Mathematically-based stories in junior classes: Do stories change attitudes toward mathematics?

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Abstract

This study explored evidence of a change in students' attitude towards mathematics in junior classes through the use of a mathematically-based stories unit. Using a questionnaire, observations, interviews, and classroom audiotapes, a pre- and post- design was used with the implementation of the unit. Attitude did not change quantitatively according to the questionnaire results, but there was a positive reaction by participants, as noted during the interviews, to the mathematically-based stories unit. A small sample size and limited choice in teacher volunteers are possible limitations to the results. A longitudinal study using the same elements might produce more definitive results.

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Chapter One

Introduction

Context. There has been much discussion about attitude toward mathematics and its relation to achievement (Schoenfeld, 1989). There are researchers who believe it is achievement that affects attitude, but others claim it is attitude that affects achievement (Papanastasiou, 2000). While causality may be difficult to discern, there has been extensive research on the effect of various teaching methodologies on student attitude toward mathematics (Whitin, 1992). One promising area may be the incorporation of literature in the mathematics class. I first read of the incorporation of literature into mathematics during my curriculum and instruction in mathematics class while studying for my Bachelor of Education. I could understand the use of stories in the primary grades, but I wondered how effective this context might be in the junior grades.

Mathematics stories are frequently used in the primary grades as the introduction to mathematics (Kelly & Burke, 1998) or to explore a topic (Jenner, 2002). However by grades 5 and 6, there is a decline in teacher use of children's literature in mathematics, because teachers tend to view the use of storybooks as more of an add-on than a potential teaching method (Zambo, 2005). As students progress through the grades, it may still be useful to provide the opportunity for them to experience a good mathematics story (Austin & Thompson, 1997). Children's literature provides an alternative to the workbook and silent seat work. It creates real-life connections for students and increases their interest through relevancy and meaning (Pillers Dobler & Klein, 2002). It can be the perfect springboard into numerous topics and discussions (Jenner, 2002). Using books in mathematics provides connections between subjects and develops a more holistic view of education for a student (Reilly & Pagnucci, 2007). With all the cited

advantages, it raises the question of whether the use of stories has an effect on students' attitudes.

Past research on the problem. There have been a number of studies examining students' attitudes toward mathematics using an inventory of questions, which are usually attached to large scale studies and generalized to the population (Aiken, 1970; Antonnen, 1969; Tapia & Marsh, 2004). Attonnen (1969) found it difficult to link mathematics achievement to mathematical attitude in the junior grades using an attitude scale, but found it more reliable for high school grades. Recently, Tapia and Marsh (2004) created an attitude instrument with high reliability and used it with secondary students. Finally, Simon and Schifter (1993) investigated the attitudes of grades 5 and 6 students before and after the use of constructivist problem solving in their classroom. They based their attitude scale on research performed by Aiken (1974) and Schoenfeld (1989). These studies focused their energies on measuring attitude, but, during the current investigation, limited research was found on the use of an intervention and the measured effect on the students' attitudes.

Limitations of past research. In the research examined, most studies have either considered the use of mathematical stories (mathematically-based stories) or measured attitude. Many studies using children's literature in mathematics are qualitative in nature (Ronau & Karp, 2001; Wickett, 1998; Margerm, 1999) and mainly reported as case studies or action research. With respect to attitude, researchers examined students' attitude and mainly linked it with achievement in a quantitative manner, but not with qualitative inquiry (Antonnen, 1969; Fennema-Sherman, 1976). Research is needed to determine the use of children's literature in the teaching of mathematics for grades 5 and

6 and its effect on the attitudes of both students and teachers, as well as an examination of the experience of these participants throughout the process. There is a need to connect the qualitative aspect of student attitude with the quantitative aspect and how each relate to the implementation of children's storybooks in mathematics in order to better understand the connection between attitude and this teaching method as well as its overall impact. Using both qualitative and quantitative aspects may provide a more holistic picture of the mathematically-based stories unit's effect on attitude.

Purpose of the study. The purpose of my research was to examine the effect that a mathematically-based stories unit had on attitudes toward mathematics of 17 fifth grade French immersion students' This particular class was chosen due to my supervisor's previous research connection, and the teacher's willingness to incorporate the 5-week research unit into her teaching plan. Additionally, my bilingual capability permitted me to understand the classroom discussions as the teacher taught mathematics in French. The teacher's perceptions of the effect of the mathematically-based stories unit were also investigated. Finally, a mathematically-based stories unit for a grade 5/6 class was developed.

Research question. The research question that the study explores is:

> How does the implementation of a children's literature unit affect students' attitudes toward mathematics as perceived by the students themselves as well as their teacher?

Significance of the study. Depending on the outcomes of the study, this research may be significant by providing an example of a learning environment that supports both contextually-based mathematics learning concomitant with the development of more

positive attitudes towards mathematics. The unit integrates both mathematics and literature demonstrating that language and mathematics are connected. The unit continues to be offered in detail for use by other classroom teachers.

Limitations of the study. As this study is using case study methodology, the results are not generalizable to new settings, people or samples. Validity was achieved qualitatively with triangulation, member checking and rich, thick description to ensure the "trustworthiness, authenticity, and credibility" of the findings (p. 191, Creswell, 2009). The questionnaire being used is from Simon and Schifter (1993). It was developed from existing attitudinal surveys (Aiken, 1974; Schoenfeld, 1989), designed for this target population, and created in recent years. However, since there is no indication that this survey has been tested for validity or reliability, it was only used to obtain preliminary understanding of the students' attitudes toward math and offer insights about the students' attitudes regarding the mathematically-based stories unit. The results of the questionnaire were also used to further inform the semi-structured interview questions.

Another limitation to this study was the teacher volunteer. Teacher volunteers for research projects in the district are limited in number especially teachers willing to incorporate a 5-week unit into their yearly plans. Our volunteer was known to my supervisor and an enthusiastic mathematics teacher. A final limitation to the design of this study is the lack of comparison. A comparison with the same students or another class would provide more information for the results, but, with the limited teacher volunteers, it would have been challenging to get two teachers' permission to be present

in their classrooms for the same strand of math and still be able to complete the entire thesis process within the two-year time limit of a Masters degree.

A final limitation to this study was the lack of video. Video might have captured more nuances in throughout the unit, but the observation notes combined with the audio which was used for confirmation was thought to be representative of what happened within the class. As well, there was concern about the likelihood of obtaining permission to do video analysis.

Possible outcomes. The research indicates there should be an improvement in students' attitudes toward mathematics through the use of literature. For students who are strong in language, but not in mathematics, the use of a storybook could present connections not seen in a traditional mathematics lesson (Jenner, 2000). Another feasible outcome is the creation of a curricular unit that addresses a number of curriculum expectations. Writing, reading, speaking, listening, artistic, and mathematical expectations can be met throughout the unit and the students' culminating task of creating their own stories embedded with mathematics. One final benefit is an addition to the limited French immersion resources that currently exist for the teachers at the school. This unit contains English storybooks translated into French by the teacher, and it will contain French language activities.

Chapter Two

Literature Review

Achievement and attitude. Achievement in mathematics (AIM) and attitude toward mathematics (ATM) have been major concerns for mathematics educators for many years (Ma & Kishor, 1997). Over time, there have been inconsistencies in the research literature as to the strength of the correlation between AIM and ATM (Ma & Kishor, 1997). Steinkamp (1982) deduced that ATM was most important among the variables to determine AIM. His conclusions, supported by correlations higher than 0.40, signify the observation of a strong connection between ATM and AIM which has been corroborated by other researchers (Schoenfeld, 1989; Ma and Kishor, 1997).

Another group of findings demonstrate that there was a definitive statistically significant correlation (0.20 – 0.40) between AIM and ATM (Aiken, 1972; Anttonen, 1968). Although the strength of the correlation was in two different ranges, there was reason to believe that achievement in mathematics was affected by attitude toward mathematics. It was with this theoretical lens that much of attitude measurement research has been framed. In order to utilize the measurement of attitude in mathematics for this study, it was imperative to look at how it has been used in the past.

History of the Measurement of Attitude in Mathematics. One of the first scales developed for ATM was by Wilbur Dutton (1954). He collected statements from a pre-service teacher program at the University of California to assist in the creation of his measurement of attitude. These statements were scaled using techniques from Thurstone and Chave (as cited in Dutton, 1954), who had developed a measurement of attitude, but it was not related to any specific subject. The reliability of the scale was tested and found

to have a 0.94 correlation between the two sets of scores. Dutton did not have a specific definition related to attitude, but was looking more at general attitude toward mathematics, the period of the development of that attitude, and reasons for liking/disliking mathematics. However, in a study published in 1968, he more specifically defined attitude as "a learned, emotionally toned predisposition to react in a consistent way, favourable or unfavourable, toward a person, object, or idea" (p. 259). In that study, he used his previously mentioned measuring device and combined it with a Likert-type scale. After testing its reliability (0.84), he tried it out on 346 elementary-school students. He described one of the limitations of his study as the inability of the scale to tell why students dislike/like certain aspects of math. The scale itself was only able to identify what aspects of math the students liked/disliked.

Aiken was another early explorer into mathematics attitude. Although Aiken and Dreger (1961) originally developed a uni-dimensional scale, Aiken developed his own *Mathematics Attitude Scale* that has been used repeatedly for secondary students over the years as it is heralded for its validity. It measured the affective dimension of attitude adequately (1972). He admitted in his 1974 paper that most attitude scales are only measuring "one of the affective goals of mathematics instruction" (p. 67). It was as a result of this realization that he decided to create the E (enjoyment) and V (value) scales which had statements from his original 1972 Mathematics Attitude Scale.

In 1976, one of the largest multi-dimensional scales was created by Fennema and Sherman which included a set of nine instruments that have been extremely popular and used in research frequently over the last three decades. Their scales included a teacher scale, a mother/father scale, attitude toward success in mathematics, confidence in

learning mathematics, mathematics anxiety scale, mathematics as a male domain, mathematics usefulness scale and effectance motivation scale. It contained 108 items and takes 45 minutes to complete. Researchers have questioned the validity, reliability, and integrity of the scores as well as whether the scales assess their intended measurement aspect (Suinn & Edwards, 1982; Melancon, Thompson, & Becnel, 1994).

More recently, Tapia and Marsh (2004) created a 49-item inventory completed by high school students exploring self-confidence, value of mathematics, enjoyment of mathematics, and motivation. It was reported to have a high reliability coefficient of 0.97. However, currently, it has not been reported validated by any other researchers. The inventory itself has not been published in its entirety either, so the items contained within the inventory are inaccessible for comparison to other studies.

Finally, of particular importance to this research is the study by Simon and Schifter (1993) of how a program designed to teach teachers from the constructivist perspective of mathematics would in turn affect the attitude of their junior-grade students. They found that the students' attitudes toward mathematics improved as measured by their *Attitude Toward Mathematics* questionnaire. They also found the students' scores on the standardized test were maintained.

After reading Chamberlin's review of the instruments (2010) and examining a few more closely (Tapis, 2004; Aiken, 1970), I decided it was best to use an instrument specifically designed for my target population as was found in Simon and Schifter (1993). Another reason for my choice was that the research design in Simon and Schifter uses the questionnaire to measure attitude in conjunction with an intervention, as does my research. Finally, because the research of Simon and Schifter (1993) study happened

more recently, I opted for their instrument as opposed to Aiken (1970) or Fennema and Sherman (1976).

Components of attitude in mathematics class. According to Simon and Schifter (1993), there are three components of ATM, which are interest, enjoyment, and confidence in mathematics. Other researchers have identified a fourth component, which is the value of mathematics (Aiken, 1974). These four components have been found to have support throughout the examined case studies and action research. Through the research conducted for this study, qualitative studies did not seem to focus on all four aspects within a single article. It was often the case that one or two of the aspects were examined in great detail. I thought that it would be important to consolidate the observations and qualitative contributions to better inform the survey results. Therefore, these aspects were retained and analyzed in the current study because of the support contained in both qualitative and quantitative studies. Beyond the use of survey instruments, many qualitative studies demonstrated positive effects of literature when used in mathematics while inadvertently discovering a connection to one or more of the four aspects of attitude being investigated in this study.

Interest. Interest, as noticed by a few researchers, can help students to incorporate the information presented in the story into their daily life. For example, in a study by Pillers Dobbler and Klein (2002), grade one students used what they learned in *The Fly on the Ceiling: A Math Myth* by Julie Glass and made an everyday connection outside of class. The story is about René Descartes and the Cartesian coordinate system. After spending over a week working with various activities related to the text, parents began commenting on their children's learning. A parent reported their child wanting to use the

atlas to find places using only "B-4". Another parent reported their child seeing the Cartesian coordinate system in the optometrist shop. By translating this concept into their life, it was obvious that the children's interest had been aroused by what they had learned. In another incorporation of literature (Ronau & Karp, 2001), the teachers integrated mathematics, science, and literature to cover the environmental topic of garbage.

Through the use of the storybook *The Wartville Wizard* by Don Madden (1993), the teachers got the students in touch with their environment through the use of fractions. The students counted different types of trash in their schoolyard, and they represented this data using 4 different formats. Using the Internet, they found information about their nation's garbage. Students commented, "If people recycled, we would have ¾ less trash." and "Paper is our biggest litter problem around the school." (p. 28). These students were integrating the concepts they learned into their daily life. The examples indicate that students found the stories relevant enough to add the information to their daily schema.

Another possible indication of interest is students trying to make sense of the story or math related to the story. During an unusual rendition of the three little pigs that presented tangrams, students' knowledge of the traditional version made them curious as to the differences between the two stories (Margerm, 1999). The story's mathematical language became audible in the class while students were working on their own tangram creations. The mathematical language reappeared in the new endings they wrote which were linked to their tangrams. Their enthusiasm was evident in the work samples as they paid attention to the details and were creative with their shapes.

Enjoyment. Enjoyment is another aspect of attitude that can be seen when students respond immediately following or spontaneously during a story. The story of Neil (Jenner & Anderson, 2000) demonstrates how reading *Caps for Sale* by Esphyr Slobodkina stimulated this student's interest. Neil had issues with attention, active listening and responding with a related answer. He had math difficulties that often required teacher assistance. Using videotapes, the teacher saw Neil actively listen, ask questions for clarification, and share his observations. All of these observations indicated that Neil was definitely interested in the story being read.

In another incorporation of literature Lewis, Long, and MacKay (1993), reported on two classes, primary and junior where students had spontaneous math discussions that occurred at the same time as the reading of a story. The authors indicated the lesson allowed all students "to contribute to the dialogue, even though they were at different developmental levels." (p. 471) As there was no need for 'correct' mathematical vocabulary during the discussions, students employed their conceptions of what was happening in the book. Also, listening to other students' mathematical thinking spurred them to try alternative problem solving methods.

In another primary class, the 'brief, impromptu discussion' displayed integrative thought (Whitin & Gary, 1994). They used predictive skills from reading and estimating skills from mathematics to aid the character in solving the problem. Researchers observed that the students were capable of expressing themselves without the 'right' mathematical words. Through discussion, students were able to come to their own conclusion about the situation. Therefore, these students developed their own informal

concept and were ready to test it by presenting it to the class. These conversations developed because of the story.

A final example of a spontaneous response came from a lesson on factorials taught with the book *Anno's Multiplying Jar* by Masaichiro and Mitsumasa Anno (Bintz & Delano Moore, 2003). Students responded quickly after the story finished indicating their focused attention. Their work samples also clearly indicated comprehension of factorials introduced by the story. The creativity reflected in their stories demonstrated an apparent grasp of the underlying mathematical concept.

Another indication of enjoyment of the material can be seen through Grade 5 students "begging to continue working after the bell rang" (Lewis, 1993, p. 5). Students had been working with the story of *Anno's Mysterious Multiplying Jar*. The story tells of a factorial problem presented through a fascinating progression, which begins with one jar and ends with ten jars in nine boxes. The teacher posed the question about the total number of jars. The students were working so intently on finding the answer; when the bell rang, they wanted to continue.

