comes out of poor student performance on reading assessments. An increase in mathematics standards has made literacy in mathematics especially important due to the modern mathematics classroom requiring a large amount of reading by students in order to acquire information. This paper focuses on the need for literacy instruction in the content area of mathematics.

There is an extensive amount of literature and research available on the subject of literacy in the content area. This paper initially discusses the history behind educational reform dealing with literacy in the content area. The literature shows that the idea of using reading in the content area of mathematics has been around many years. However, the need was not recognized until students were performing below basic levels on exams in all content areas. The need for literacy in the content area is discussed at length later in the paper.

The different literacy components; reading, writing, listening, and speaking are each discussed for a general content area classroom. Reading and writing are the two most common forms of literacy and are therefore discussed at length with respect to the area of mathematics. Specific literacy strategies used in the content area are discussed in detail. Some of the strategies are specific to the mathematics classroom, while others can be used in any content area. The final section of the literature discusses the use of children’s literature in the mathematics classroom. This section explains how the use of fictional writing in the mathematics classroom can improve student learning.
The use of reading in the mathematics classroom is not a new topic in educational reform. According to Clinard, "policies and statements about content area reading instruction can be found as early as the 1920's" (2000). The implementation of policies for reading in the content area was discussed for many years but not put into place into much later. A big push for content area reading was in the 1970's when *Teaching Reading in the Content Areas* by Herber (1970) was published. In the book Herber first explained content area reading as the use of literacy to learn content (Grady, 2002, p. 2). Throughout the 1970's some pre-service teachers were required to take courses in content area reading instruction (Clinard, 2000). With the publication of *A Nation at Risk* in the 1980's more teacher education programs started to include content area reading instruction.

Nationwide reading performance did not increase from the efforts made during the 1980's and 90's. "The 1998 Reading Report Card by the National Assessment of Educational programs showed that only 60% of students could comprehend factual statements and less than 5% could elaborate on the meanings of materials the read" (Way, 2001, p. 2). It was clear at that time that there was a need for educational reform in literacy instruction. Over the past ten years content area literacy has become a focus of reform initiatives. Research has shown that "when consideration of literacy development is extended, it is logical that teachers of all content areas would appreciate the language demands of their particular fields" (Crumbaugh & Schram, n.d., p. 2). Secondary teachers many times do not feel as though they are qualified to teach reading to their students.

Draper states that "despite the continued call for literacy instruction across curriculum,
secondary teachers have been reluctant to take up the cause. It is important that teacher education programs and district initiatives show content teachers how to incorporate literacy strategies into the secondary classroom. The research has shown "that enhancing literacy skills will improve learning in the content areas" (Way, 2001, p. 1).

Current mathematics reform has started to include mathematics literacy initiatives. This reform was started with the National Council of Teachers of Mathematics Principles and Standards for School Mathematics which included communication as a standard. "The National Council of Teachers of Mathematics (2000) asserts the following regarding communication:

Communication is an essential part of mathematics and mathematics education. It is a way of sharing ideas and clarifying understanding. Through communication, ideas become objects of reflection, refinement, discussion, and amendment. The communication process also helps build meaning and permanence for ideas and makes them public. When students are challenged to think and reason about mathematics and to communicate the results of their thinking to others orally and in writing, they learn to be clear and convincing. Listening to others' explanations gives students opportunities to develop their own understandings." (Crumbaugh & Schram, n.d., p.60)

Along with an emphasis on communication the council also recommended a "more student-centered math classroom that deemphasizes rote memorization of isolated skills and facts and emphasizes problem solving and communication" (Draper, 2002, p. 521).
The need for Content Area Reading

The amounts of reading necessary to acquire content increases as students move into secondary classrooms. Research has shown that “as students move beyond the primary grades, the focus of their school lives shifts from learning how to read to using reading to learn” (Research based content area reading, 2002, p. 1). Reading is necessary for learning in the middle and high school grades. The amount of vocabulary and written materials requires students to be competent in literacy skills. Secondary classrooms rely heavily on the use of expository text to introduce new material. It has been shown that “literacy skills must become increasingly sophisticated to meet more challenging academic expectations” (Way, 2001, p. 1).

According to Dieker and Little the No Child Left Behind Act has caused many states to implement content tests in order to graduate. These tests require students to “use the skill of reading to learn content” (Dieker & Little, 2005). In a report from the National Assessment of Educational Progress it was found that “26% of eighth graders nationwide performed below the Basic Level in reading in 2003. Low performance in reading affects learning in all the content areas at the secondary level” (Spor, 2005, p. 19). Students who are below average in reading will have a more difficult time in the other content areas. Content area reading is more factual than that in English Literature. Students are accustomed to narrative reading instead of expository reading that is needed to understand content area textbooks. Spor states that “with the exception of English Literature, content-area textbooks contain facts and information that are conveyed as main ideas and details, not in story form” (2005, p. 19).
Content areas such as mathematics, science, and the social sciences require students to learn a large amount of new vocabulary and concepts in a short period of time. It is necessary for students to have a deep understanding of literacy to be able to synthesize the required information. Spor states “reading is fundamental to learning from textbooks and other written materials in all content areas” (2005, p. 19).

In the secondary classroom it is important to continue literacy research and reform. However there are many roadblocks to the implementation of new literacy programs in the content area. One of the major problems with the lack of use of literacy strategies in content area is that “many high school teachers maintain the assumption that their job is to focus on content areas, not to teach reading or writing” (Way, 2001, p. 2). Teachers may also believe that they are unprepared to teach literacy strategies in their content area. Most secondary content teachers have not received training in literacy strategies. School reform needs to focus on training secondary teachers to adapt and use literacy strategies that would make students more successful in the classroom. Districts need to “create a climate that believes reading is important in all classes, and all students can use reading skills to learn” (Dieker & Little, 2005, p. 279).

In order for literacy integration to be successful, teachers will be required to change their instruction. Many content area teachers rely heavily on lecture based instruction followed by independent reading by the students (Dieker & Little, 2005, p. 279). Teachers will need to use a more collaborative approach to teaching in order to incorporate more literacy into the content. Reading teachers should collaborate with the content teacher in order to optimize student learning. Research shows teachers each have expertise in different strategies and when they collaborate each brings their own teaching
practices that can help students who need help in reading (Dieker & Little, 2005, p. 279).

If content area literacy is to improve classroom teachers need to take the initiative to try new strategies and methods.

Reading in the Content Area

There are four main components of literacy instruction in the secondary classroom; the components are reading, writing, speaking, and listening. Reading in content area most often involves expository text, which is much more difficult for students to master than narrative text. Common expository text structures are shown below:

- **Problem solution**-the text presents a problem, perhaps explains why it is a problem, and then offers possible solutions, usually settling on one solution as most appropriate.

- **Description**-the text provides specific details about a topic, person, event, or idea.

- **Cause-and-effect relationships**-the text links events with their causes.

- **Enumeration or Categorizing**-the text is organized by means of lists or by collecting together like items.

- **Sequencing**-the text presents information in terms of a time or order progression, such as the actions that led to an important historical event or the steps in a scientific process.

- **Comparison**-the text points out differences and similarities between two or more topics. (Research based content area instruction, 2002)

Most textbooks are examples of expository text; it is difficult for students to gain comprehension if they have difficulty understanding expository text. Mathematics
textbooks contain a large amount of expository text that interferes with student acquisition of content. Expository text is paired with mathematical symbols and diagrams. In order for students to learn the necessary literacy skills to use while reading, teachers should model the correct way to read for meaning.

Writing in the Content Area

The second literacy component that is used in content area classrooms is writing. “When students commit ideas and knowledge to writing, they must be more thoughtful, organized, and precise than when speaking” (Alvermann & Phelps, 2005, p. 294).

Content area classes require the use of writing on a daily basis. Writing in the content area can take many different forms, note-taking is the most often thought of way to write in the content area. However there are many others that can be very useful in all content areas.

One type of writing that a growing number of content area teachers are using is a learning log or journal. Alvermann and Phelps define learning logs as “notebooks that are dedicated to informal writing, note taking, and musing on content area subjects” (2005, p. 307). Journals give students an opportunity to reflect on the content they are learning and any difficulties they are experiencing. The logs are a great way for students to be aware of their own meta-cognition. This is a very important piece of writing in the content area since most students do not reflect on their own thinking. Journals require students to look back at their work and decide if their thinking was correct. In some cases students may be able to transfer some of their journal writing to a more formal piece of writing. “Learning logs are good platforms for prewriting rehearsal and drafting” (Alvermann & Phelps,
Entries in the logs can vary from day to day depending on the material being covered and whether the teacher gives prompts for the entry.

According to Alvermann & Phelps another useful strategy for content area teachers is to use design writing assignments is the acronym R.A.F.T. (Role, Audience, Format, and Topic) (2005). An example of a R.A.F.T. prompt for a Geometry classroom is given below.

**Role:** Circle  
**Audience:** π  
**Format:** Love Letter  
**Topic:** Write a love letter to π explaining your relationship. Make sure to include the relationship between circles and π clearly so that someone who knows nothing about the relationship can learn from your writing.

R.A.F.T. assignments should be real life assignments that students can make a connection with. If students do not find the topic or role interesting then they will not have the motivation to complete the assignment with effort. It has been shown "writers are likely to invest the most effort and motivation in topics that hold strong personal interest (Graves, 1983)" (Alvermann & Phelps, 2005, p. 306).

Students find writing in the content area to be the most difficult of the literacy components. Crumbaugh and Schram pointed out that from a student’s point of view "writing was hard, their hands got tired, it was hard to explain in writing, and writing was too much work" (n.d., p. 4). Students do not like to write and therefore it is a challenge to incorporate writing into the content area. However if teachers can provide assignments that make students a stakeholder, then the quality of work by the students will improve.
When students feel a personal connection to an assignment they will devote more time and effort to their work.

Listening and Speaking in the Content Area

Another component of literacy in the classroom is the use of listening and speaking. The listening component is used almost on a daily basis in mathematics classrooms. "Most students preferred listening as the way they learned best and speaking as they way they could best demonstrate their understanding" (Crumbaugh & Schram). These components are not usually recognized as literacy components because they are used on a daily basis in all content areas. Students are required to obtain material that the teacher is lecturing on. The students are then questioned to see if they understand the material.

Speaking in the classroom can occur in both whole class and small group discussion about a topic. Classroom discussions allow students to have metacognitive conversations that help to increase student learning (Grady, 2002). Teachers are able to assess student understanding quickly through observation during classroom discussions. Pugalee described that "the oral dialogue... gave students a forum for examining not only their mathematical skills but their ability to express their reasoning with details sufficient to convey the validity of their approaches" (2001, p. 298). During classroom discussions students are also able to listen to other students and compare their own thoughts with classmates. Another way of incorporating speaking into the classroom is to require students to present material they have researched to the entire class. It has been shown that students learn more if they are teaching a subject to their peers.
Reading in Mathematics

Reading that is required in mathematics is the most difficult that students will encounter in the content areas. It has been said "the language of mathematics is comparable to a foreign language; math is a combination of symbol, numbers and words" (Beliveau, 2001, p. 2). The difficulties that many mathematics students face are related to their inability to understand the language of mathematics. According to Adams "for students across all grade levels, weakness in their mathematics ability is often due in part to the obstacles they face in focusing on these symbols as they attempt to read the 'language of mathematics'" (2003, p. 786).

Mathematics textbooks are written in a different way than most content area reading. "In general, math texts are written in a terse unimaginative style, offer few verbal context clues to help in decoding meaning, and lack the redundancy which one finds in most writing" (Nolan, 1984, p. 28). Mathematics textbooks also involve numerical expressions, symbols, and operations. The combination of different types of text makes it difficult for students to comprehend the material being presented. Barton, Heidema, and Jordan state that "in addition to comprehending text passages, students must be able to decode and comprehend scores of scientific and mathematical signs, symbols, and graphics" (2002, p. 25). Mathematics textbooks also present difficulty with the way that the text is organized. Students are used to reading from left to right in most writing. In mathematics there are many different eye movements that are required to read the materials. Students will need to "read and interpret information presented right to left (number lines), top to bottom (tables), bottom to top (charts), and even diagonally (graphs)" (Nolan, 1984, p. 29; Barton, Heidema, Jordan, 2002, p. 25).
including the use of key words that students may not connect to the correct operation. One problem is “the use of synonyms rather than words actually used in formulas, e.g., rate instead of speed” (Adams, 2003, p. 792). Students may have difficulty making the connection between the rate at which an object is moving the speed of an object. One way for teachers to help students with word problems is to connect word problems to the student’s prior knowledge so that students are able to make the connections between the problem situation and the operations needed to solve the problem.