Evidence of enjoyment was also found in student writing. In an inspiring teaching unit combining a biography of a female geneticist, genetics, data management and probability, Cwilka and Patterson (2000) asked students to write reflections on completion of their unit. The student quotes indicated that students enjoyed the lesson, working together as well as doing the bar graph.

Value. A final aspect of attitude found in the literature is the value of mathematics to students. Two aspects of value have been identified in the research to be the retention of the mathematics as well as the use of mathematics in their daily life. Mathematics,

Arts, Research, Collaboration, and Storytelling: The High M.A.R.C.S. project headed by Reilly and Pagnucci (2007) involved students being creative with mathematics, art, research, collaboration, and storytelling. One of the many confirmations of the success of this project presented itself while reviewing for the state tests. As the teacher went through key concepts studied in mathematics that year, students were recalling the stories that included these concepts. All of the students remembered one particularly memorable story that involved the concept of volume. Similarly, students recognized the value of mathematics when they saw how it was useful for their everyday life.

In the first week of the High M.A.R.C.S. project, students were asked to record daily all of their uses of mathematics in a chart. They were only permitted one example per day in school, but it could not be in mathematics class. The rest of the examples they recorded were expected to be outside of school. Students compared examples and constructed grids displaying their information with the data from the other members of the project team. Numerous students remarked that mathematics was more important than they had thought because of the data they had gathered.

Based on the previous discussion, it seems that one method of incorporating all the aspects needed to support positive attitudes toward mathematics might be the incorporation of the development of stories that involve mathematics into the math classroom such aspects of stories that might contribute to this goal include novelty (Margerm, 1999), high interest (Watters, 2000), and real-life connections (Wickett, 1998) and challenging mathematics within the story (Wickett, 2000). Because of these positive aspects, teachers incorporate mathematically-based stories into their mathematics class. There are a variety of ways to incorporate these stories.

Incorporating mathematically-based stories in primary and junior classrooms. Reading storybooks in class is an activity that is familiar to students, especially in the primary grades. *The Grouchy Ladybug* is a favourite of many for introducing time to children, but can also be used to teach students about patterns, proportions, and character development (Kelly & Burke, 1998). It goes through a number of animals ranging in size from the ladybug up to the whale. It shows the rising and setting of the sun as it corresponds to the time of day. It also touches on the character of the grouchy ladybug, which could definitely be extended into a discussion on his behaviour.

Another popular book is *The Doorbell Rang* by Pat Hutchins, which is about sharing cookies and introduces multiplication and division in a context rooted in a child's reality. As each new friend arrives, each person's cookie share gets smaller and smaller. Another book used in grades 2-3 is *Selina and the Bear Paw Quilt* (Jenner, 2002). The aspect of math used in this story is subtle on the topic of tessallations. The book's pictures are framed in quilts, which, in this case study, led to a discussion of transformational geometry. Gaily (1993) has listed numerous books for teaching specific numbers and counting for primary classes providing elementary school teachers with a depth of choice. Using math stories has been well documented in the primary grades (Whitin, 1992).

In higher grades, multiplication can be addressed in *The King's Chessboard* by David Birch and *A Grain of Rice* by Helena Pittman, both of which have similar storylines regarding successive doubling (Whitin, 1992). These beautifully illustrated folktales depicting life in India have versatility. They can be used in younger grades to

show doubling through addition, but they can be used in higher grades as well for exponent expressions or multiplication.

Also, a book such as *Gulliver's Travels* by Jonathan Swift provides opportunities to work with proportions, scale, ratio, area, and measurement, but also has great potential for writing and other creative activities such as paper mâché or painting of figures from the land of Gulliver (Kliman, 1993). Non-fiction is also a good choice for the older grades such as in Cwilka and Patterson (2006). This researching team used the biography of a geneticist to teach algebraic equations as well as genetics for a science class.

Stories as a catalyst. Mathematical storybooks have been used as a catalyst to review previously studied concepts, introduce topics, extend learning and stimulate discussion. For example, in Kelly (1998), a teacher wanted to push her students beyond rote memorization with regards to telling time on an analog clock. The teacher wanted to review time and reinforce the concept using the book as a vehicle. She asked the students to track the patterns in the book, and then used, a clock manipulative to demonstrate the relationship existing between the hands of the clock. The final project was to create books based on *The Grouchy Ladybug* by Eric Carle. Their conversations during the project involved mathematical terminology and concepts with respect to time as per the teacher's intent. However, an unexpected learning extension occurred when confusion around 'a quarter after the hour' meant fifteen minutes, but a quarter with respect to money meant twenty-five cents. The book was a catalyst used to clarify and review vocabulary previously learned.

In a seventh grade class introduction, students read the text *Socrates and the Three Little Pigs* by Misumasa Anno during which they explored the topic of probability

and patterns. An extension of their math arose as the students learned to develop orderly arrangements, conjectures, and algebraic representations (Thompson & Austin, 1999).

A mathematical storybook provides opportunities to extend learning beyond the math presented in the story. Another example, in Long and Crocker (2000), the fifth grade students heard the problem in *Sir Cumference and the Round Table* by Cindy Neuschwander. In their search for the perfect table to seat all the knights, they not only learned of diameter, radius, and circumference, but they also examined area and perimeter. Furthermore, a suggestion provided by the author broadens the topic's scope to include a 'review of the attributes of shapes beyond those discussed' (p. 245, Long & Crocker, 2000). Another case is presented through the book *Swish!* by Bill Martin Jr. & Michael Sampson (Watters, 2000). The story covers the final moments in a girls' championship basketball game. Following the story, a discussion of the types of shots and the possibility of making each one was the natural progression. Although the teachers could have stopped there, the lesson continued with calculations of the students' field-goal percentages and those of the professionals as well as the measurement comparisons of a regulation court to the one present at their school. The measurement of the courts was an extension providing a true catalyst to learning further than the book.

Another way books extend student learning is making them aware of the math that is present in their immediate surroundings. In the previous article mentioned (Watters, 2000), the teachers had local university women basketball players come in to assist the students with the unit. The students could see that the percentages they were calculating were applicable for these players who live in their community. They were not just people they saw on television. Connection was also made to the community in an

article by Berry (2002). This teacher used a book by Peter Scieszka and Lane Smith called *Math Curse*. She read the book to the class and used activities, but, as a culminating task assessment, the students invented their own 'math curse' book. Proofing other students' work gave the class a broader scope of daily math. Upon completion of the project, the teacher then went to the local bookstore and had the children's books displayed alongside the original for all the community to see. The injection of their work into the community generated a sense of 'pride and accomplishment' and gave students the chance to see that others were interested in their work.

Stories with cross-curricular connection. What students might also be missing is the connection between mathematics and other subjects if their teacher only uses one textbook and workbook. As the storybook the *Math Curse* (Scieszka, 1995) illustrates mathematics is connected to all the aspects of our daily life, so it should be important to show how it is related to other subjects. In a remarkable project reported in Reilly and Pagnucci (2007), mathematics was not only combined with storybooks, but it was also related to other subjects such as art and language. Students collaboratively created math stories based on a concept previously covered in class. They performed research, struggled through the writing process (outline, draft, feedback, revise), and drew illustrations. English, art, and math mixed into one project provided a connection between subjects. Many teachers used the writing of story problems or a math journal in their classroom as the connection to other subjects, but there are many other connections.

Other subjects that could possibly connect with math are science (Cwilka & Patterson, 2006), poetry (Bintz, 2010), social studies (Wickett, 1998), and technology

(Little, 1999). In the Cwilka and Patterson (2007) study, the teacher used the biography of the geneticist Barbara McClintock to study "estimation, pattern recognition, probability, and data representation" as well as teaching genetics using Punnett squares. Reported by Bintz (2010), the students wrote poems utilizing Fibbin, "a number sequence in mathematics and recurring pattern in science" associated with Fibonacci, an influential mathematician in the Middle Ages. Although the students in this class were graduate students, the lesson would have been possible to use over a number of days with middle or high school students.

Social studies was applied through the story *Saturday Sancocho* (1995). A Mexican market is described with its bartering system giving students a peek at the life of a child their age in another country. The book also prompted a student to compare the prices locally and internationally. The student then inquired about the price of chickens around the world (Wickett, 1998). Global markets would be a great topic to delve into from this lesson.

Finally, technology is another subject that can be used in conjunction with math. In the article by Little (1999), students used technology to create a Geometry Construction Manual using Geometer's Sketchpad. In fact, the students were offered 3 choices to express their comprehension of the concepts covered. They could use technology, create an example of Escher art (tessellations), or write and illustrate a children's picture book. These examples of cross-curricular integration helped to show students that subjects are linked and not isolated. It gave them multiple options to express their understanding of the mathematics involved. This enabled them to see education as a whole entity.

A teacher using children's storybooks within mathematics class is given a wider window to explore and connect other subjects to math (Gailey, 1993). In Cwilka & Patterson (2006) article, using the biography of Barbara McClintock, the teacher was able to incorporate non-fiction, science, writing and mathematics for her grade seven class. The teacher created a unit tying several mathematics topics to the genetics of corn using written reflections. Catherine Little (1999) provides another example of connecting subjects. This innovative Canadian teacher combined technology, art, and literature with mathematics as three possible options for their final project. The choices required the students to develop a geometry construction manual, write and illustrate a children's picture book, or investigate Escher's art and link it to mathematics. The process demonstrated to the students how all three subjects could be linked to math.

Another interesting article was able to link social studies to mathematics (Harris, 1998). The teacher used a story that is set in Eastern Europe. The story, *A Cloak for the Dreamer* by Aileen Friedman (1994), introduces a few novel ideas for children in the Western world such as the father's occupation as a tailor as well as the concept of his young sons sewing garments, not something most ten-year-old boys experience. Additionally, with the setting of the story earlier in the century, the culture seeps through the story to illustrate a life very different from our own. The teacher in this article used the story to introduce transformations in geometry. The story was also used to exemplify family dynamics of this time in Europe. The link to social studies was indicated by the author as an extension to the lesson. For a classroom teacher who is teaching all the subjects, literature provides an avenue for studying numerous subjects within one unit saving on time and addressing several curriculum expectations from the premise of one

book (Gailey, 1993). However, for teachers working on a rotary teaching system, this integration provides the opportunity for collaboration between colleagues, which demonstrates for students the definite connection that math has to other subjects (Cwilka & Patterson, 2006). With this cross coverage between subjects, teachers are bound to be able to combine subject curriculum expectations and save some time in what many teachers feel is a compressed curriculum (Zambo, 2005).

Incorporating literature as alternative assessment forms. With the use of multiple skills and multiple subjects connected through the use of mathematically-based stories, assessment options for teachers may widen from straight procedural tests and fluency exercises to a diverse array of choices (Whitin, 1992). One of the most popular preferences is to use writing to examine a student's conceptual understanding of a topic (Zambo, 2005). Rubenstein and Thompson (2002) detailed the troubles children have with mathematical language and language arts strategies for teachers to employ. Using mathematical stories tops the list along with the writing of terminology, stories, cartoons, journal entries, and many other choices. Although it is popular to get students to write their own story problems (Bintz & Delano Moore, 2003; Whitin & Gary, 1994) which may relate to the story read, an article written by Kolstad, Briggs, and Whalen (1996) details various other options for writing. Children can be encouraged to write their own definitions of vocabulary words, translate math symbols, or describe processes. When students employ their own understanding of a concept, they are more apt to remember it than if they memorized it. It also suggests in the article that students should draw on graphic organizers to help organize and record acquired knowledge. Another idea was to create a 'how math works' story. The students use their description of a procedure for

solving a specific type of problem, and detail it through a number of steps for someone who does not know how to perform this mathematical method. A final idea was to have students write math limericks, which has support in the Bintz article (2010). In the Bintz article, students wrote poetry with Fibonnacci numbers as the guide for the number of syllables per line. Writing can take a variety of formats and is not limited to story problems. The use of stories in mathematics class may take many forms and have many aims; for example, stories may be used to support learning of content, processes, creative expression, and also support students' level of engagement.

However, writing is not the only means of assessment available when using mathematically-based stories. Other alternative assessment options may be art or drama. Referring back to the Harris article, which was based on *The Cloak for the Dreamer* (Friedman, 1994), the students in this lesson used patterning and transformational geometry to create little pieces of art through tiling (i.e. a repeating pattern covering a shape completely). As well, Gailey (1993) offers the idea of having children communicate their understanding of a story through a visual piece such as diorama, mural, mobiles, or posters. They could design book jacket covers or a bulletin board. An interesting option was constructing quilt squares with construction paper and art supplies that describe square by square the story in a book in much the same manner as one would make a storybook quilt or storyboard. The author also suggests students may want to try to do a mock television show, perform monologues, pantomime, or produce puppet shows which allow a teacher to offer different types of assessment to students who may never have received it with respect to math. With writing, art or drama, a teacher may be

able to more clearly identify conceptual understanding through the student's interpretation of the concept in these alternative assessments (Golembo, 2000).

In summary, we have evidence that attitude affects student achievement in mathematics and, further, that instructional practice affects student attitude. We also have an extensive documentation and anecdotal reporting by teachers on the positive attitudinal impact of incorporating literature into the class at various levels of education. However, mixed methods studies of the implementation of a literature unit in the math class and the effect on student attitude with junior-aged students were not found in the current literature search.

Chapter Three

Methodology

The purpose of my research was to examine 17 fifth grade French Immersion students' attitude toward mathematics and determine the effect of using mathematically-based stories on their attitudes toward mathematics. The teacher's perceptions of the effect of the mathematically-based stories were also investigated. The question driving my study was: How does the implementation of mathematically-based story unit in mathematics affect the students' attitude toward mathematics as observed by the students and teacher? To examine students' attitudes and the teacher's perceptions, a mathematically-based stories unit for a Grade 5 class was developed.

Research design. This mixed-methods study included a case study of the process of the implementation of the unit (Appendix A). A case study is "an intensive, holistic description and analysis of a single instance, phenomenon, or social unit" (Merriam, 1988, p. 21). It contains an examination of a system bounded by time and space. The system is the single case or multiple cases one chooses to study (Creswell, 1998). Case study methodology attempts to study details and the intricacies of a case instead of generalizing to a larger group, with a central focus of interpretation (Stake, 1995).

Unit design and classroom instruction. The teacher taught the students using mathematically-based stories and problems created by Margerm (2010) on the topic of ratio, proportion, and percentage for 18 days which did not include the pre- and post observation periods. The unit of study contained three picture books (Shea, 2003; Smith, 2002; Winter, 2008;) and problems based on the mathematical ideas presented in each

book (Margerm, 2010). The teacher had not yet taught ratio, proportion and percentage in her mathematics class, and volunteered to use the 5-week book unit to meet these particular curriculum expectations. The original plan was to have more pre- and post observation making it a 6-week unit, but due to field trips and unexpected duties of the teacher (acting principal for a few days), these observation times were cut down which made the unit decrease to occur over a five-week span.

The Carpet Boy's Gift by Pegi Deitz Shea is about a bonded labourer, Nadeem, who works to pay off family loans received from the factory owner, and his subsequent emancipation from child labour. The story is set in Pakistan and deals with the Pakistani rupee, which lends itself to lessons on currency conversion. *Wangari's Trees of Peace* by Jeanette Winter details a true story of one woman's journey to re-plant the devastated Kenyan forest. Wangari begins with 9 seedlings and enlists the help of the village women to plant more trees. The story encourages the use of ratio problems (see Appendix K). Finally, *If the World were a Village* by David J. Smith involves mathematics explicitly on every page, regarding ratio, proportion and percentage. It calls on the reader to imagine that the world's population was in a village of 100 people and provides a snapshot of other countries' food security, energy and health. After working through all of the stories and the associated problems, the final week of the unit was dedicated to students creating their own mathematical story.