Another stumbling block for students when working with word problems is extraneous or insufficient information. Students who are not skilled at decoding the language of the problem may not realize when there is extra information contained in the problem. They will also have difficulty understanding if the problem does not contain enough information to solve it. It is for this reason that Adams suggests teaching students the four step problem-solving process by George Polya as described below:

1. **Read the problem:** Students should read the problem in its entirety without focusing on key words and questions.

2. **Understand the problem:** The student should look for vocabulary, context/setting, questions of the problem, needed information, and extraneous information.

3. **Solve the problem:** Students must select and use appropriate strategies to respond to the problem. These strategies may be student created or introduced by the teacher.

4. **Look Back:** This provides the student an opportunity to check the validity and accuracy of the solution. By viewing the solution in the context of the problem,
students can find errors in understanding the problem, the procedures, or even in the recording of the solution. (2003, p. 791)

The four step problem solving process is not the only way to approach a word problem, but it can give students with low reading ability a tool to help decode word problems. Another useful tool to help students with difficulty with word problems is to underline important information. It will be necessary for students to activate their prior knowledge in order to find the information that is necessary to solve the problems. However students with low reading ability may have difficulty recognizing what information is needed to solve the problem.

Writing in Mathematics

The most common type of instruction in mathematics classrooms is review of the previous day's lesson, lecture by the teacher on the new material, followed by individual practice by the students (Draper, 2002). This type of instruction leads students to memorize content for a short period of time rather than developing an understanding of the major concepts. Writing in the mathematics classroom helps to develop student's understanding of concepts through metacognition. Mathematical writing includes more than writing biographies of famous mathematicians. Although those assignments can be beneficial, there are many other ways in which mathematics teachers can use writing in their content area.

One of the most utilized writing tools in the mathematics classroom is that of math journals. Students write daily in their journal about the topic that was discussed during the previous class. Belivue sometimes uses math journals to introduce lessons as is the case during the statistics unit. “I gave the students the following list: analyze, bar,
circle, collect, data, display, frequency, graph, pictograph, question, statistics, tally, and title. Students are to construct a meaningful paragraph using as many words as possible” (2001, p. 3). The activity described by Belivue is called a ‘word splash’. The words used should also be positioned somewhere in the classroom as a word wall.

Another excellent use of writing in the mathematics classroom is the use of a ticket to leave or exit slip. The ticket to leave is most often used to “review the content of the day’s lesson and is an excellent method for teachers to quickly check student understanding” (Belivue, 2001, p. 4). If students are having difficulty with a concept then it will be easy for the teacher to discover when the student tries to explain the topic in their own words. It is not necessary to collect a ticket to leave on a daily basis however because it would become too tedious for the teacher to assess. Belivue likes to collect one ticket to leave each week. A ticket to leave is also an excellent closure to the day’s lesson.

Sister M. Luka Brandenburg started including writing assignments into her mathematics classroom because her students were having difficulty making connections between different techniques they had been taught. She was not sure why her students were having the problems but decided to look into what the causes might be. “After doing some research, I decided to try a variety of writing activities in class to see whether the students could think at a higher level and make meaningful connections” (Brandenburg, 2001, p. 67). At first she found that students were very resistant to writing in mathematics class. She found that if she kept her expectations high the students eventually were able to think and reason at a higher level and write about mathematical concepts. Brandenburg explained that “in the end, I saw a tremendous increase in students’ comprehension and
their ability to explain what they knew" (2001, p. 67). She does, however caution teachers to start incorporating writing activities slowly because it can be overwhelming for the teacher at first.

**Content Area Literacy Strategies**

It has been shown that when teachers use strategies to improve student literacy student learning will also improve (Way, 2001). The problem remains that many teachers do not know how to successfully implementing literacy strategies into the classroom. There is very little teacher training devoted to the practical use of reading strategies. “To facilitate change, teachers must be provided high quality professional development and time to implement and practice new skills with recognition of their ability to solve problems and affect change in the school” (Dicker & Little, 2005, p. 278). Teachers need to be provided with literacy strategies that are proven to work. Research has shown that the strategies discussed below are highly effective in content area classrooms. These strategies were found in many different sources.

Activating prior knowledge is a pre reading technique that many teachers use on a regular basis in the classroom. It is important to activate the students’ prior knowledge as a pre reading activity so that they are able to make “explicit connections between what they already know and what they will be learning” (Martinez, 2003, p. 6). When students are able to make these connections it becomes “much easier for students to assimilate new knowledge” (Martinez, 2003, p. 6). The research has shown that students will be able to retain more information if they can make a personal connection with the material. Barton et al. explain that “activating students’ prior knowledge prepares them to make logical connections, draw conclusions, and assimilate new ideas” (2002, p. 25).
Fisher, Frey, and Williams illustrate seven literacy strategies that can be used in any content area. One of these strategies is a read-aloud, which takes place when the teacher reads the text while students follow along. The second strategy, a K-W-L chart, is a strategy that is used in many secondary classrooms. A K-W-L chart is divided into three sections, what students know about a topic, what they want to know, and what they learned. The next strategy, "graphic organizers provide students with visual information that complements the class discussion or text" (Fisher et al., 2002, p. 71). In the past graphic organizers have been used in other content areas such as English or Social Studies. Graphic organizers were most often used in the planning stage of the writing process. In mathematics graphic organizers can be used to show connections between topics, vocabulary introduction, or concept development.

Another strategy that Fisher et al. discuss is vocabulary instruction. It has been shown that if students have a large knowledge of vocabulary then they also have higher reading skills (Richel, 2005). Fisher et al. stresses the importance of focusing on "transportable vocabulary skills—that is, skills that students could use across content areas"(2002, p.72). One useful technique for teaching vocabulary is to “have students look up words in a dictionary, copy or restate definitions, and then create sentences using the words”(Richel, 2005, p.414). Students may have difficulty with this technique if they are unable to interpret the correct meaning of the word from the dictionary. Another technique discussed by Richel is the use of word expert cards. In this strategy students are each given a few words to be responsible for learning. Once students have defined their own words they will teach the words to the rest of the class. Vocabulary words should be used repeatedly in the classroom to gain student comprehension. If students
have more exposure to vocabulary they will have a higher rate of retention of those words. One way to expose students to vocabulary is the use word walls, which are visual displays of the vocabulary that is to be covered throughout a unit. Students will be constantly exposed to those words and will have a greater rate of retention.