Participant sample. The research was conducted with a *convenience sample* of students. A convenience sample is defined as a subject group chosen for its availability (McMillan, 2000). The teacher volunteered for this study. She had a previous research connection with my supervisor and was willing to incorporate the 5-week unit into her

teaching plan. The project took place in a Grade 5 class at a public elementary school in Thunder Bay. The class consisted of 17 students, all of whom are French immersion students. I was comfortable doing the research in this French immersion class because of my bilingualism. Of the 17 students, only 2 students were designated with an IEP. The school is located in a middle- to upper-middle class neighbourhood.

For the interview portion of the study, students were selected purposively by their teacher. A *purposive sample* is selected based on the sample being representative of the population and the judgement of the investigator who identifies the important sources of variation within the population (Singleton, Straits, Straits, & McAllister, 1988). I asked the teacher to choose students according to a balance in gender and a range of achievement levels, in order to get a clear picture of the experience of students with a broad range of capabilities.

The teacher made the choices of the students on her own without discussing the choices with me, so I cannot be sure that the teacher was completely unbiased in her choice. It is possible that she chose those students who generally work hard, are engaged and would be likely to respond well to me as the researcher, but asking for a range of achievement levels was one way to broaden the sample. Had I asked the teacher to choose students that best represented the majority of the population in her class of 17, the interviews might have consisted of the midrange and higher achieving students in the class, likely 6 girls and 2 boys as well as more students from the upper levels of achievement. Therefore, a purposive sample was chosen as a way to get a broader and more representative sample. The teacher selected eight students according to their overall level in mathematics with a boy and girl from each achievement level, ranging from level

1 (average 50-50%) up to level 4 (average 80-100%). At each level, two students, a boy and a girl, were chosen.

In order to provide some examples of individual students, I selected three students from the sub-group of students who were interviewed. The students were purposely selected to exemplify some of the varied responses to the unit. Megan, Aaron, and Brittany all reacted differently to the unit and brief descriptions of their experiences are provided to follow.

Ethics procedure. The students were given an information sheet about the study (see Appendix B) as well as two consent forms, one for participation in the study (see Appendix C) and one for authorization of the audio-recording of the class discussions (see Appendix D). All of the consent forms were collected by the teacher prior to commencement of the study. The teacher (see Appendix E) and the principal (see Appendix F) also signed consent forms to participate in the study.

Procedure and data collection. Data was collected before, throughout, and after the intervention (see Table 1).

Teacher Interviews. The teacher was interviewed prior to the commencement of observations as to her views on mathematics teaching, her attitude towards math, and her general impression of her class' attitude toward mathematics as well as after the implementation of the unit (see Appendix G).

Student questionnaire. The teacher administered the questionnaire at the beginning of the first week of observation (see Appendix H).

Student interviews. A sample of students (n = 8) were interviewed and questioned further about their answers from the questionnaires (see Appendix G). The

interviews were audio-taped. The unit was implemented in the second week of May, 2011.

Observations. I observed the class for a week prior to the unit noting the routines, interactions, and general atmosphere of the class. The purpose was to view the class and how it operated without stories as part of their regular mathematics class. I wrote my observations as notes on the components of attitude prior to the implementation of the unit. The class was observed using an observation protocol (Appendix I) and audio-taped. The teacher created and used her own assessment tools (e.g., rubrics, checklists, worksheets) in order to ensure it suited her needs and requirements of her long-range plans.

The data collection is summarized in Table 1. All data collected was entered into ATLAS.ti as primary documents except the questionnaire results, which were transformed and analyzed in SPSS as descriptive statistics. I transcribed both sets of observation notes that were taken by myself and my supervisor. However, the audio was transferred in audio format from the recorder to ATLAS.ti without transcribing into a word document.

The amount of data that was collected was done in order to get a representative picture of the interactions of the class was abundant. There were 5 weeks of daily audio recordings of the math class, observation notes from 22 days, 18 interviews (including 2 of the teacher), and the questionnaire data from 34 questionnaires. It was fortunate that one of the digital recorders had a PC connection, which allowed for the direct transfer of the audio files into ATLAS.ti. This permitted those audio files to be coded without transcribing them into a word document. The material gathered was beyond the

capabilities of one graduate student researcher to analyze. To properly digest the data, it would have taken a much longer time period than the time period allotted to complete a masters' thesis. Instead, the classroom audio files were used to clarify anything that was found to be unclear within the observation notes.

Table 1

Data Collection Summary.

Week	**Data Collection**	**Instrument**	**Primary Documents for ATLAS.ti (unless otherwise stipulated)**
Pre	Interview Teacher	Semi-structured interview questions	Interview audio
	Student questionnaire	Simon and Schifter (1993) questionnaire	Student questionnaires (17)
	Class observation		3 days observation notes
	Interview students	Semi-structured interview questions	Interview audio (8)
1	Class observation		4 days observation
	Audio-taped discussions		4 audio-taped classes
2	Class observations		4 days observation
	Audio-taped discussions		4 audio-taped classes
3	Class observations		5 days observation
	Audio-taped discussions		5 audio-taped classes

4	Class observations		5 days observation
	Audio-taped discussions		5 audio-taped classes
5	Class observations		2 days observation
	Audio taped discussion		2 audio-taped Math classes
	Interview teacher	Semi-structured interview questions	Interview audio
	Interview students	Semi-structured interview questions	Interview audio (8)
	Student questionnaire	Simon and Schifter (1993) questionnaire	Student questionnaires (17)

Design of the pre-test and post-test questionnaire instrument. The questionnaire was selected from Simon and Schifter (1993) as the current study is based on the same methodology as that study.

Quantitative analysis. The data from the questionnaire was analyzed using a two-tailed *t*-Test with SPSS as was the case with Simon and Schifter (1993). This data was also transformed into themes that coincide with the qualitative themes so that they could be compared. The data was transformed using the numbers 1, 2, and 3 to correspond with the answers of *agree*, *don't know* and *disagree* to provide a component score for each aspect of attitude. For example, a positive statement regarding attitude, the answer 'agree' would be given a score of 3. The answer 'don't know' would be given a

score of 2, and the answer 'disagree' would be given a score of 1. With the negative statements about attitude, the opposite scoring would be assigned.

Within the questionnaire, I, along with my supervisor, linked the statements to certain components of attitude. For example, statement 1 is "It is fun to work math problems" which is linked to enjoyment of math. All of the statements within the questionnaire were transformed into the attitude components of value, interest, enjoyment, and confidence within attitude. This set of questions was chosen over using any of the popular instruments in the literature because it had been used on the target population and was used successfully in a similar manner to the present study. Question 15 was eliminated from the calculations as it stated "I have always liked math". This was considered to be a statement that would not likely change or produce mixed results because of the word 'always' contained within it. Question 9 was also eliminated as it stated, "Someone who likes math is usually weird." It was considered not to be explicitly related to mathematics attitude and its components. Descriptive statistics such as average score were used to explain the questionnaire data.

Qualitative Analysis. All of the student data (interviews, observation notes, and audio) were analyzed for content using codes created from observable characteristics of each aspect of attitude from the literature research. It was then coded using ATLAS.ti for further analysis. New codes were created as themes recognized within the student data. Student anonymity was secured by the use of numbers for the identity of the student. Questionnaires and any work samples collected were coded by the student number. Any information that was not clear from the observations was clarified with the student or teacher.

Three audio-taped interviews were double coded by a second researcher, my thesis supervisor. Inter-rater reliability was found to be within 85% accuracy. Any of the discrepancies between the codes were resolved through discussion. We created new codes through the analysis of the interviews and the observations from class. These codes were used on the post-interviews with the students and the teacher. Furthermore, pre-interviews and observations were re-coded to reflect occurrences of the new codes. All post interview comments were included in the treatment column of the table below as they were all about the treatment period. However, the comments segregated at the bottom of the column were not observable during the research and only able to be explored during the interviews.

Emergent codes. These codes were not part of the original design, but, during the course of the data analysis, we created new codes from the data. When a high frequency of comments or observations was noticed, I conferred with my supervisor to determine whether my new code was accurate in title and content. My supervisor then reviewed the content associated with these codes and agreed that these codes should be added to the list. Any discrepancies, as noted within the results section, were discussed and resolved. The new codes are listed in table 3 with an asterisk beside the code name.

Mixed methods data analysis procedures. The descriptive statistics of the overall component values from the questionnaire statements were compared to the coding frequencies found in the observations, audio-taped discussions, and interviews. This comparison provided a clearer picture that neither the questionnaire nor the interviews alone could have given. For example, I used the components of attitude to group observable examples of *enjoyment*, *interest*, *confidence*, and *value* that were found during

my literature review. These observable examples were used as my codes during my observation of the classes. These were then comparable to the quantitative results as the two methods used the same components for analysis.

Chapter 4

Results

In this study, I explored a potential change in attitude towards mathematics with the use of mathematically-based stories in a junior classroom. My study was based on the Simon and Schifter (1993) study which saw positive changes in student attitude. I examined 4 components of attitude: *enjoyment*, *interest*, *confidence*, and *value* with the questionnaire from Simon and Schifter (1993) as well as qualitative data from observations, audio-recordings, and interviews. I performed interviews and asked students to fill out the attitude toward mathematics questionnaire before and after the implementation of the unit as seen in Table 1.

Quantitative Analysis. Two-tailed t-Tests were run to compare pre- and post-program questionnaire responses and examine the effect of the mathematically-based story unit on the overall attitude of the junior students. The average scores the overall attitude toward mathematics are displayed in Table 2. The mean for attitude before (M= 2.54, SD= 0.29) was essentially the same as the mean for attitude after (M= 2.53, SD= 0.39), $t(15) = 0.26$, $p < 0.80$. The 95% confidence interval for the mean difference between the two ratings was 1.753 to 2.131. These findings suggest that overall attitude toward mathematics according to the survey was not affected by the implementation of the mathematically-based story unit as there was no significant change.

Grouping of statements into components. Questionnaire statements (Appendix H) concerning attitude toward mathematics and its importance were collected into components of enjoyment, interest, confidence, and value. Each component was grouped

together into several statements from the questionnaire as can be seen below. This division was deemed necessary in order to look at each component clearly. A judgement was made on each of the questions to determine which component suited the question best. I made the groupings and consulted with the second researcher, my thesis supervisor, for consensus on the placement of each question within the components or deletion from the analysis altogether.

In the original use of this questionnaire (Simon & Schifter, 1993), the individual questions were not grouped under the components of attitude. A few questions from the questionnaire were removed from the pre-post comparison.

No conclusive evidence was found to indicate a change in attitude towards mathematics. A slight increase in the average of the confidence component scores was noticed. There might be a suggestion of a change in confidence that might warrant further investigation after the removal of the outlier which is discussed after figure 1.

Table 2

Questionnaire statements under the components of attitude

Interest

3. If I could skip just one class, it would be math.

6. Math is boring.

7. I'd rather do math than any other kind of homework.

10. I like to do math number problems.

14. I already know as much as I need to know about math.

16. It is interesting to do math story problems.

Enjoyment

1. It is fun to work math problems
8. Math is one of my favourite classes in school.
13. We study too much math in our school
17. I enjoy doing math puzzles in my spare time.

Value

2. It is important to take math every year until you are out of school
5. Most people who work need to know something about math for their jobs.
11. People who have a calculator or a computer need very little math.
12. We can learn about math in school, but rarely use math outside of school.

Confidence

4. Most of my friends are better at math than I am.
14. I already know as much as I need to know about math.
18. Doing mathematics makes me nervous.
20. I like to explain how I solve a problem.

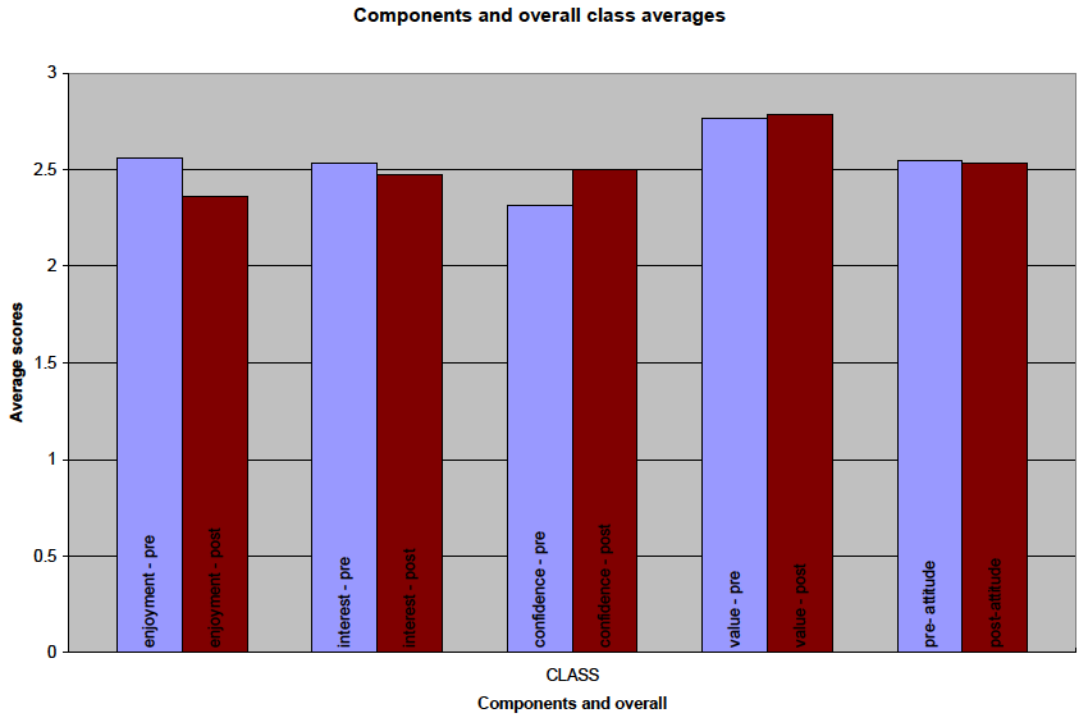
Table 3

Average scores of each component (out of 3) and overall attitude

Component		**Full data set**	**Outliers omitted**
Enjoyment	pre	2.56	2.59
	Post	2.36	2.43

Interest	pre	2.53	2.56
	post	2.47	2.54
Confidence	pre	2.32	2.36
	Post	2.5	2.57
Value	pre	2.76	2.8
	Post	2.79	2.84
Attitude	pre	2.54	2.57
(combined score)	post	2.53	2.59

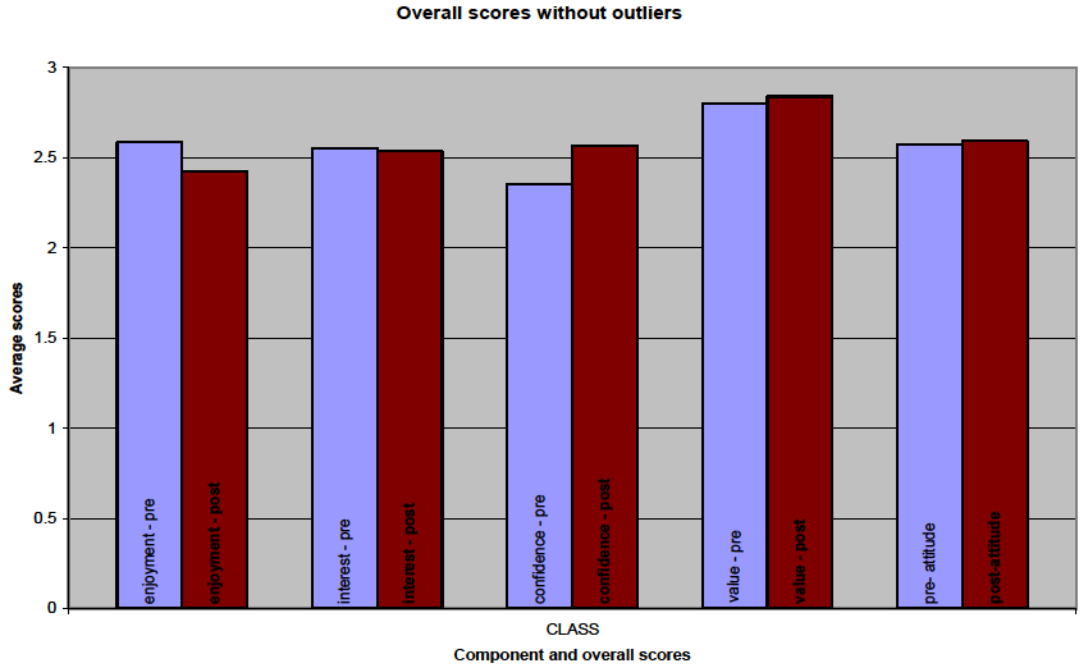
Figure 1. Averages of each component of attitude and the overall class attitude before treatment and after treatment.



Removal of outlier. While doing the post-survey results, there seemed to be a slight decrease in the overall attitude. Upon further investigation of the questionnaire

responses, I noticed that David[1] had responded negatively to most of the statements. Also, he held the belief that he did not need to learn any more math as he knew all he needed to know about math (Primary Document #35, David, June 14, 2011, 2:50.45). The teacher indicated that David had been declared as gifted, and perhaps I should delete him from the results (pers. comm., Theresa, June 14, 2011). The graph (Figure 2), with the outlier omitted, shows a marginal increase in the average score of overall post-attitude, as confirmed by the numbers in Table 2. Each component of attitude in the post-questionnaire also showed a slight increase in the average score of the response as a result of the removal of this student. However, the change demonstrated by the results still remained statistically insignificant.

Figure 2. Average scores of each component of attitude and overall attitude before and after the treatment without outliers.



[1] Pseudonyms have been used to protect the anonymity of the participants.

Timing of the unit. The time of year that the unit was implemented may likely have influenced these results. Originally, the unit was going to be implemented immediately after Spring break. However, some delays, such as field trips, research ethics clearance issues, and teacher absenteeism, postponed the start of the unit to the second week of May and the end of the unit finishing close to the end of June. The timing may have affected the survey results. Both my supervisor and I observed that the students were less focused compared to the beginning of the unit. As the month of June progressed, their behaviour became more restless than was observed during the previous weeks. The timing seemed to have affected the students' attention during the last set of observations performed after the completion of the unit. The second researcher, my thesis supervisor, noted a great deal of off-task behaviour as the teacher taught the final mathematic topics of the year (PD#61, Observation notes, June 13, 2011) while I performed the final interviews. Less attention was paid to their answers than the first time they filled out the results. In fact, with two students, I had to request that they fill out the questionnaire a second time as I noted some differences in their pre- and post-questionnaires. For example, in a post-interview, Aidan asked for my assistance to go through all of the questions as he realized from my line of questioning that his answers were not what he wanted (Primary Document #33, Aidan, June 14, 2011, 7:53).

Qualitative analysis. Through the use of ATLAS.ti software, audio clips of interviews and classroom activities as well as observations were coded using the observation protocol (see Appendix I). All of the interviews were used, but classroom audio was only used to clarify the observation notes.

Pre-treatment. The week prior to the implementation of the mathematically-based story unit, the general atmosphere of the class and students' actions were observed for three days; additionally, interviews with the students and the teacher were conducted after the first three days of observation. The class had a lively atmosphere during mathematics with frequent use of the Smart board for checking answers and ample opportunity to work within groups selected by the students. The teacher employed a mixture of reform-based mathematics with traditional textbook work.

The elements of reform-based mathematics took the form of manipulative use for developing conceptual understanding (e.g. fraction pieces, money) and questions with multiple strategy possibilities. A collaborative atmosphere was created by the teacher through the use of large flip chart papers and markers being used by the students to display their strategies for a whole class discussion. Children were free to develop their own strategies of problem solving (PD#39, First week of observation, May 9-13, 2011).

Codes for pre-treatment observations, interviews, and classroom audio-recordings can be found in Table 3. There were 12 expressions of confidence during the pre-interviews made by the students. Some students expressed confidence about their overall ability in mathematics while other students expressed confidence in the depth of their knowledge about a specific numerical procedure such as multiplication. For example, Megan said she found multiplication and division pretty easy (PD#10, pre-interview Megan, May 13, 2011, 00:27.06). "When I do math, I actually really like it because I'm actually good at it. 'Cause I practice all the time at home. I do the times tables and I do division a lot." Aaron replied when asked to tell a little about how he felt about math (PD#6, pre-interview Aaron, May 12, 2011, 00:12.55).

Also, during the pre-interviews, students expressed their understanding of how they were able to use math in daily life. For example, when asked if she used math outside of school, Brittany stated "Sometimes for homework. Umm.(pause). And then ..umm..I would use it like if you were at the cash register and someone forgot to give you money or gave you too much money." (PD#4, pre-interview Brittany, May 11, 2011, 10:48.72). In Jordan's response, he included uses of math in the measurements for building houses, and angles for being able to hit a ball out of the park in baseball (PD#3, pre-interview Jordan, May 11, 2011, 03:55.39).

Prior to the implementation of the math story unit and the interviews, students' actions were coded from the observations most frequently (four times) as *animated during group work* found within the enjoyment component of attitude in the 5 days of coding. This was observed as discussing math with energy, being animated while using manipulatives, and chanting as a student did some work on the board for the class (PD#36, First week of observations, May 9-13, 2011).

Table 4
Code list and their frequencies from interviews and classroom observations. Emergent codes contain an asterisk (*).

Codes	**Pre (3 days)**	**Treatment (18 days)**	**Post (2 days)**
		Interest	
Connects context to life	4	5	0
Connects context to	0	0	0

life (negative)			
Direct statement*	0	4	0
Disinterest*	1	6	0
Distracted*	n/a	23	4
Making sense	4	18	0
Making sense (negative)	3	1	0
Enjoyment			
Animated during group work	4	27	0
Animated during group work (negative)	2	8	3
Direct statement*	2	8	0
Spontaneous talk	6	10	0
Spontaneous talk (negative)	0	2	0
Wants more time "to figure it out"	1	2	0
Value			
Content retention	3	0	0
Daily use	11	6	0
Daily use (negative)	3	0	0

Direct statement*	0	5	0
Confidence			
At ease speaking about mathematics	3	5	1
At ease speaking about mathematics (negative)	2	0	0
Direct statement*	12	1	0
Perceived ability	11	0	5
Perceived ability (negative)	5	0	2
Concentration*			
Engagement	n/a	8	0
Perseverance	n/a	18	n/a
Physical	n/a	23	n/a
Additional emergent codes*			
Chose to use concrete materials	0	2	0
GW_dislike	n/a	n/a	7
GW_personal development	2	3	0
Literature_enjoy	n/a	n/a	7

Teacher interview data pre-treatment. During the pre-interview with the teacher, she discussed the students with respect to the four components of attitude: interest, enjoyment, value, and confidence. She felt her students have engaged in ways of making sense of the mathematics, a subsection of interest, by critically analyzing their classmates' work, and asking questions throughout the class. With respect to enjoyment, students in her class have often asked spontaneous questions and made spontaneous comments during her class (PD#9, pre-interview Theresa, May 12, 2011, 21:07.60).

She stated that she does not require the students to raise their hands for every comment or question in order to create a more open communication between student and teacher. She called this 'interacting with the teaching within the class', not interrupting, and this is a foundational component of her teaching style as it appears in all of her classes (PD#9, pre-interview Theresa, May 12, 2011, 22:48.15).

When questioned about the value her students find in mathematics, the teacher mentioned a strategy that she uses to help students find the daily use of their math. She asks them to put their name into the problem in order to help them connect with the content better (PD#9, pre-interview Theresa, May 12, 2011, 05:13.40). She also reported that the students retain the content better when they feel personally connected to the material (PD#9, pre-interview Theresa, May 12, 2011, 11:37.48). Finally, the teacher explicitly stated the students were not confident with math when the year started, but she feels that they have become more confident since September (PD#9, pre-interview Theresa, May 12, 2011, 01:31.88). Once the pre-interviews with the students and teacher were complete, the mathematically-based storybook unit was implemented.

Treatment. Observations in this grade 5 classroom began in early May and continued for x-number of days. During the reading of the mathematically-based stories, students were given the opportunity to select their group members to solve problems associated with the story (PD#11, Audio-taped class, May 17, 2011, 23:37.16). However, in the latter part of the unit for the writing of their own mathematical story, students were told by their teacher that they should choose classmates with whom they don't typically work (PD#46, Observation notes, May 26, 2011).

The timeline depicted (see Appendix A) was followed closely with the exception of times when the classroom teacher was absent and a supply teacher was needed. The material for *If the World were a Village* was not presented as expected, but the pages of the story were used in the approximate manner outlined in the original unit plan. Due to the limited time of the teacher, only 3 days, instead of 5 days, were used for observation prior and after implementation of the story unit. On day 5 of the unit plan, Fosnot and Jacob's (2007) *Best Buy on Cat Food* was not used by the teacher as she felt the students understood the topic through the problems used and added an anecdotal problem of her own to assist the students in comprehending proportional reasoning. The timeline for the students to create their own story was longer than intended. In fact, students worked on their stories for 2 more weeks after the observations had ended because of their desire to make a complete book of the stories for everyone to take home with them.

Throughout the 18 days of observation of the unit implementation, the most frequently occurring code with 27 occurrences was *animated during group work* found in the enjoyment component of attitude, which is an average of 3 occurrences every 2 days which is similar in frequency to the pre-treatment phase. *Animated during group work*

was defined as lively discussions using mathematical discourse as well as an eagerness to assemble into their working groups when assigned a problem (see Table 3) (PD#46, Observation notes, May 26,2011).

Within the component of interest, the code *making sense* was noted 18 times. This was exemplified by students asking questions and discussing the math with their peers to understand it better. Megan indicated in a post-interview that she liked working with groups because it made it easier to clarify misunderstandings, "If you don't understand one thing, they can tell and help you." (PD#31, post_int Megan, June 13, 2011, 05:47.16).

While analyzing the recordings and the observation notes, some new codes emerged. My supervisor and I noticed an increase in prolonged concentration, both physical and perseverance was noticed leading to the creation of the new code. The most frequently occurring code was *physical–concentration* with 23 observations recorded. There is no comparison to pre-treatment of this code as it was introduced only during the students' math story creation portion of the unit. We noted that students concentrated on their work with pen to paper, eyes focused on their teacher, or reading their written material for their own stories (PD#48, Observation notes, May 30, 2011).

Post-treatment. In the last phase of observation, which was three days, the students had switched to using their math text as the primary resource, and it was the second week of June. After the completion of the storybook unit, I conducted interviews with the same original 8 students while the second researcher, my thesis supervisor, recorded classroom observations. It was noted that the most frequently coded action was *distracted* (PD#61, Observation notes, June 13, 2011). While discussing the unit in the

post-interviews, there were an equal number of occurrences of the new codes of *group work dislike* (gw_dislike) and *literature-enjoy*. Overall indication was that the students liked the literature unit, but there were some students that did not enjoy elements of the group work.

Teacher interview data post-treatment. During the post interview with the teacher, comments regarding the students' overall interest in the literature unit were positive with respect to their concentration on the work and their 'making sense' of the material. She indicated that she rarely had to speak to students about doing their work as it seemed that the class remained 'on task' for the majority of the unit (PD#64, Theresa, June 16, 2011, 07:11.09). She stated that even when a researcher stood right beside a group, the students did not pay attention to either researcher in the room. Students did their best to understand what they needed to do for solving problems associated with the stories as well as creating their own stories; however, the teacher remarked that, with the types of questions they were bringing for her clarification, the students had to be intensely involved in order to create such questions (PD#64, Theresa, June 16, 2011, 07:32.70). She believed the students enjoyed the work in the unit as they were "very into it." (PD#64, Theresa, June 16, 2011, 08:14.13).

The teacher mentioned some students threw out their first version of their story because the teacher proposed to publish the stories in a booklet. She felt this was an indication of the pride they took in their work and the enjoyment of the story writing (PD#64, Theresa, June 16, 2011, 08:34.01). One concern the teacher made was about the confidence exhibited by the students when she was in the room as compared to when she had a supply teacher for the day. She found there were numerous questions regarding

math upon her return. She felt these questions would never normally be asked when she was present.

Emergent codes. These emergent codes were discovered after analyzing the data. New sub-codes were established, and the data was re-analyzed for their frequencies.

Concentration. One code category in particular, *concentration*, appeared quite often within the observations. I determined that there were two different sub-codes needed to completely capture what was occurring during the class. *Physical concentration* was noted above all the other new codes occurring 23 times. At times, the classroom was completely silent as students worked with intensity. Some were focused on completing the illustrations while others were performing revisions and creating a new draft for review. I felt that physical concentration encapsulated these actions well as it is unclear whether the students were mentally engaged with what they were doing. It is possible to do an activity, which is physical and have the mind involved with thinking about another topic. Therefore, the *physical – concentration* code was considered the most appropriate for describing what was observed. For example, at one point during a class, I noticed that Jessica's group was re-writing their good copy and putting finishing touches on their illustrations. At the same time, Jordan's group was researching on the computer verifying details and finding better pictures for their story. There was no talking, but physical focus on their task at hand (PD#48, Observation notes, May 30,2011).

Perseverance – concentration was another code, which emerged from the observations occurring 18 times. Both researchers agreed that the students showed the

ability to follow through with the writing process intently. For example, Brittany, a student the teacher indicated as a lower-ability student, showed diligence through her continual revisions and her focus on the product over several days (PD#54, Observation notes, June 2, 2011;PD#56, Observation notes, June 6, 2011; PD#58, Observation notes, June 7, 2011). After students wrote their second draft, the teacher mentioned that she would like to publish the stories in a book for each student as well as possibly publishing them with a company. Students began throwing out their illustrations and changing their story in major ways. Brittany's group created a more, complicated plot (PD#33, post_int Aidan, June 14, 2011, 03:44.02). They also searched for images on the Internet to use in their story rather than their hand-drawn pictures. A few groups decided to type out their stories to make it look neater and more professional. Through all of this and a couple of days with a supply teacher, the groups persevered in order to complete their story.

Both researchers made observation notes to indicate students remaining on task and seemingly engaged, and this became a separate code, *engagement - concentration*. *Engagement-concentration* was noted 8 times. Katie stated "Even if it doesn't look like you're paying attention, maybe you're analyzing what she's [the teacher] saying, and you're trying to remember it." (PD#29, post_int Katie, June 13, 2011, 07:22.90). Aidan expressed engagement in the activity by working with a group member and "deciding if it's [the content in their story] good or not. Me and Brittany thought of it, like, does that really match the story" (PD#33, post_int Aidan, June 14, 2011, 03:14.40). There were no visible signs of these particular actions as they were cognitive and only able to be discovered during interviews. However, within the observation notes, when a researcher noted that anyone or any group "was on task," this was connected to this code. Based on

the forgoing discussion, the two new sub-codes under *Concentration,* namely physical concentration, perseverance, and engagement were added.

Distracted. An additional code was *distracted*. Although this comment reoccurred 23 times within the observations, 15 occurrences are attributed to one student. It should also be noted that the other 8 instances occurred in the second week of June. Thus, timing could have attributed to the frequency.