The next strategy described by Fisher et al. is writing to learn or quick writes. In this strategy students are given a prompt or question to write about, and then are given 5 minutes to write. This strategy is a good way to start class to activate prior knowledge or also to conclude the lesson to reflect on what was learned. Another strategy that was discussed was structured note-taking or the Cornell method of notes. In this method “students draw a vertical line about two inches from the left side of the paper, log main ideas and key words to the left and details to the right of the line, and write a brief summary of the lesson at the bottom of the page” (Fisher et al., 2002, p. 72). This method of note-taking helps students to organize their thoughts and reflect on the information learned immediately. Most students, especially in the middle school, do not have good note-taking skills and their comprehension tends to suffer. The Cornell method of notes gives students a method for organizing their notes and the ability to reflect on their learning.

Reciprocal teaching is the last literacy strategy that was discussed by Fisher et al. In reciprocal teaching students will work in small groups to learn the content they are studying. The students follow a “protocol for predicting, questioning, clarifying, and summarizing-skills that teachers have modeled over a series of lessons until students are comfortable assuming these assigned roles” (Fisher et al., 2002, p. 72). Other research has shown that:
Reciprocal teaching provides a window into the thinking of proficient readers as they problem-solve their way toward meaning. Students are conditioned to approach reading as an active and strategic process and to learn behaviors that will help them become more independent readers, capable of handling increasingly sophisticated material. (Buehl, 2001) (Hashey & Connors, 2003, p.225)

Reciprocal teaching gives students the opportunity to be in control of their own learning experience. Students will learn valuable skills by working with other students at different ability levels. This method requires more work for the teacher at the planning stage, however once students are aware of the roles the teacher is able to act only as a guide for learning.

**Mathematics and Literature**

The use of children's literature to teach mathematics in the elementary grades is growing. Many K-8 teacher education programs are developing coursework connecting mathematics to children's literature. Ward explains that "a growing body of research in the fields of mathematics education and literacy supports the inclusion of children's literature into the teaching and learning of mathematics" (2005, p. 132). The research shows that children learn mathematical concepts at a faster rate when they are able to make a connection to previous knowledge. Students are able to activate their prior knowledge of a subject when they can make a connection to a well known story.

According to Moyer, "children learn mathematics through the use of language and mathematics concepts are often tied to the language children use to express these ideas" (2000, p. 246). It should naturally follow that children will benefit from the use of
language in mathematics. There are many examples of children’s books that develop early mathematics concepts. These books are able to connect mathematics to real world concepts and help students see the value of mathematics. “Placing mathematics in the familiar context of children’s literature makes sense to children because it allows them to see mathematics as an integral part of their everyday experiences” (Moyer, 2000, p. 248).

It is important to place mathematics concepts in the context of a story where the need for mathematics is obvious. An important aspect of using literature is the development of problem solving strategies. Students will encounter a problem situation in the story that requires the use of mathematics. The use of literature allows students to discuss the mathematical concepts they are “learning through the use of language” (Moyer, 2005, p.254).

Some pre-service mathematics teachers are using children’s literature to teach mathematics in their methods courses. These courses are showing students how literature can be used to “engage students in meaningful conversations and investigations in mathematics, which serve as bridges for students to connect the abstract, symbolic language of mathematics to their own personal world” (Ward, 2005, p. 133). The use of literature as a tool for mathematics is not a new idea. Unfortunately many mathematics teachers in the past have not been open to the use of new ideas. Moyer believes “teacher educators need to equip K-8 pre service teachers with the tools and knowledge of pedagogically sound strategies for effectively integrating literature with their future classrooms” (2005, p. 141). Teacher education programs need to emphasize that students will benefit from the use of literature in classroom. If more teachers are using this literacy strategy elementary student’s mathematics proficiency should rise.
Methodology

Data was collected from three seventh grade mathematics classes at Penn Yan Middle School. The demographics were similar in all three classes and student performance on previous was comparable. Class sizes range from 18 – 20 students in all three classes and there are 3-5 students on average that do not complete assignments. Data was collected over a month long unit on two and three dimensional geometry. All classes covered the same material and took the same assessments; however instruction in two classes implemented the use of proven literacy strategies. The control class covered the unit using traditional teaching methods.

The unit began by using a pre-reading strategy called an anticipation guide. Students answered true or false questions about topics in the unit to access their prior knowledge and highlight any misconceptions that students had about geometry. Graphic organizers were used to present many new topics throughout the unit. The control class was given notes using traditional methods of instruction. Circles and circumference were introduced using a read aloud with the book “Sir Cumference and the Dragon of Pi”. Students then completed a think aloud about the properties of circles and the circumference of a circle. As a conclusion to the unit students completed a R.A.F.T. (role, audience, format, topic) assignment as a post reading activity. The final assessment of the unit was a unit test. A section of the unit test consisted of the same questions as the anticipation guide.

Data was collected on student performance on both assessments and student engagement throughout the unit. Assessments included homework assignments, class work, quizzes, tests, and tickets to leave. Student engagement and participation was
assessed through observation from one of the teachers involved. The two teachers collaborated to plan the unit along with all lessons and assessments. Lesson Study was used to improve individual lessons. One teacher observed while the other gave instruction.
Results

The results for the three classes were the same for most of the assessments throughout the unit. There was not a significant increase in achievement for those students in the experimental classes based on qualitative data. Students in the experimental groups tended to be more attentive and engaged throughout the unit. It was also shown that although the control group performed equally as well as the experimental groups, the experimental groups showed more improvement from the beginning to the end of the unit.