Direct statements. This code was created as there were direct statements made by students that expressed interest, enjoyment, value and confidence during the interviews that did not relate to any of the pre-existing codes. Seven out of the eight students expressed confidence in their mathematical ability in pre-interviews. Students reported by the teacher to routinely score lower on tasks given expressed confidence about some topics more than others, but stated outright that they had confidence in their abilities. Twelve of these confidence statements were made in the pre-interview process. One of the seven students, who had expressed confidence prior to the unit, had provided written comments on the post-questionnaire stating "I liked your storybook...It made me very confident in math." However, he did express difficulty in some of the group work.

Regarding direct statements of interest, when Megan was asked about her disagreement with the questionnaire statement "Math is boring" in a post interview, she responded, "I think it's fun because then you can concentrate on something and you're not looking at the clock. Because if it's too boring, the math question, then you are always looking at the clock." (PD#31, post_int Megan, June 13, 2011, 07:51.18). She had then had gone on to explain that she had experiences in her math classes in the

previous year where she found herself watching the clock. It's more fun which is why she said she understands math a lot better this year.

Group work dislike (Gw_dislike). There were three students interviewed who expressed difficulty in working with group members with seven comments related to this code. During the cumulative project of creating their own story, the teacher had asked the students to work with classmates with whom they normally did not work (PD#46, Observation notes, May 26, 2011). Aaron made the comment "Me and my friend would play around when we were working. This group was all serious and it was harder." (PD#38, post_int Aaron, June 15, 2011, 00:59.16). He had been the only boy with three girls in his group. He felt that these girls wanted to do all the work and did not want his contributions. He felt they disagreed with most of his suggestions and only permitted him to do one thing because "that's what they would want" (PD#38, post_int Aaron, June 15, 2011, 03:23.00).

Katie, as discussed in an earlier section, indicated that she did not like group scores because sometimes students went to other groups to talk and got a good mark due to her hard work. She felt doing group work all the time was not helpful for her (PD#29, post_int Katie, June 13, 2011, 03:15.33). The last of the three talked a lot about her dissatisfaction with the groups that were made. Within her group, Brittany was the only girl. The three group members were approximately at the same level of understanding in mathematics. This information was provided by the teacher. With this 'homogeneous' level group, there were many issues that came up during the post interview. The student felt the boys did not contribute as much because they were "talking about hockey the whole time." (PD#32, post_int Brittany, June 14, 2011, 00:49.55). Even though she

made efforts to get the group back on track, she stated that the boys wanted to continue to talk about hockey. This "limited peer support" was also cited the Kotsopoulos article (2010) as a drawback to group work as found by Sinclair (2005) (p.130).

Through the revision process, the teacher had suggested the students expand the depth of their parts of the story. This female student did not receive the suggestions for her part of the story, but her male counterparts were to make changes and "add more details" (PD#32, post_int Brittany, June 14, 2011, 03:07.39). She was frustrated because one of the male students had copied the details from her section of the story. "I wasn't very happy about that" she said (PD#32, post_int Brittany, June 14, 03:51.56). She revealed that she would love to do a story unit again, but only "if we got to choose our own group members." (PD#32, post_int Brittany, June 14, 2011, 07:29.80). Although a dislike of the groups they were working with emerged as a code, a positive aspect of the group work also arose.

Group work - personal development (GW_personal development). A more positive code related to group work surfaced in the interviews. The five comments indicated there was some personal benefit from group work. For example, Jessica, a higher achieving student as indicated by her teacher, felt that "I can help other people working on it. And.. um .. when I am doing it, I can make sure I have it all right for the future." (PD#7, pre-interview Jessica, May 12, 2011, 11:51.33). Also, Jordan stated "If I'm not sure about something, and that they have like..uh.. the wrong answer and I do it, I'm like "No guys, this is...this is the answer" and they're like "Oh!" and I'm like "That's how I got it" and it helps them and it helps me. So I like find out their way and they find out mine." (PD#34, post_int Jordan, June 15, 2011, 09:24.31). The general overall feeling

was that group work was helpful in assisting in test preparation, by teaching another student your strategy, or learning a new strategy from a classmate.

Literature enjoy. This code developed due to the responses received in interviews to the question "What did you think of the storybook unit?" Although an overall effect was not seen in enjoyment, five out of the eight students interviewed indicated their affinity for the use of the literature unit. "I really liked the stories, because they had something that had to do with math. And instead of just reading a story and afterwards the teacher making up the problems, she made up the problems as we were half way through the book and then we did them and we came back to the story to find out if our answers were right." Katie stated (PD#29, post_int Katie, June 13, 2011, 02:24.66).

David, a gifted student as indicated by his teacher, indicated that the stories "were good and all" and "made it [math] a little more interesting, but they were like the only interesting thing about math." (PD#35, post_int David, June 15, 2011, 06:22.29).

Numbers included in the treatment column include information provided by students during the post-interviews. These items were kept within the treatment column as they were comments regarding events which occurred while experiencing the implementation of the unit. Also, it is important to note that any coding of the teacher's comments was separated from the numbers in the table. The numbers in table 2 only pertain to the audio files related to the students, and observations made by the researchers.

Student cases. The previously described data gives a sense of the overall picture, but the classroom observations of individual students' reactions adds to the overall understanding of the study. The three students selected for more in-depth were Megan,

Aaron, and Brittany. Overall, Megan seemed to enjoy the unit more than she usually enjoyed math, but both Aaron and Brittany encountered issues with their respective groups, which appeared to interfere with their enjoyment of the culminating project.

Megan was a lower achieving student in math according to her teacher. She found math challenging when it came to certain topics like division, but expressed confidence with respect to topics such as multiplication (PD#10, pre-interview Megan, May 13, 2011, 00:27.06). Physically, both in height and weight, she seemed to be above the average size of the females in her class. At times during class, she yawned and seemed tired (PD#43, Observation notes, May 20th, 2011). She also seemed rather shy in her interaction with me during class observations and in interviews, as she was soft-spoken. During the group-work, both my supervisor and I noticed that Megan did not seem to be verbally contributing to the discussions much (PD#42, Observation notes, May 17, 2011; PD#45, Observation notes, May 25, 2011), and was frequently observed to be looking around the room and so on while her other group members carried the conversation.

Both observers (my supervisor and I) felt she didn't seem engaged in the material; however, in a post interview, she indicated that she did in fact enjoy the group work because it allowed her to get help with confusing aspects of the math and see others' strategies (PD#31, post_int Megan, June 13, 2011, 05:47.16). For example, she claimed she enjoyed being able to work more with fractions in her story as it made her feel more confident when her cumulative project was finished (PD#31, post_int Megan, June 13, 2011, 01:23.54). She stated she thought the whole unit was fun (PD#31, post_int Megan, June 13, 2011, 02:22.18), but thought the making of her own math story

with her group was easiest (PD#31, post_int Megan, June 13, 2011, 03:47.00). She found that this was so interesting to her that she was not preoccupied with looking at the clock the whole time (PD#31, post_int Megan, June 13, 2011, 07:51.18) which she said she had done in her previous year's math class because she said she didn't understand as much as she has this year. Overall, Megan stated she felt more confident with certain topics in math that she hadn't prior to the start of the unit and liked the unit.

Aaron was an average achieving student in math according to his teacher. He was outspoken with his opinions during group work (Observation notes, May 17, 2011; PD#42, Observation notes, May 18, 2011). He often raised his hand to answer questions in the classes observed (PD#39, Observation notes, May 13, 2011). He expressed confidence in his abilities with respect to math during the pre-interview (PD#6, pre-interview Aaron, May 12, 2011, 00:12.55). He indicated in his pre-interview that he had a strong sense of the connection of math to his everyday life (PD#6, pre-interview Aaron, May 12, 2011, 00:53.29; PD#6, pre-interview Aaron, May 12, 2011, 02:08.66) and to the life of others (PD#6, pre-interview Aaron, May 12, 2011, 03:02.87). Aaron enjoyed the idea of helping his peers during group work when working with his friends because he stated it could help clarify his errors and help others (PD#6, pre-interview Aaron, May 12, 2011, 10:32.24). Interestingly however, the potentially positive response of Aaron to the unit appeared to be significantly affected by the group composition aspect. During the reading of the stories, Aaron had worked mostly with his friends (PD#39, Observation notes, May 13, 2011; PD#40, Observation notes, May 17, 2011; PD#42, Observation notes, May 18, 2011), but, during the cumulative project, he was grouped with three girls (PD#46, Observation notes, May 26, 2011). In his post-interview, he stated that working

with this group was harder (PD#38, post_int Aaron, June 15, 2011, 00:42.12), because his group members did not agree with him [in terms of what he wanted to do] (PD#38, post_int Aaron, June 15, 2011, 02:34.26).

Aaron indicated that he was delegated to do one thing because it's what they wanted (PD#38, post_int Aaron, June 15, 2011, 03:07.59). He felt the story could have had more details and have included more complicated math (PD#38, post_int Aaron, June 15, 2011, 04:51.56; PD#38, post_int Aaron, June 15, 2011, 05:50.64). Overall, he thought it was interesting to make the book (PD#38, post_int Aaron, June 15, 2011, 09:14.09), but the book created by his group was not "his kind of book" (PD#38, post_int Aaron, June 15, 2011, 14:22.27).

Brittany was also a lower achieving student in math according to her teacher. She stated that she didn't really understand math and didn't feel she was able to get answers to her questions in a timely manner during class time (PD#4, pre-interview Brittany, May 11, 2011, 00:34.17). She liked fractions, multiplying and division, but did not like doing word problems (PD#4, pre-interview Brittany, May 11, 2011, 01:07.61). She indicated that she was not a strong French reader, which was why word problems sometimes provided difficulty for her (PD#4, pre-interview Brittany, May 11, 2011, 01:34.36). She made few connections to using math outside of school (PD#4, pre-interview Brittany, May 11, 2011, 10:48.72). During the reading of the stories and related problems, Brittany grouped herself with her friends and was often noticed doing activities that were not related to the current math task (PD#42, Observation notes, May 18, 2011; PD#45, Observation notes, May 25, 2011). During the cumulative project, she was grouped with two boys (PD#46, Observation notes, May 26, 2011). In her post-interview, she

indicated that she had a great deal of trouble with her group who talked "about hockey the whole time" (PD#32, post_int Brittany, June 14, 2011, 00:49.55). When asked to add more detail to the story, she stated that she had done a good job, but her group members had not added sufficient detail to their parts of the story (PD#32, post_int Brittany, June 14, 2011, 03:07.39). Despite her difficulties with her group, she felt pride in the story that was created (PD#32, post_int Brittany, June 14, 2011, 06:14.17). Brittany said she would love to do the same kind of unit again, but would like to choose her own group (PD#32, post_int Brittany, June 14, 2011, 07:15.33).

Teacher perceptions of the effect of the unit. The teacher liked the unit overall. She felt the students learned a lot and used proper inquiry skills "as is needed in math" (PD#64, Theresa, June 16, 2011, 01:30.01). She did feel that the unit alone could not be used as solely to cover a topic, and some "teaching" would be required (PD#64, Theresa, June 16, 2011, 01:42.30). However, she stated "it would be very much less than most people have been doing." (PD#64, Theresa, June 16, 2011, 01:51.14). She stated the unit made the problems more "real." Her feeling was that the students could "figure out solutions much better when they [the students] can associate it [their solution] to a story." (PD#64, Theresa, June 16, 2011, 02:17.71). The teacher indicated the overall effect of the unit was positive. In her opinion, the students demonstrated interest, enjoyment and pride in their work throughout the implementation of the stories and the creation of their math stories.

The culminating project became a book with all of the students' stories. She was impressed by the amount of detail included by the students and their serious attitude toward the project. She stated "It proves that math cannot be taught without the inclusion

of literacy." (PD#64, Theresa, June 16, 2011, 00:41.91). When the unit was presented to her with the conclusion of a story to be written, she believed that the stories would be maybe 1-2 pages in length, but the resulting stories were much longer than she expected. She expressed that the students were very happy with final result (PD#64, Theresa, June 16, 2011, 01:03.09). Overall, she felt the unit was effective based on what she had assessed thus far.

Chapter 5

Discussion

Importance of Studying Attitude. Overall, attitude has been linked to achievement (Tapia & Marsh, 2004). It is important to study attitude as it provides the educational field with another option for improving and measuring achievement in students, but its importance is not limited to achievement (Papanastasiou, 2000). Sub-components have been examined in attitude such as the ones examined in this study: interest, enjoyment, value, and confidence (Simon & Schifter, 1993). Although difficult to define, the sub-components are addressed in pre-service education as important components of planning in any subject. However, many teachers find these particular aspects difficult to infuse into their mathematics class. Thus, this research attempted to examine a possible effect on the attitude of the students in this junior class towards mathematics with the use of mathematically-based stories and problems that encouraged multiple strategies for solving.

Quantitative results. The quantitative results did not show either a positive or negative effect on the attitude of the students towards mathematics. The t-tests did not reveal any significant result overall. This may be due to the fact that the questionnaire from Simon and Schifter (1993) was not a reliable instrument since the instrument was created for the sole purpose of their research, but no reliability or validity testing is mentioned. It may also be that the students had an overall positive attitude to begin the unit as their teacher used alternative methods of instruction from time to time (Theresa, 5:54.9, May 12, 2011). It could be that the mathematically-based stories did not affect the students' attitudes.

Sample size. The sample size of this study was originally 33, but dropped to 17 due to circumstances beyond the control of the researcher. The sample size may have affected the significance, or insignificance, of the questionnaire results. With a larger sample size, it could more accurately be determined if attitude was affected by the mathematically-based story unit as was the case with the large sample size in the Simon and Schifter (1993) study producing a positive change in attitude toward mathematics.

On the other hand, the class already had a very positive attitude toward mathematics, and there might have been little room for improvement in their attitude. It is important to note that this class was chosen because the teacher was willing to participate in the study. The teacher, herself, liked mathematics and was active in a local mathematics educator group. This is mentioned to highlight that the students seemed to already have a healthy attitude toward math possibly due to the teacher's enthusiasm toward the subject matter. Thus, the fact that no change was seen quantitatively is not necessarily indicative of a poor attitude towards math. In fact, looking at the numbers, it is appears that the majority felt positively toward mathematics before and after. The survey results quantitatively demonstrate that there was no negative impact to their attitude because of the implementation of this mathematically-based story book unit. It may be that implementation of the unit in a classroom where students have a poor attitude toward mathematics would have had different results.

A comparison with the same group during an earlier unit, or with another class covering the same topic would have provided additional information for a clearer picture. However, due to the length of the unit (6 weeks), scarcity of teacher research volunteers, timing for ethics approval, and the limited time of the masters program, a single unit,

single classroom study was conducted. However, I feel this study would be a helpful starting point for further research.

Qualitative results. While there was no measureable difference over time in the quantitative data, the interviews provide a more nuanced picture. Prior to commencing the unit, students were asked about their feelings about mathematics. All of the students interviewed reported liking mathematics. Some mentioned they liked particular topics such fractions, multiplication or addition. These qualitative results coincide with the quantitative survey results. After the unit was completed, most students, when questioned about changes in their feelings from the previous interview, replied they believed that they did not answer anything differently. These results are also found to be reflective of the survey results found in Table 2. Thus, in the case of overall attitude, both the qualitative and quantitative information concur that there was neither a positive nor a negative overall change in attitude toward mathematics based on the study. This again could be attributed to an overall positive attitude towards mathematics from the beginning as mentioned previously.

Components of attitude in mathematics class.

Interest. The component of interest did not show much change from the first questionnaire to the last questionnaire. There was no positive or negative impact portrayed by the quantitative results. However, this does not indicate that there was no interest in the unit implementation. The numbers show a relatively high overall interest in mathematics by this class to start, so the unit didn't increase their interest or decrease it; so it remained relatively stable. However, the quantitative results do not provide much information as to how the students interacted with the material from this unit.

In the interviews and the observations, a clearer picture of the students' reaction was illuminated. Within the qualitative information, interest was coded in the study with the codes: *connecting the context to life*, and *making sense of the material* presented. In pre-interviews, only two students mentioned the connection of mathematics to their daily life.

Jessica mentioned she "found it easier" when the problem involves "something I do every day". "I find it a lot easier if it uses something I do every day," she stated (PD#7, pre-interview Jessica, May 12, 2011, 03:59.09). Megan stated the teacher made efforts to help the students connect the math to their daily life by asking them to substitute their name, or a familiar name to them, in the problem given (PD#10, pre-interview Megan, May 13, 2011, 09:05.31). Another example of something she found interesting was when her teacher used "le mod" and "la mode" as a comparison to assist students in remembering the definition for the mathematical term, mode (PD#10, pre-interview Megan, May 13, 2011, 05:18.32). This student thought the teacher's comparison made "math more interesting". She also mentioned that she liked that the teacher did "things that were not the same as all the other teachers."(PD#10, pre-interview Megan, May 13, 2011, 05:46.44). All of these comments help support that the interest level for this class was relatively high prior to the unit implementation.

During post-interviews, two students mentioned connections they made to their life. Megan expressed a deep, personal connection to the story written with her group members for the cumulative project. The story was about a fire and people being rescued from it. She confided that her father would have probably rescued the people in the story "in the same way" since he had been a firefighter "if he was still alive" (PD#31, post_int

Megan, June 13, 2011, 00:34.12). Katie spoke of a clearer connection between the need for mathematics in jobs. She spoke of cashiers, carpet layers, carpenters, teachers, and "a lot of other jobs" (PD#29, post_int Katie, June 13, 2011, 08:25.65). She also made this realization that came to her during the unit when she thought "my answer to that question (about needing math for your job) was wrong on the last questionnaire she (the researcher) gave us." (PD#29, post_int Katie, June 13, 2011, 09:26.63). She recognized a link with fractions and money after discussing different jobs and money earned during the class in relation to the stories. She had never considered money to be fractions and could now see that fractions were used every day (PD#29, post_int Katie, June 13, 2011, 09:47.12).

Students also tried to make sense of information presented by asking questions in class and discussing it with their peers. Although students made comments about the ways in which they try to understand the information presented in mathematics class in the pre-interviews, it was clear through multiple observations during the unit implementation by both me and the second researcher, my thesis supervisor, that students were actively making sense of the material. There were observations such as "hand waving to answer the question" (PD#39, Observation notes, May 9, 2011; Jenner & Anderson, 2000), "lively discussion – equivalence" (PD#39, Observation notes, May 10, 2011; Lewis, 1993), students "actively working out it (the answer to the question posed from the teacher about the story) verbally" with partners (PD# 42, Observation notes, May 18, 2011; Margerm, 1999), and two students blurting out the same question while a group is presenting their final story project (PD#58, Observation notes, June 8, 2011;

Bintz & Delano Moore, 2003; Jenner, 2002; Whitin & Gary, 1994). These students were involved in their comprehension, which shows definite interest.

Distracted. Although there were 23 occurrences of this code, as indicated in the results, 15 can be attributed to one student. This student was a girl who often was recorded as "colouring on her notebook" (PD#39, Observation notes, May 13, 2011), "picking at nails" (PD#58, Observation notes, June 8, 2011), "picking at skin" (PD#51, Observation notes, June 1, 2011), "mostly played with her calculator" (PD#40, Observation notes, May 17, 2011), and "plays with lid of milk container" (PD#60, Observation notes, June 10, 2011). She did not seem to have any close friends in her class as she was often seen alone at lunch and working alone during class (PD#39, Observation notes, May 13, 2011; PD#40, Observation notes, May 17, 2011). She made frequent trips to the bathroom (PD#40, Observation notes, May 17, 2011) and often did not contribute verbally to assigned group work in math (PD#44, Observation notes, May 24, 2011). During math conferences, where groups of students show the class their strategy that was used to solve the problem, she often stood to the side of her group as they present and looked anywhere else but at the class. This student was not interviewed, so more in-depth comprehension of this student's action could not be determined.

Another point that may have assisted in the frequency of this code is the timing of the unit. As the final 2 weeks of the unit were during the month of June, it is possible that the fair weather and the ending of school could have caused certain students to be "wandering around" (PD#59, Observation notes, June 9, 2011) or "playing with the meter stick" (PD#54, Observation notes, June 2, 2011) much more than during the month of May.

Enjoyment. Sometimes interest and enjoyment can seem like the same concept or expression when observed. Within this study, the codes that we recognized as *enjoyment* were spontaneous responses during or immediately following the story, animated during group work and desire to continue work after class is through. Within the questionnaire results presented in figure 1 and 2, there is a slight drop in the enjoyment toward mathematics. When students were questioned in the post interviews about their enjoyment toward mathematics after the completion of the unit, three of the eight students interviewed mentioned issues that they had with either working in groups continuously or the group composition for the final project. Katie who was excelling academically at mathematics felt that working in groups continuously was difficult for her. By working in groups continually, she felt she was not able to gauge her own progress as well as if she had been judged individually for her work. "When you work in groups all the time like we were doing again today, it kinda gets hard ... when you get stuck in a group of people who either go to a different group and start talking or someone who doesn't do the work, it's like they're getting graded for what you did instead of what they did." (PD#29, post_int Katie, June 13, 2011, 03:15.33). These comments were echoed by Brittany who felt that her group members were not contributing as much as they should. She felt her group members were more interested in discussing hockey than working on the cumulative project (PD#32, post_int Brittany, June 14, 2011, 00:49.55) . She felt it was mostly her responsibility to keep the group on track (PD#32, post_int Brittany, June 14, 2011, 01:03.53). Aaron mentioned he was normally an equal partner with students with whom he normally worked (PD#38, post_int Aaron, June 15, 2011, 03:07.59), but did not find himself an equal partner in the final project. However, the

cumulative project group was a different composition, and he felt his opinion was not valued. Thus, he did not enjoy the cumulative project time as much as the rest of the unit.

As found in other research (Kotsopolous, 2010), groups and their composition had an effect on the results of the enjoyment of the unit. These groups were seemingly designed as collaborative learning environments which are defined by Kotsopoulos as environments which:

> "allow all students to participate in meaningful ways, generate opportunities for students to learn from one another in ways that enable individual students to move along in their own continuum of learning, have individual accountability where knowledge and skills acquired will be necessary for future learning or will be assessed in some way, include group-level academic accountability (i.e., assessment of common academic goal), have social accountability in that individual students are concerned with other students' individual learning, and are centered around academic goals" (pp. 129-130)

However, as can be noted in the examples from the interviews above, at times, students felt that they were neither able to participate in meaningful ways (as in Aaron's case) nor were they able to learn from one another in ways that enabled them to move along in their own continuum of learning as was Brittany's case with the lack of contribution from her group members. In Katie's case, her case seemed to indicate a lack of individual assessment that she craved rather than always the group-level assessment. It may be that there would have been measurably different effects if there had been different compositions of groups as well as methods of assessment.

While some students may have enjoyed the unit more had there been different groupings there was nonetheless a great deal of student engagement. In the results section, it was reported that 27 occurrences of 'animated during group work' were recorded in the course of the study. It should be noted that I felt there were many more occurrences of this code than was possible to record. At times, during the class audio-recordings, there was so much discussion in the groups that it was difficult to decipher who was speaking and whether the animated discussion had been recorded in reference to the specific group speaking within the observation notes (PD#13, Audio-taped class, May 19, 2011, 01:51.02). However, there was definitely much animated discussion during group work throughout the unit.

An example of a direct statement related to enjoyment, stated in a pre-interview with Brittany who described the parts of math she liked: fractions, multiplying and division (PD#4, pre-interview Brittany, May 11, 2011, 01:07.61). Megan expressed enjoyment within the unit writing on her questionnaire "I loved doing the math story because it gives you the chance to do the math that you like best or improve the types of math that you are not good at." (PD#31, post_int Megan, June 13, 2011, 01:23.54). Aaron wrote on his questionnaire that he liked the storybook unit, but he "had some changing moments" (PD#38, post_int Aaron, June 15, 2011, 00:31.85).

Literature enjoyment. In post interviews, students were asked about their feelings regarding the mathematically-based storybook unit. Five out of eight of the students explicitly stated they thought using the stories was "fun"(PD#30, post_int Jessica, June 13, 2011, 01:25.75), " a little interesting" (PD#35, post_int David, June 15, 2011, 06:22.29), and "would love to do it again."(PD#32, post_int Brittany, June 14, 2011,

07:29.31) Katie stated it made the math "easier to understand" (PD#29, post_int Katie, June 13, 2011, 01:37.00). It is clear from these statements that using storybooks in mathematics is a definite tool for teaching as it obviously provides enjoyment to some students.

Value. This aspect of attitude did not appear to be impacted by the mathematically-based stories. To see a change in this aspect would have been a surprise as it scored quite high prior to implementation and remained high after completion. This group of students connected mathematics with its uses outside of school, at work, and the importance of continuing to study math until their school career was completed. Jordan stated, "life is based around math." (PD#3, pre-interview Jordan, May 11, 2011, 03:22.09). He used examples to illustrate his point such as building a home, playing sports, and working at any job. This was in an interview prior to the unit, which exemplifies the class' strong link between math and its utility inside and outside of school. With such solid comprehension of the value of mathematics prior to the unit, to see an effect from the stories and their cumulative writing project would have been difficult to obtain with the score being so close to 100%. Furthermore, within the results for value, the majority of the students also recognized the importance of being able to do math without technology. There were responses from before and after indicating the need to be able to do mental math in case technology failed.

The responses for value were all from the interviews. The two qualitative codes, the retention and use of mathematics in daily life, were not observable in the class. Therefore, the questions related to these codes had to be pointedly asked within the

interviews. As a result, the responses from students that weren't interviewed came only from the questionnaire.

No direct statements of value were heard in the interviews or during the class discussions. The comments made in connection with value were linked to the daily use of mathematics.

Confidence. Due to the slight increase in the overall confidence score from 2.36 in the pre- to 2.57 in the post questionnaire (see Table 2), I did a separate t-test to check for significance as was done in Simon and Schifter (1993). Confidence revealed a small, statistically insignificant, change. With such a small sample size, the change in confidence was not statistically significant, but, with a larger sample size and further research, this aspect has potential for an effect to be seen with mathematically-based stories.

With the code, *at ease speaking about mathematics*, both Jessica and Katie, during their pre-interviews explained they liked explaining their solutions to others (PD#5, pre-interview Jessica, May 11, 2011, 04:09.70; PD#7, pre-interview Katie, May 12, 2011, 02:57.19). While observing the class prior to implementation of the unit, there were 4 instances in which multiple students had their hands up wanting to answer questions (PD#39, Observation notes, May 9, 2011; PD#41, Observation notes, May 17, 2011; PD#44, Observation notes, May 24, 2011; PD#48, Observation notes, May 30,2011). These were interpreted as *confidence*, because it was thought that if they were not at ease speaking about mathematics they would not raise their hand to speak. Also, observed prior to implementation, Aidan blurted out "Can I answer this one?" (PD#42, Observation notes, May 18, 2011). It too was added to this category for obvious reasons.

In post interviews, Megan, a lower ability student according to her teacher, indicated an increase in confidence due to the story that her group had created because it had allowed her to improve her ability in working with fractions (PD#31, post_int Megan, June 13, 2011, 01:40.00).

However, as with value, perceived ability for the confidence aspect of attitude could only be ascertained by asking the students directly. During interviews, students were questioned about their responses to the questionnaire before and after. Prior to execution of the mathematically-based stories unit, six of the eight students interviewed relayed confidence in their ability regarding mathematics in general (PD#2, pre-interview David, May 11, 2011, 02:11.61; PD#6, pre-interview Aaron, May 12, 2011, 00:12.55). and/or referring to specific strands as well as standard operations such as division and multiplication (PD#7, pre-interview Jessica, May 12, 2011, 15:12.11; PD#3, pre-interview Jordan, May 11, 2011, 12:32.26; PD#10, pre-interview Megan, May 13,2011, 03:11.61; PD#5, pre-interview Katie, May 11, 2011, 01:05.26). In post interviews, most students' confidence had not shifted and had remained positive. Megan in particular had raised questions regarding confidence during observations. She had appeared tired, was passive in her participation and often looked disinterested in the task at hand. When interviewed, she had expressed a rise in confidence, as stated earlier, about her ability to do fractions (PD#31, post_int Megan, June 13, 2011, 01:40.00). She had explicitly stated that she had a chance to work more with fractions within the story that her group had created. She had indicated "I liked it [working in groups] because then if you don't understand one thing ..uh.. some of the other people who are better at it can explain it to you." (PD#31, post_int Megan, June 13, 2011, 05:44.74). She expressed feeling more

confident overall about fractions after this experience. This was an interesting note as an educator because the student seemed to learn passively and still claimed to have become more confident as a result. However, her passive participation and increase in knowledge about fractions does find some support in the literature. Lave and Wenger (as cited in Kotsopoulos, 2010), suggested that "participation at the periphery is sufficient at the onset of collaborative learning and a bare minimum for a student to be able to acquire knowledge and skills." (p.130).

Emergent codes developed. As mentioned in the results, a number of new codes were developed during the process of the study.

Concentration. Two different sub-codes, *physical concentration* and *perseverance*, were noticed to occur with some frequency. Although physical concentration can occur in any math class doing procedural or fluency activities, students in this class were re-writing stories or perfecting their illustrations, but it wasn't clear how much mathematical thinking was occurring during their work time (PD#54, Observation notes, June 2, 2011; PD#57, Observation notes, June 7, 2011). They were focused on the physical activity of writing or drawing. *Perseverance – concentration* was frequently noted. The students did not seem to lose any drive for completing their projects by continually working during the time given to them (PD#48, Observation notes, May 28, 2011; PD#57, Observation notes, June 7, 2011). The students received peer feedback, and had two feedback sessions with the teacher, but the critical feedback on their stories did not seem to have an effect on their enthusiasm for the finished product. *Engagement-concentration*, as indicated in the results section, was not as easily discernable as the other two new codes, so my thesis supervisor and I deemed any of the

"on task" observation notes as engagement. At times, students were analyzing and deciding on information, and most certainly engaged in the material at a cognitive level (PD#33, post-interview Aidan, June 14, 2011, 00:14.40). We noted these observations as "on task" because they were doing work related to the creation of their story that was not exactly visible, such as thinking. It demonstrated that there are processes at work that a questionnaire, observations, and audio cannot pinpoint.

With the total of 49 occurrences under the category of concentration indicated in Table 3, it must be transparent the focus of the class in the last 2 weeks for the cumulative project was very productive. Students worked diligently at their tasks and stayed on track for the timeline set by their teacher.

Group work dislike (Gw_dislike). As indicated in the results, a definite dislike for creating a project with unfamiliar working partners was mentioned in the interviews by both Brittany and Aaron ((PD#32, post_int Brittany, June 14, 2011, 00:49.55; PD#38, post_int Aaron, June 15, 2011, 00:59.16). I noticed that prior to the implementation of the unit these students would work in same-gender groupings. However, with the suggestion of the teacher to work with people they hadn't worked with before, mixed-gender groupings, as opposed to same-gender groupings, were more prevalent for the cumulative project. Having groups that were not their first choice seemed to have created a few problems for students. It is unclear whether these problems arose from the mix of the gender or the lack of choice in partners. Webb (1997) found that "teacher-selected versus student-selected groups suggest that teachers' efforts to form mixed-gender groups were at odds with students' preferences for same-gender peers as grouping partners."

(p.102). Clearly, a few problems did arise in the groupings that were not student-selected which may have affected their attitude toward the mathematically-based storybook unit.