Anticipation Guide

As an introduction to the geometry unit students completed an anticipation guide consisting of 10 true or false statements about geometry. The anticipation guide was used to activate student’s prior knowledge and uncover any misconceptions that students may have possessed. At the end of the unit students were given the anticipation guide to show their progress throughout the unit. The anticipation guide is included in appendix A. Class averages for correct responses were found at the start and conclusion of the unit. The experimental groups were shown to have made the most improvement throughout the unit on critical questions. Questions 1, 3, 5, 7 were considered critical due to the low initial scores. Table 1 shows the comparison of correct answers from before and after the unit.
A major misconception that was uncovered was the belief that all rectangles are squares. In the first experimental group only 11% answered correctly, 57.9% of the students in second experimental group answered correctly, while 70.6% of students in the control group answered correctly. It was shown that students in the experimental groups showed the most improvement. At the end of the unit students in the experimental groups performed better than the students in the control group. Table 2 shows the results of question one of the anticipation guide before and after the unit.

Table 2

Class Percentage for Correct Answers on Geometry Anticipation Guide

<table>
<thead>
<tr>
<th>Question 1</th>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>E1</td>
<td>2/(11.1)</td>
<td>16/(80.0)</td>
</tr>
<tr>
<td>E2</td>
<td>11/(57.9)</td>
<td>13/(81.3)</td>
</tr>
<tr>
<td>C</td>
<td>12/(70.6)</td>
<td>9/(76.9)</td>
</tr>
</tbody>
</table>

Note. E1 = experimental class 1; E2 = experimental class 2; C = control class.

Another misconception that students had was the difference between the radius and diameter of a circle. Question three on the anticipation guide stated that the radius is the distance across a circle. Students in all three classes showed a large improvement
throughout the unit. The percent of students who answered correctly before and after the unit is shown in Table 3.

Table 3

<table>
<thead>
<tr>
<th>Class Percentage for Correct Answers on Geometry Anticipation Guide</th>
</tr>
</thead>
<tbody>
<tr>
<td>Question 3</td>
</tr>
<tr>
<td>Before</td>
</tr>
<tr>
<td>E1</td>
</tr>
<tr>
<td>E2</td>
</tr>
<tr>
<td>C</td>
</tr>
</tbody>
</table>

Note. E1 = experimental class 1; E2 = experimental class 2; C = control class.

Another significant question was number 7, in which students were asked if a rectangle is a polygon. The percentages of correct answers in the experimental classes were lower than the control group prior to the unit. Students in the experimental groups improved their scores by the end of the unit, while the percentage of correct responses in the control group decreased. The results of question 7 are shown in Table 4.

Table 4

<table>
<thead>
<tr>
<th>Class Percentage for Correct Answers on Geometry Anticipation Guide</th>
</tr>
</thead>
<tbody>
<tr>
<td>Question 7</td>
</tr>
<tr>
<td>Before</td>
</tr>
<tr>
<td>E1</td>
</tr>
<tr>
<td>E2</td>
</tr>
<tr>
<td>C</td>
</tr>
</tbody>
</table>

Note. E1 = experimental class 1; E2 = experimental class 2; C = control class.

Tickets to leave

As a daily assessment students were given tickets to leave on seven out of the fifteen days of the unit. The first ticket to leave asked students to explain which of the following statements is true: all rectangles are squares or all squares are rectangles. In the control class 77.8% of the students answered correctly but only 22.2% of the responses
were considered quality. The first experimental class had 73% correct responses with 47.4% considered quality and the second experimental class had 64.7% correct responses with 35.3% considered to be quality. A response was considered quality if the student stated at least two properties of quadrilaterals.

On day three students were asked to find the area and perimeter of a triangle, and the perimeter of a quadrilateral. The collaborating teachers assessed each question separately. Students in the experimental groups performed well on the perimeter of a triangle but the percentages decreased for the area of a triangle and the perimeter of a parallelogram. The percentage of students correctly answering the perimeter question was 84.2% in the first experimental group, 88.9% in the second experimental group, and 52.6% in the control group. Students found the area of a triangle correctly 26.3% of the time in the first experimental group and 61.1% in the second experimental group, while only 52.6% answered correctly in the control group. The control group scored higher than the experimental groups on the perimeter of the parallelogram with 73.7% correct, while 47.4% answered correctly in the first experimental group and 22.2% in the second experimental group.

The ticket to leave on day four tested student’s ability to name a square using all six classifications. The two experimental groups had more students able to name at least 4 classifications, yet the second experimental class also had 11.1% of the students only able to name 1 classification. Table 5 shows the results the ticket out the door on day four.
Days five and six focused on circles. The assessments on both days were tickets out the door. Day five focused on the circumference of a circle and day six was the area of a circle. For the circumference of a circle, class averages for the experimental groups were 88.9% for the first group and 60% for the second group. The average for the control group was 77.7%. Students in the second experimental group scored the lowest for the circumference of a circle, but the control group scored the lowest for the area. The results for the area of a circle were 94.4% correct responses in the first experimental group and 68.4% in the second experimental group, while only 52.9% of the students answered correctly in the control group.

On day five students were asked to find the surface area of a cylinder. The percentage of students who answered correctly was lower in the experimental classes than in the control class. However the responses in the experimental classes showed a higher level of understanding. In the control group 68.8% of the students answered correctly. The first experimental group had 38.9% correct responses and there were 21.4% correct responses in the second group.

The last ticket to leave of the unit required students to find the volume of rectangular prisms and cylinders. In the control group 85% of the students answered correctly whereas 65.8% answered correctly in the first experimental group and 75.1% in

Table 5

<table>
<thead>
<tr>
<th></th>
<th>0-1</th>
<th>2-3</th>
<th>4-5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>E1</td>
<td>6/(31.5)</td>
<td>13/(68.5)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E2</td>
<td>2/(11.1)</td>
<td>7/(38.9)</td>
<td>8/(44.4)</td>
<td>1/(5.6)</td>
</tr>
<tr>
<td>C</td>
<td>10/(71.4)</td>
<td>4/(28.6)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. E1= experimental class 1; E2 = experimental class 2; C = control class.
the second experimental group. Students in the second experimental group scored higher than the first experimental group for the first time throughout the unit.

Take home quiz

On day seven students were given a take home quiz on the first six days of the unit. The quiz is included in Appendix B. Student averages in the experimental groups were ten percent higher than those in the control. Average quiz scores for the first experimental group was 78.1% and the scores for the second experimental group was 76.0%. The average quiz score for the control group was 64.4%. Table 6 shows the percentage of grades in each range. The quiz scores reflect a number of students in each class that did not complete the assignment. There were four students in the control class that did not complete the assignment and two students in each of the experimental classes that did not complete the assignment.