With such strong emotions related to the group work and only eight of the students interviewed, it is unclear whether other groups had the same issues as the groups mentioned throughout the interviews. There were two groups of six that had no participants interviewed. One of these two groups had the student that was often indicated as distracted. The group composition definitely had an effect on the attitude of the students toward this mathematics unit. Therefore, the group composition should be carefully noted for future research as it might have a lasting effect on the attitude towards mathematics and did appear to have an influence on the results of the current study.

Group work personal development (GW_personal development). Personal development was a benefit of group work mentioned by 4 students both before and after the unit implementation. In a pre-interview, Aaron said it was helpful to discuss with your classmates your strategy (or lack of one) to solve the given problem because "you get to help each other... When you're helping each other, you learn stuff at the same time." (PD#6, pre-interview Aaron, May 12, 2011, 10:32.24). He continued on to say he was able to find a mistake in his work while helping another student with their work. Jessica enjoyed the aspect of being able to help other people with work in which she already felt confident. She thought it helped her by "making sure I had it all right for the future." This same student, in a post interview, expressed a great deal of pride in her group's final story. "It felt good to show everyone how hard we worked on it." (PD#30, post_int Jessica, June 13, 2011, 02:02.42). In another post interview, Jordan spoke about his enjoyment while working with friends. He stated "I like finding out their ways [to

solve a problem] and them finding out mine." (PD#34, post_int Jordan, June 15, 2011, 10:31.41). He only spoke about working in groups with his friends and did not mention the group that worked together on the story. What is left out of his comment alludes to the fact that he prefers to work with his friends because he feels they have a good relationship and he can learn more.

Student cases. Much of the student cases were discussed within the discussion of the codes. Due to this, an overall sense of their journey is discussed here. It is important to note that I have taken the responses of the students as honest representations of their experiences, thoughts and feelings. Also, prior to their interviews, the students were reminded that their comments had no bearing on their grade and would not be heard by their teacher. They were asked to respond as honestly as possible. However, it is still possible that students have misrepresented themselves in their interviews to provide what they think I want to hear as the researcher.

The response of Megan to the unit was surprising. Basing a judgement on the teacher's assessment of her as a lower achieving student, combined with the observed lack of visible participation and engagement in the unit, it might have suggested that this student did not have a positive reaction to the unit. In fact, Megan's claims during the post-interview described her response to the unit quite differently, especially as compared to her usual or previous typical response to math class. Megan claimed she had overall a positive experience with the unit (compared with other experiences in math) and indicated she felt more confident working in groups and learning from others in the small group setting. Her experience is an excellent reminder that student responses must not

only be compared to their typical classroom response, but also viewed from their own point of view and not only what is visible to an observer.

Aaron also enjoyed the unit overall. However as a high-achieving student who generally demonstrated good participation in math, this may be true of his other experiences in math as well. Aaron is a student whose response to the group project component of the work did likely effect his enjoyment as well as the quality of work he was able to produce. For example, when he stated that he felt the story should have contained more challenging mathematics, he implied that in fact the group composition did not allow or challenge him to work to his potential. Although the issue of mixed gender versus homogeneous groupings is beyond the scope of this study (Linchevski & Kutschener, 1998) Aaron's case provides an example of how critical this component may be to consider in future studies. Aaron claimed he had difficulty with his group as will be discussed further under the code Group work dislike (Gw_dislike).

Brittany's story echoed that of Aaron's, in terms of her response to the group composition. Brittany claimed she enjoyed the unit and would love to do the unit again, but only if she was able to choose her group members herself. Megan on the other hand, did not appear to be particularly engaged during the group aspect, yet she claimed she enjoyed it much more, as well as learning more, than she usually did math. These various cases illustrate the conflicting impact of the group composition factor on the students' experiences with the unit. In particular, the culminating project part of the unit, the creation of students' mathematical stories, might best be re-thought for future implementations of the unit. It is important to note that their self-reports were taken at face value. It is possible that the students may have stated what I wanted to hear, but they

were advised prior to the interview that their teacher would not be privy to the recording and asked to be as honest as possible.

Teacher perceptions. The teacher indicated that one of the unexpected effects of the unit was the coverage of "character education" (PD#64, Theresa, June 16, 2011, 03:36.92). This was not an intended inclusion, but it emerged as an area that she did not expect to cover with the storybook unit. She stated that "the students had to work together, talk about their differences, compare their opinions, and explain to each other where they were coming from." (PD#64, Theresa, June 16, 2011, 03:43.00). One of the drawbacks of the unit was the time dedicated to the unit for the number of curriculum expectations needed to be covered in any given year. She felt the depth of the coverage of the unit was good, but, with the breadth of the curriculum, she felt rushed to complete two other mathematics topics in order to adequately meet the curriculum expectations for the year (PD#64, Theresa, June 16, 2011, 04:03.13).

Future research. The teacher in this case was regarded as confident in mathematics and in using a variety of tools to convey material to her students. She normally integrates mathematics cross-curricularly and makes every effort to draw connections to the students' live. Therefore, many aspects of this unit may have not had the impact intended due to the familiarity of novel techniques employed regularly in this class. Using a teacher who may be less confident in mathematics, and/or more traditional – strictly using textbook material – in her daily practice might have produced slightly different results.

This class also seemed to have a positive attitude towards mathematics from the beginning. Thus, it would have been difficult to make an enormous change in their

attitude towards mathematics. In subsequent research, it might be important to select a class that has significant numbers of students who either struggle with mathematical concepts and/or have a distinct dislike for mathematics. Comparing the class to another class covering the same topics could have also provided interesting results, however this would have been a challenge as teachers tend to progress through their strands at differing speeds. It also was not the intention of the study to do a comparative analysis, but to do a case study to investigate the possibility of attitude towards mathematics being altered with the involvement of literature within a mathematics class. Additionally, it might have also been helpful to see the same group cover another topic, but the timing of the clearance of research and board ethics did not provide adequate time to enter the classroom earlier. This study did not specifically investigate the differences between the gender or ability levels. Achievement was assumed to be linked with attitude as supported by the literature review. Further investigation into these topics was beyond the scope of this current study.

Due to the limited time frame and the limited number of teacher volunteers for classroom research, as well as the volume of data involved in a study such as the current one, it would have been difficult for me to conduct a study of more than one unit, or in more than one classroom .

Chapter 6

Conclusion

The purpose of this study was to investigate the effect that mathematically-based stories had on the attitude towards mathematics of junior students. A case study was conducted with 17 grade five students during a 5-week unit involving mathematical stories. Questionnaires, observations, and interviews were used to describe a more holistic picture of the effect of the intervention. The teacher's perspective on the effect of the mathematically-based stories unit was also explored. Finally, the creation of a new French as a second language resource was developed.

The examination of the students' attitude towards mathematics with a written survey took place before and after the implementation of the unit by using the questionnaire that was developed by Simon and Schifter (1993). After comparing the response to the two sets of questionnaires, the results seemed to reveal no change, negative or positive, in attitude towards mathematics. The survey measured attitude as an aggregate of the four components of attitude: interest, enjoyment, confidence and value. These results did indicate a possible change in confidence that could be explored in further research.

Although this study did not show a statistically significant change in attitude quantitatively, there were a number of positive occurrences that were observed and discovered through interviews. The initial results of the questionnaire indicated that the class had a positive attitude to begin, and hence it would have been difficult to improve it significantly. Through these interviews and observations, the students indicated an overall positive attitude towards the mathematically-based storybook unit as was the case

with Megan, Aaron, and Brittany. Students stated explicitly they enjoyed the unit, but some had encountered some problems with the grouping of unfamiliar partners. It was unclear whether these problems developed due to the mixed-gender in the groups or due to the fact the groups were not student-selected. The grouping issue was not considered when planning the unit.

The fact that the groups were not chosen by the students themselves, as per the usual routine, was a detail that caused issues for Brittany and Aaron, in particular. The response of the students to the group composition appeared to affect the study in an unexpected way. As an unanticipated outcome of the study, it is thus recommended to carefully consider the composition of student learning groups when planning an intervention, since evidence was gathered that the group composition substantially affected the outcomes.

The teacher's perceptions of the effect of the unit were examined with respect to her evaluation of the unit as a teaching tool. She did indicate that the lack of French as second language resources was the reason she used many anecdotal stories rather than actual storybooks in her class, but did enjoy using the stories as they seemed to "engage the students". She deemed the unit to be effective at "making the math more real" for the students. It would be her wish to use more of these stories if she could find French language mathematically-based stories.

The unit performed as expected by guiding the teacher in introducing the topic, stimulating discussion, offering the opportunity to share ideas in group work, and creating alternative assessment opportunities for the teacher. It also created a viable resource for this teacher, and others, to use at a later date. The unforeseen factors of

learning group composition, as well as timing of the unit, sample size, the copious amounts of data, and the teacher/class combination did influence the results of this study. These would be points to contemplate if pursuing further research as a follow-up from the current study.

I found that the use of mathematically-based stories in junior math class could be a viable tool for any teacher as it was enjoyed by the students as well as the teacher. I used the Simon and Schifter (1993) instrument conservatively to gain a preliminary understanding of the class attitude, to inform my semi-structured interview questions and to provide a final glimpse of the typical attitude towards the mathematics unit, although it did not reveal any significant change in attitudes. However, an unchanging overall attitude measured quantitatively does not mean that the unit didn't alter the attitude of a select few students as the qualitative data indicates. For example, Megan did indicate she felt confident in certain strands of math in her pre-unit interview, and the topic covered in this unit was not among them, yet she expressed greater confidence due to the stories unit. However, it is not possible to know whether Megan always felt low at the beginning of units and high when she felt mastery of units, as this was not a question asked of her. Without interviewing all of the students in the class, it is not possible to tell the impact that the mathematically-based stories had on the other nine students' attitudes. It is also possible that if this class had not had such a positive attitude towards mathematics from the outset, more substantial positive change would have been seen in their overall attitude similarly to the Simon and Schifter (1993) study.

During many of the pre-interviews, the students indicated that their teacher was different from other math teachers that they had in the past in that she tried new

approaches in math which "made it make more sense" such as personalizing problems and using personal experiences to exemplify the math. A class possessing a teacher who worked strictly from the text and provided no other supplemental tools might have experienced this unit in an entirely different manner. The results may have shown greater variation. Also, had the students been able to choose their group mates for the final project, the resulting negative sentiments regarding the composition of the groups might not have been the residual feeling for those students who struggled with their groups. It is thought that more research performed longitudinally and with a larger sample size could provide different results.

Further research implications. More research needs to be done to explore attitude towards mathematics in relation to teacher-selected and student-selected groups as well as same-gender versus mixed-gender groups. Although grouping has been explored in depth with relation to achievement (Linchevski & Kutschener, 1998, Aiken, 1970), this study highlighted the necessity to explore student attitude towards mathematics when same-gender as well as student-selected grouping are utilized. Another area of further research would be a replication of this unit implementation as it could yield better results with a longitudinal study of a larger sample. Furthermore, a class and a teacher whose attitude towards mathematics may not be as positive as the combination involved in this study would provide potentially interesting results if this study were to be replicated. Additionally, performing a rigorous experimental design by adding a control group that did not receive a mathematically-based story unit within their mathematics class and comparing it to an experimental group would increase the reliability and validity of the results as compared to the present study. Finally, a teacher

who is more "traditional" in his approach to teaching mathematics, teaching with the textbook as the only resource, might benefit from the use of this unit as it is a self-contained unit. It would be an excellent starting point for using contexts in mathematics.

As a result of my study, a viable unit based on the use of literature in a French-language mathematics class was created and tested. As a research-based unit, it is now available for other classes and teachers (see Appendix A). It is hoped that other students and teachers will be able to benefit from this unit, and that further research will augment our understanding of the use of literature in mathematics teaching, student understanding of the mathematics involved, and ultimately how to further support positive attitudes about mathematics.

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Appendices

Appendix A

Proposed unit plan

Day 1 -	Read *The Carpet Boy's Gift* (Shea, 2003)(based on true story) Use question from OAME (Margerm, 2010) for students to work on during class period and prepare their large sheets for presentation the following day. Have students keep rough work. Good copy posters to be collected by teacher and selected order of least efficient to most efficient solution for the presentation the next day (of course, the order is not communicated to the students)
Day 2	Ask students to re-tell the story in their own words to their partner Ask for volunteer to re-tell to the class to ensure students remember the story Gather students together for the math congress (if not done before in class, set out guidelines as to how it will work) Have students present their ideas and defend their choices for solutions.
Day 3	Work on the pencil problem (Margerm, 2010) while relating it back to the gift from Iqbal to main character. Students work with partners and come up with as many solutions as possible. Choose favourite solution for good copy and to present the next day in class.
Day 4	Discuss context of the pencil problem. Math Congress.
Day 5	Use Fosnot & Jacob's (2007) Best Buy on Cat Food day plans Develop context: introduce and discuss the cat food context Ask students to investigate which store has the better price As students work, encourage proportional reasoning and keep students ground in the context to help them understand what the numbers represent. Ask students to make posters as before Sort the poster by strategy in preparation for small-group discussions to be held on Day 6. Plan to arrange each small group to include students who use a variety of strategies
Day 6	Have students facilitate small-group discussions so that all students have a chance to share their strategies from Day 5. Encourage students to consider connections among different strategies. As students share, use a ratio table to represent their proportional reasoning. Encourage students to consider how they might use the ratio table to determine numbers that are not already listed on the table.

Day 7	Read *Wangari's Trees of Peace* (Winter, 2008) Present seedling ratio problem. Have students work on the problem as before
Day 8	Math congress Discussion of strategies used Present OAME (Margerm 2010) lemonade problem for thinking over night. Ensure context is a problem that teacher has and needs student help.
Day 9	Re-present lemonade question from OAME (Margerm, 2010) for students to work on during class period and prepare their large sheets for presentation the following day. Have students keep rough work. Good copy posters to be collected by teacher and selected order of least efficient to most efficient solution for the presentation the next day
Day 10	Have students present their strategies again. Present the idea of a math story and examples of math stories Talk about project and expectations for the creation of a math story Read If the World were a Village by David Smith (2002) Give students a brainstorming session with partner
Day 11	Have examples present for students to peruse again By the end of the period, pairs must have selected possible math problem to write story about.
Day 12	Students must develop story outline (rough copy) by end of the period with layout
Day 13	Have a second set of student reviewers edit work for punctuation, spelling, and sentences which don't make sense. Sign review sheet. If possible, either begin revisions or have another pair review the story.
Day 14	Students begin revisions and final copy.
Day 15	Gallery walk of the stories for students to view. Anyone who would like to share their story with the class may read it.

N.B.: Additional Problems may be added through the Fosnot & Jacob (2007) book depending on the children's comprehension of the material and the teacher's desire to give the student's extra challenge.

Appendix B
Information letter

Lakehead
UNIVERSITY
Faculty of Education

Dear Parent/ Guardian & Potential Participant,

Your child is being invited to take part in a research study through Lakehead University. Your child's participation would take place during their percentages, ratios, and decimals unit in mathematics. This research titled: *Mathematically-based Stories in Junior Classes: Do Stories Change Attitude towards Mathematics?* involves the teaching of a curriculum unit based on the use of storybook that has math content within it. This unit will be taught using the storybook to introduce the mathematics topic and several activities will be based on the information provided within the story. The purpose of this research is to see the affect of the use of the literature on the attitude of the student.

If you and your child agree to the child's participation in the study, they will be asked to complete two questionnaires asking about attitude toward mathematics. The questionnaire will be completed before and after the unit and takes approximately five minutes to complete. Some students will be asked to take part in individual interviews which will also be performed before and after the unit. These interviews will be ten to fifteen minutes. This gives the student the opportunity to explain their ideas further. These interviews will be audio-taped as will classes during the implementation of the unit. There are fifteen lessons in the unit which will be used during the regular math class. All participation is voluntary, if your child participates in the study they are free to refuse to answer any questions asked of them as well as to have things they have previously said taken out of the research write-up. You and your child can refuse to participate in any or all parts of this study and can withdraw from the study at any time without penalty or negative consequence. If your child does not participate in the research, he or she will still be able to participate in the unit, including class discussions and their contribution will not be included in the study. Students will not be marked or graded on any aspect of their participation or lack of participation in the research.