Table 6

<table>
<thead>
<tr>
<th>Class Average Range for Geometry Quiz</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-64</td>
</tr>
<tr>
<td>------</td>
</tr>
<tr>
<td>E1</td>
</tr>
<tr>
<td>E2</td>
</tr>
<tr>
<td>C</td>
</tr>
</tbody>
</table>

Note. E1 = experimental class 1; E2 = experimental class 2; C = control class.

Test

The final assessment for the unit was a test that is included in appendix C. Test scores for the control group were comparable to the experimental groups, however the experimental groups had a higher percentage of students scoring in the 90 to 100 grade range. The average test score for the first experimental group was 85.5% and the score
for the second experimental group was 71%, while the average score for the control group was 83.8%. Table seven shows the data from the test.

Table 7

<table>
<thead>
<tr>
<th>Class Average Range for Geometry Unit Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-64</td>
</tr>
<tr>
<td>-------</td>
</tr>
<tr>
<td>E1</td>
</tr>
<tr>
<td>E2</td>
</tr>
<tr>
<td>C</td>
</tr>
</tbody>
</table>

Note. E1 = experimental class 1; E2 = experimental class 2; C = control class.

Raft

On day fourteen students were given a raft assignment to complete that consisted of three choices. The raft assignment is included in appendix D. There were many students in all three classes that did not turn in the assignment and therefore the grades are lower than would be expected. In the control class 12 out of 17 students turned in the assignment, in the first experimental group 13 out of 22 completed the raft and in the second experimental group 17 out of 20 were completed. The assignment was given a grade out of 50 points. Students in the control group had an average of 60% with zeros averaged in for the incomplete assignments and a score of 83.2% without the incomplete grades factored in. The first experimental group had an average score of 44% with the incomplete scores and an average of 74.8% without the incomplete scores. In the second experimental group there was an average score of 60% with the incomplete scores and 70% without the incomplete scores.
Discussion and Conclusion

Throughout the geometry unit the experimental classes were exposed to pre reading, during reading and post reading strategies that were discussed in the literature. These strategies included graphic organizers, frayer model notes, read alouds, think alouds, and a R.A.F.T (role, audience, format, topic) assignment. A daily topic and assessment tracking form is included in appendix E. The quantitative data showed inconclusive results for the effect of literacy strategies as a whole. Students in the control group scored comparably to those students in the experimental groups. However the comparison of the results on the anticipation guide (see table 1) showed that students in the experimental groups made the most progress from the beginning to the end of the unit. Student behavior and engagement was also shown to have improved for those students in the experimental classes.

The collaborating teachers noticed the biggest difference in the second experimental group. Students typically are very disruptive during class and very few are willing to participate in class discussions. During the geometry unit students in the second experimental class were actively engaged in daily lessons and participated freely. Students enjoyed using the graphic organizers as opposed to traditional methods of note taking and they were heard saying “it’s easier to keep up with notes when we don’t have to write everything”. The read aloud dealing with the circumference of a circle was also enjoyed by most students. They were active in completing the think aloud and followed along during the reading. As a classroom teacher I noticed that the introduction of reading strategies improved the behavior and engagement of students especially those that are considered at risk of failing.
Graphic Organizers

Graphic Organizers were used five different times throughout the unit. On day 1 a graphic organizer was used to show the relationship between different quadrilaterals and a triangle graphic organizer was used on day 2. The quadrilateral graphic organizer is shown in appendix F and the triangle organizer is in appendix G. Students in the experimental class were able complete the graphic organizer using their own knowledge and were engaged throughout the entire instructional period. In the first experimental class students were actively participating and contributing to the discussion, including those students who normally avoid speaking in class. While completing the organizer students voiced connections between the anticipation guide and the graphic organizer. Traditional methods were used to define the characteristics of quadrilaterals. Students in the control group were less likely to offer answers and appeared to be less engaged during the lesson. The ticket to leave on day 2 showed that students in the experimental classes showed a higher level of thinking, yet the control group had 77.8% correct opposed to 73% and 64.7% in the experimental groups. Day 4 showed that students in the experimental groups were able to name more classifications for a square. In the control group 28.6% of the students were able to name more than three classifications, while 68.5% in the first experimental group and 44.4% in the second experimental group named more than three classifications.

Graphic organizers on identifying three dimensional objects, finding the surface area and volume of three dimensional figures were used on days 10-12. The three dimensional graphic organizers are included in appendix H. Students in all classes were shown models of solids. The experimental groups were able use the graphic organizer to
connect the model to the drawing of the solid and the net. Students in the experimental
groups were engaged during the lesson and able to construct their own knowledge. Using
the graphic organizer students were able to find the formula for surface area when guided
by one of the collaborating teachers. Students in the control groups performed higher on
all assessments for three dimensional figures. Teachers noted that although students in
the control group were able to find the surface area or volume when given a formula,
many were unsure of the meanings of the formulas. Qualitatively it was shown that
although students in the experimental groups performed poorly on the assessments, they
tended to be more engaged and showed higher level thinking when answering questions.

*Read aloud and think aloud*

The research showed that connecting mathematics with children's literature can be
very beneficial to student learning. Collaborating teachers in this study chose the
mathematical storybook, *Sir Cumference and the Dragon of Pi*, by Cindy Neuschwander,
to introduce the concept of the circumference of a circle. In the experimental classes the
teacher read the story and then students made connections using a think aloud. The think
aloud is included in appendix I. Students were actively listening and taking notes while
the teacher was reading. The second experimental group was the most actively engaged
during the read aloud. Behavior and engagement of the experimental classes was much
better than that in the control class. Results on the assessment did not show that the read
aloud made an impact on student learning. The control group had 77.7% correct
responses while the second experimental group only had 60% correct responses.
Engagement in the second experimental group was noted to be the best; however results
on the assessment were the lowest of all classes.
Frayer model

On day one of the unit students in the experimental classes discussed the characteristics of polygons by using a Frayer model. Students completed the model using their own knowledge. Students were enthusiastic about sharing what they knew and filling in the Frayer model. The entire class discussed the characteristics together and finished completing the model. Prior to the model students completed the anticipation guide. Question number seven stated that a rectangle is a polygon. It was shown that students in the control group had a better understanding of polygons prior to start of the unit. At the completion of the unit the percentage of students who answered correctly in the experimental groups increased while the percentage in the control group decreased. See table 4 for question 7 results.

Recommendations for future research

The use of literacy in the mathematics classroom is a topic that should be the subject of continued research. Future studies should eliminate the influence of outside factors that contributed to some of the inconclusive results in this study. It is the recommendation that any assessments that are compared should not take place outside of the classroom. There were too many students that did not complete assessments and therefore the results of the study were altered. In future studies the literacy strategies should be isolated so that assessments accurately reflect the use the strategy. It was difficult to determine the effect of each strategy as so many were used throughout the study.
References


Beliveau, J. (2001). *What strategies strengthen the connections between literacy and math concepts for higher math achievement with culturally diverse students?* Manuscript submitted for publication.


Appendix A

Geometry Anticipation Guide

Use your prior knowledge of geometry to answer the questions below. Be sure to make an educated guess if you are not sure of the answer.

1. All squares are rectangles
   True  False

2. All rectangles are squares
   True  False

3. The radius is the distance across a circle
   True  False

4. The perimeter of a circle is called the circumference
   True  False

5. A rectangular prism is the same figure as a rectangular pyramid
   True  False

6. A circle is a polygon
   True  False

7. A rectangle is a polygon
   True  False

8. All the sides of an isosceles triangle are equal
   True  False

9. An acute triangle must be equilateral
   True  False

10. A trapezoid is a type of triangle
    True  False
Appendix B

Directions: 
1. Classify each figure. 
2. Find the perimeter of each figure. 
3. Find the area of each figure. 

* Be sure to show all your work.

1. Name __________
   Area __________
   Perimeter __________

2. Name __________
   Area __________
   Perimeter __________
(3) Name ___________________
Area ___________________
Perimeter ___________________

(4) Name ___________________
Area ___________________
Perimeter ___________________

(5) Name ___________________
Area ___________________
Perimeter ___________________
Name ______________
Area ______________
Perimeter ______________

Name ______________
Area ______________
Perimeter ______________

Name ______________
Area ______________
Circumference ______________
9. Name ____________  
   Area _______________  
   Circumference ____________

10. Name ____________  
    Area _______________  
    Circumference _______________
Appendix C

Name_________________________ Period_____

Geometry Test

Directions: 1. Show all your work.
   2. Make sure to label your answers.
   3. Round each answer to the nearest tenth.

Part 1: True or False: Circle the correct answer for each question. (1pt each)

11. All squares are rectangles
    True False

12. All rectangles are squares
    True False

13. The radius is the distance across a circle
    True False

14. The perimeter of a circle is called the circumference
    True False

15. A rectangular prism is the same figure as a rectangular pyramid
    True False

16. A circle is a polygon
    True False

17. A rectangle is a polygon
    True False

18. All the sides of an isosceles triangle are equal
    True False

19. An acute triangle must be equilateral
    True False

20. A trapezoid is a type of triangle
    True False
Part 2 Matching: Write the correct Letter on the line next to the number (1 point each)

11. A quadrilateral with 4 right angles
12. A triangle with 3 equal sides
13. An eight sided polygon
14. A quadrilateral with 1 pair of parallel sides
15. A triangle with a 90° angle
16. A trapezoid with 2 equal sides
17. A quadrilateral with 2 pairs of parallel sides
18. A prism with a triangle for the base
19. A pyramid with a triangle for a base
20. A parallelogram with 4 equal sides

Word Bank

A. Octagon  
B. Pentagon  
C. Rectangular Prism  
D. Triangular Prism  
E. Isosceles triangle  
F. Equilateral Triangle  
G. Triangular Pyramid  
H. Hexagonal Pyramid  
I. Parallelogram  
J. Isosceles Trapezoid  
K. Rectangle  
L. Rhombus  
M. Right Triangle  
N. Triangle  
O. Trapezoid
Part 3: Area and Perimeter: Find the Area and perimeter of each figure being sure to show all your work and circle your final answer. 5 points each.

21.

22.

23.

24.

25. Find the diameter of a circle if the circumference is 200 cm. (worth 2 points)
Part 4 Volume: Find the volume of each figure. (5 points each)

26. \(7 \text{ cm} \times 7 \text{ cm} \times 12 \text{ cm}\)

27. \(7 \text{ ft} \times 4 \text{ ft} \times 5 \text{ ft}\)

28. \(9 \text{ in.} \times 7 \text{ in.} \times 15 \text{ in.}\)

29. \(10 \text{ mm} \times 5 \text{ mm} \times 6 \text{ mm}\)

30. \(3 \text{ in.} \times 24 \text{ in.} \times 2 \text{ in.}\)

31. \(9 \text{ cm} \times 9 \text{ cm} \times 9 \text{ cm}\)
Part 5 **Surface area:** Find the surface area of each figure. (7 points each)

31. 

32. 

33. 

34. 

**Bonus:** Find the volume of the following figure.
Directions: Chose which RAFT you would like to complete. You may not mix roles, format, audience, or topic. Be creative, but also make sure that your completed RAFT completely covers the topic stated.

<table>
<thead>
<tr>
<th>Role</th>
<th>Audience</th>
<th>Format</th>
<th>Topic &amp; Strong Verb</th>
</tr>
</thead>
<tbody>
<tr>
<td>Square</td>
<td>Math Class</td>
<td>Family tree</td>
<td>Create your own family tree and give characteristics of each family member.</td>
</tr>
<tr>
<td>Circle</td>
<td>$\pi$</td>
<td>Love Letter</td>
<td>Explain relationship</td>
</tr>
<tr>
<td>Cartoonist</td>
<td>Math Class</td>
<td>Cartoon</td>
<td>Show the interaction between instructor and students while a teacher teaches his/her students about the different types of 3 dimensional figures.</td>
</tr>
</tbody>
</table>

Choice 1: You are a square. You are to create a family tree for the quadrilateral family. Along with your family tree you should include a description of each member of the family. Make sure to include what you know about each figure we have studied and use proper names and terminology.

Choice 2: You are a circle. Write a love letter to $\pi$ explaining your relationship. Make sure to include the relationship between circles and $\pi$ clearly so that someone who knows nothing about the relationship can learn from your writing.

Choice 3: You are a cartoonist. You have been hired by a teacher to create a cartoon for their math class. This cartoon must show how a teacher teaches to his/her class about the different types of 3 dimensional figures and their properties. Students reading this cartoon should learn the proper names and properties of different 3 dimensional figures.
<table>
<thead>
<tr>
<th>Day</th>
<th>Topic</th>
<th>Assessments</th>
<th>Strategies</th>
<th>Class</th>
<th>Quantitative Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Classification, Area, and Perimeter of Quadrilaterals</td>
<td>Anticipation Guide See Appendix</td>
<td>Anticipation guide, Frayer model, &amp; graphic organizer</td>
<td>E1</td>
<td>See Class Average on the Assessment of Applying Area and Perimeter Formulas Chart</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Traditional instruction</td>
<td>E2</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ticket out the door See Appendix</td>
<td>Graphic organizer</td>
<td>C</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Classification, Area, and Perimeter of Triangles</td>
<td>Ticket out the door “Explain which statement is true: 1. All rectangles are squares, or 2. All squares are rectangles”</td>
<td>E1</td>
<td>Class Average: 73% Correct 47.4% Quality</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>E2</td>
<td>Class Average: 64.7% Correct 35.3% Quality</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Traditional instruction</td>
<td>C</td>
<td>Class Average: 77.8% Correct 22.2% Quality</td>
</tr>
<tr>
<td>3</td>
<td>Area and Perimeter of Trapezoids</td>
<td>Ticket out the door “Find the area and the perimeter of the triangle”</td>
<td>E1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>E2</td>
<td></td>
<td>See Class Average on the Assessment of Applying Area and Perimeter Formulas</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Review of Days 1-3</td>
<td>Ticket out the door “List all the names of this figure”</td>
<td>E1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>E2</td>
<td></td>
<td>See Class Average for the Assessment on the Ability to Name a Square using all Classifications</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Circumference of Circles</td>
<td>Ticket out the door “Find the circumference of the circle”</td>
<td>E1</td>
<td>Class Average: 88.9% Correct</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>E2</td>
<td>Class Average: 60% Correct</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>C</td>
<td>Class Average: 77.7% Correct</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Area of Circles</td>
<td>Ticket out the</td>
<td>Traditional</td>
<td>E1</td>
<td>Class Average for the Assessment on Area and</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Review of Days 1-7</td>
<td>Take home quiz See Appendix</td>
<td>Review of Graphic Organizers</td>
<td>Traditional instruction</td>
<td>E2</td>
</tr>
<tr>
<td>---</td>
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<td>Traditional instruction</td>
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<td>&quot;Find the surface area of the cylinder&quot;</td>
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<td>R.A.F.T.</td>
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<tr>
<td></td>
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<td></td>
<td>C</td>
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Appendix F
What are the Properties of special Quadrilaterals?
Appendix G

CLASSIFICATION OF TRIANGLES

<table>
<thead>
<tr>
<th>Classifying Triangles by the number of equal sides</th>
<th>Classifying Triangles by the size of the angles</th>
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</table>
Connections between Sides and Angles

- An isosceles triangle can be

- A right triangle can be

- An obtuse triangle can be

- A scalene triangle can be

- An acute triangle can be

- An equilateral triangle is always a
<table>
<thead>
<tr>
<th>Prisms</th>
<th>Pyramids</th>
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<tbody>
<tr>
<td><img src="image1" alt="Prism 1" /></td>
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<tr>
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<td><img src="image4" alt="Pyramid 2" /></td>
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<tr>
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<td><img src="image6" alt="Pyramid 3" /></td>
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<td><img src="image9" alt="Prism 5" /></td>
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<td><img src="image11" alt="Prism 6" /></td>
<td><img src="image12" alt="Pyramid 6" /></td>
</tr>
<tr>
<td><img src="image13" alt="Cylinder" /></td>
<td></td>
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</tbody>
</table>
Finding Surface Area of 3-D Shapes

Cube
Surface Area Formula:

Rectangular Prism
Surface Area Formula:
Right Triangular Prism

Surface Area Formula:

Right Cylinder

Surface Area Formula:
### Appendix I

**SIR CUMFERENCE AND THE DRAGON OF PI**

As Miss Adam is reading the story fill any blank places. There is also a place on the back to make notes about the story or write any questions you may have.

#### "Sir Cumference and his son, Radius"

<table>
<thead>
<tr>
<th>What math concept does this remind you of?</th>
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</thead>
<tbody>
<tr>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>The name radius is used to represent what in geometry?</th>
</tr>
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<tbody>
<tr>
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</table>

#### "Lady Di of Ameter"

<table>
<thead>
<tr>
<th>What is the mathematical term that is connected to the mother's name?</th>
</tr>
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<tbody>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>What is the connection between the mother's name and the sons?</th>
</tr>
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</table>

#### "Measure the middle and circle around, Divide so a number can be found."

<table>
<thead>
<tr>
<th>What is the riddle telling him to find?</th>
</tr>
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<tbody>
<tr>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>What will radius find when he does this?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>
"Radius thought about Sym’s wheel. He arranged the strips on the pie like the spokes. There were three strips left over. He draped them around the rim of the pie pan. One, two, three strips go almost all the way around the edge… Lady Fingers handed him another strip of dough. Radius folded it in half, but half was longer than he needed. He folded it in quarters, but even a quarter of the piece was too long. He folded it in eighths, and an eighth was almost right."

Radius found that the distance around the pie was about one-eighth more than three strips. Find the decimal equivalent to $\frac{31}{8}$.

"Radius knew the magic number was more than three, but exactly how much more did it take to make a whole circle?"

Each time he measured he found the distance around the circle divided by distance across the middle was $\frac{31}{7}$. What is $\frac{31}{7}$ written as a decimal?
What was the circumference of the dragon? _______________

What was the diameter of the dragon? ________________

What was the circumference divided by the diameter? ________

“I found that the outside edge of a circle, called the circumference, is three and one-seventh times as long as the diameter, which is the measure across its middle. It’s true for any circle.”

“I say we honor this new discovery, said Sir Cumference. From now on, pie with an e will be for eating. Pi without an e will be the name of this number for all things round!”

Can you write an equation for relationship between the circumference and diameter?

What is the formula for the circumference of a circle?