Your child's confidentiality and anonymity is assured: student questionnaires will be anonymous and coded by a number, interviews will be audio taped and later transcribed, classes will be recorded and later transcribed, and field notes will be taken by me. Pseudonyms and reference to their role in the study (i.e. "student") will be used in all transcripts and later write-up of findings. If all students do not return their consent forms to allow the recording of classes, this data will not be used for the study. Raw data will only be accessible to me, Karieann Brinson, and to my thesis supervisor, Dr. Ann Kajander. This study does not pose any known risks to participants. The unit is designed only for the students to experience an alternative method of instruction in mathematics.

Students are expected to benefit from participation in this study at minimum through having the opportunity to learn mathematics through the use of a storybook. Through their active participation students will have the opportunity to share their thoughts and perspectives on mathematics and the unit.

The information from this study will be used for a Masters of Education thesis. Reports of the findings may also be published in professional academic journals or at professional conferences, where your child's identity, school and school board

information will be kept strictly confidential. The final thesis, nor any other product of the research, will contain any identifying references to individuals or institutions.

All data that is collected will be kept confidential and securely stored for five years in a locked filing cabinet in Dr. Kajander's office for five years. After the five-year period, all raw data (electronic, notes, or tape) will be destroyed. If you are interested in the findings or analysis of this study please contact myself, Karieann Brinson, either through email or through the Faculty of Education at Lakehead University (contact information below).

If you and your child agree that the child may participate in this study please sign and complete the attached consent form. If you have any questions concerning this study, please do not hesitate to contact me, or my thesis supervisor, Dr. Ann Kajander. Thank you for considering your child's participation in this study.

This research has been approved by the Lakehead University Research Ethics Board. If you have any questions related to the ethics of the study and would like to speak to someone outside the research team, please contact Sue Wright at the Research Ethics Board at 343-8283.

Sincerely,

Karieann Brinson

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Phone: 807-343-8283

Appendix C
Interview Consent Form

Lakehead
UNIVERSITY
Faculty of Education

Thank you for your participation in this study.

Student Interview Consent Form

Mathematically-based Stories in Junior Classes: Do Stories Change Attitude towards Mathematics?

I, _____ (participant name) understand that the information discussed in this individual interview is private. By signing below, I agree to be interviewed as part of this study.

I understand that I may choose not to answer any questions asked during the interview and this will not affect me in any way. In signing below, I may also agree to give my permission for the interview to be audio taped. Furthermore, I understand that anything I say during the interview that is used in a write up will not use my real name. In addition, I am aware that classes will be audio-taped and written down. I am aware that the audiotapes and the words from both the interviews and classes are private and will be locked in storage for five years.

Please indicate YES or NO to the following questions:

Do you agree to be interviewed for this study?	YES	NO
Do you agree to have these interviews audio taped?	YES	NO
Do you agree to allow class activities in which you are involved to be taped and used for research?	YES	NO

_____	_____	_____
Name of Participant	Signature	Date
_____	_____	_____
Name of Parent/Guardian	Signature	Date

955 Oliver Road Thunder Bay Ontario Canada P7B 5E1 www.lakeheadu.ca

Appendix D
Participation/Audio-recording Consent Form

Lakehead
UNIVERSITY
Faculty of Education

Thank you for your participation in this study.

Participant and Parent/Guardian Consent Form

By signing and dating this consent form, I am agreeing to participate in a study supervised by Dr. Ann Kajander and conducted by Karieann Brinson, MEd student of Lakehead University, entitled "Mathematically-based Stories in Junior Classes: Do Stories Change Attitude towards Mathematics?" and that I have read and understood the following:

1. I have read and understood the cover letter for this study.
2. I voluntarily agree to have my child participate.
3. There are no known or anticipated potential risks of the study.
4. Child participants are expected to benefit from participation in the study by having the opportunity to learn mathematics through the use of a mathematical storybook.
5. I/my child can have my child withdrawn from the study at any time, and/or may choose not to answer any question at any time without undergoing any consequence to my child or me.
6. Any information my child may provide will be anonymous and securely stored at Lakehead University in a filing cabinet in Dr. Kajander's office for a period of five years.
7. I can request a copy of the research findings from Karieann Brinson by completing the section below without committing to participation in the study and it will be provided to me at the conclusion of the study when the findings have been written.
8. I/my child, the school and the school board will remain anonymous in any publication/public presentation of the study research findings.
9. Consent for this research has been obtained from the Lakehead University Research Ethics Board, Lakehead Public School Board, the school administrator, Carolyn Carleson, and the two teachers involved in the study, Suzanne Huot and Jing Su.

Audio Recording: I agree to have classes and interviews involving my child recorded electronically and understand that my identity and that of my child will be kept confidential and that audio files will be kept securely at Lakehead University fin a locked filing cabinet in Dr. Kajander's office for a period of five years after which they will be destroyed. I understand that not agreeing to audio recording does not exclude my child's participation from the rest of the study.

YES ____ NO ____

Parent Consent to audio -recording of individual interviews and/or class discussions

Name of Child Participant	Signature	Date
Name of Parent/Guardian	Signature	Date

Consent to Participate in the Study

Name of Child Participant	Signature	Date
Name of Parent/Guardian	Signature	Date

I would like a summary of the research findings YES____ NO _____

Name Email or Mailing Address (for research summary)

Appendix E

Teacher Consent Form

By signing this form, I am agreeing to participate in a study by Karieann Brinson, MEd student of Lakehead University, entitled "Mathematically-based stories in junior classrooms: Do stories affect attitude toward mathematics?" and that I have read and understood the following:

1. I have and understood the cover letter for this study.
2. I voluntarily agree to participate.
3. There are no known or anticipated potential risks of the study.
4. Child participants are expected to benefit from participation in the study by having the opportunity to learn about and contribute to the creation and analysis of literature and its use in mathematics.
5. I can withdraw from the study at any time, and may choose not to answer any question without any adverse consequence to me or have any of my responses removed from any write-up of the findings.
6. Any information I may provide will be securely stored at Lakehead University for a period of five years.
7. I can request a copy of the research findings from Karieann Brinson at khbrinso@lakeheadu.ca and they will be provided to me at the conclusion of the study when the findings have been written.
8. I will remain anonymous in any publication/public presentation of research findings.

Audio Recording: I agree to have interviews and classroom discussions in which I am involved recorded electronically and understand that my identity will be kept confidential and that audio files will be kept securely at Lakehead University for a period of five years after which they will be destroyed. I understand that not agreeing to audio recording does not exclude my participation from the rest of the study.

YES _____ NO _____

_____ _____ _____

Name of participant Signature of participant Date

I would like a summary of the research findings YES ____ NO _____

_____

Name E-mail or mailing address (for research summary)

Appendix F
Principal Consent Form

Mathematically-based stories in junior classrooms: Do stories affect attitude toward mathematics?

I, _____ have read the cover letter and understand that:

1. The child participants, school, and school board identities will be protected.
2. All data collected is confidential.
3. The in-class discussions and interviews will be audio taped and only with permission of participants.
4. All data collected will be presented with the use of pseudonyms.
5. The child or parent may request retraction of any of their responses without adverse consequence and will be given an opportunity to do so.
6. Should a participant choose not to participate, or withdraw from the study there will be not adverse consequence, academic or otherwise.
7. Participants may choose not to answer any question as part of the research without adverse conditions.
8. The participants may withdraw from the study at any time without adverse consequence.
9. There are no known or anticipated risks to the participants.
10. Child participants are expected to benefit from participation in the study by having the opportunity to learn about and contribute to the creation and analysis of literature and its use in mathematics.
11. Child participants are expected to benefit from the participation in the study by having the opportunity to take part in the development of curriculum based on the integration of literacy and numeracy.
12. The participants and their parent/guardian may request a summary of the study.
13. All raw data from the study (audio tapes, written notes, transcriptions, questionnaires) will be held at Lakehead University in a locked cabinet for five years and then destroyed as per Lakehead University regulations.
14. The data collected will be used to prepare a Masters of Education thesis and may also be used to publish articles in academic journals or for presentation at academic conferences with all participant identities as well as the identity of the school board concealed.

_____	_____	_____
Name of Principal	Signature of Principal	Date

Appendix G

Possible Interview Questions

Potential student interview questions for semi-structured interviews:

1. What do you think about math? Why do you feel this way?
2. What is your favourite part of math class? Why?
3. If you could choose an activity you like from any other class, what would it be? And why?
4. Do you feel confident about math? If not, what subject do you feel confident about?
5. Have you ever read a story in Math class before? Did you enjoy the story? Why?
6. Do you like doing group work in math or working on your own? Explain

Potential teacher pre interview questions:

1. What does your typical math class look like?
2. How often do you use extra materials (manipulatives, computers, internet, calculators)?
3. How do you feel teaching mathematics? (e.g. confident, hesitant, nervous)
4. What are your strengths as a math teacher?
5. What are things you want to improve for teaching math?
6. Have you ever used storybooks or children's literature in mathematics? If yes, How? If no, Why not?

Potential teacher post interview questions:

1. Do you think the unit was successful? Why or why not?
2. Did you enjoy using the unit? Why or why not?
3. If you could change something in the unit, what would it be?
4. Do you think you will use stories again in your mathematics classroom? Why or Why not?
5. What was your favourite part of the unit? Explain
6. What was your least favourite part of the unit? Explain
7. Do you think some units of math would benefit from a story more than others? Which? Why?

Appendix H

Attitudes Toward Math

Agree	Don't Know	Disagree		
◻	◻	◻	1.	It is fun to work math problems
◻	◻	◻	2.	It is important to take math every year until you are out of school.
◻	◻	◻	3.	If I could skip just one class, it would be math.
◻	◻	◻	4.	Most of my friends are better at math than I am.
◻	◻	◻	5.	Most people who work need to know something about math for their jobs.
◻	◻	◻	6.	Math is boring.
◻	◻	◻	7.	I'd rather do math than any other kind of homework.
◻	◻	◻	8.	Math is one of my favourite classes in school.
◻	◻	◻	9.	Someone who likes math is usually weird.
◻	◻	◻	10.	I like to do math number problems.
◻	◻	◻	11.	People who have a calculator or a computer need very little math.
◻	◻	◻	12.	We can learn about math in school, but rarely use it outside of school.
◻	◻	◻	13.	We study too much math in our school.
◻	◻	◻	14.	I already know as much as I need to know about math.
◻	◻	◻	15.	I have always like math.
◻	◻	◻	16.	It is interesting to do story problems.
◻	◻	◻	17.	I enjoy doing math puzzles in my spare time.
◻	◻	◻	18.	Doing mathematics makes me nervous.
◻	◻	◻	19.	Math helps me learn to think better.
◻	◻	◻	20.	I like to explain how I solve a problem.

To do well in mathematics, how important are these?

Very important	Useful	Not important		
◻	◻	◻	1.	Working problems quickly.
◻	◻	◻	2.	Checking your own answers
◻	◻	◻	3.	Being able to explain what you did.
◻	◻	◻	4.	Neatness.
◻	◻	◻	5.	Asking questions in class.
◻	◻	◻	6.	Drawing diagrams.
◻	◻	◻	7.	Reading the textbook.
◻	◻	◻	8.	Memorizing.
◻	◻	◻	9.	Luck.
◻	◻	◻	10.	Writing down what the teacher says in class.
◻	◻	◻	11.	Thinking logically.
◻	◻	◻	12.	Being creative.
◻	◻	◻	13.	Trying new things to see how they work.
◻	◻	◻	14.	Seeing connections between things you have learned.
◻	◻	◻	15.	Trying different ways to solve problems even if you are not sure how to solve them.
◻	◻	◻	16.	Opinions.

Please answer the following on the lined paper attached:

How long do you spend on a homework problem before you give up?

What would make you a better math student?

Appendix I

Observation Protocol

Aspect of attitude	Research/ explanation	Code
Enjoyment		
Students positive reaction to material	➢ "students begging to work after the bell rang on their problem" – 5th graders (Lewis, 1993) ➢ ``Enjoyed working and sharing my ideas with others" (Cwilka & Patterson, 2000) ➢ Spontaneously responds during or immediately after (Bintz & Delano Moore, 2003; Jenner, 2002; Whitin & Gary, 1994)	Wants more time "to figure it out" Animated during group/pair work Spontaneous talk
Interest		
Adds elements learned in class to daily schema	➢ Cartesian coordinate system related to the eye optical place – Grade 1 (Pillers Dobbler & Klein, 2002) ➢ translated fractions lesson to surrounding environmental issue of trash (Ronau & Karp, 2001)	Part of daily schema
Makes sense of story	➢ Lively discussion of mathematical discourse (Lewis, 1993; Margerm, 1999) ➢ Ask questions – (Jenner & Anderson, 2000)	Making sense
Relates story to their life	➢ Identifies with character – (Harris 1998) ➢ Identifies with activity – (Wickett, 1998)	Connects context to life
Value		
Remembers content of lesson later date	➢ Had memories of stories during state exams (Reilly & Pagnucci, 2007)	Content retention
Useful for everyday life	➢ realizes math in their life (Berry, 2002; Reilly & Pagnucci, 2007)	Daily use
Confidence		
	Statements from these surveys: "When I get a good grade in math, it's	Perceived ability

	because I'm always good at math." (Schoenfeld, 1989) "I like to explain how I solve a problem." (Simon & Schifter, 1993)	At ease speaking about mathematics

Appendix J

Expectations covered in unit

The Ontario Curriculum Grades 1-8: Mathematics (Ontario Ministry of Education, 2005)
Strand: Numbers and number sense

Grade 5 Curriculum

- read and write money amounts to $1000 (e.g., $435.35 is 455 dollars and 35 cents, or four hundred fifty-five dollars and thirty-five cents) – *Quantity Relationships*
- add and subtract decimal numbers to hundredths, including money amounts, using concrete materials, estimation, and algorithm – *Operational Sense*
- describe multiplicative relationships between quantities by using simple fractions and decimals – *Proportional Relationships*
- determine and explain, through investigation using concrete materials, drawings, and calculators, the relationship between fractions and their equivalent decimal forms - *Proportional Relationships*
- demonstrate an understanding of simple multiplicative relationships involving whole-number rates, through investigation using concrete materials and drawings - *Proportional Relationships*

Grade 6 Curriculum

- multiply and divide decimal numbers by 10, 100, 1000, and 10000 using mental strategies – Operational Sense
- represent ratios found in real-life contexts, using concrete materials, drawings, and standard fractional notation - *Proportional Relationships*
- determine and explain, through investigation using concrete materials, drawings and calculators, the relationships among fractions, decimal numbers, and percents - *Proportional Relationships*
- represent relationships using unit rates - *Proportional Relationships:*

*The Ontario Curriculum Grades 1-8: Language (*Ontario Ministry of Education, 2006)
Previous knowledge required:

- process of writing and revising
-

Strand: Oral Communication

Grade 5 Curriculum

- Demonstrate an understanding of appropriate speaking behaviour in a variety of situations, including paired sharing, dialogue, and small- and large- group discussions (*2.2 – Speaking to communicate – Interactive strategies*)
- Communicate orally in a clear, coherent manner, presenting ideas, opinions, and information in a readily understandable form (*2.3 – Speaking to communicate – Clarity and Coherence*)
- Use a variety of appropriate visual aids to support or enhance oral presentations (*2.7 – Speaking to communicate – Visual Aids*)

Grade 6 Curriculum

- Demonstrate an increasingly sophisticated understanding of appropriate speaking behaviour in a variety of situations, including paired sharing, dialogue, and small- and large-group discussions (*2.2 – Speaking to communicate – Interactive strategies*)
- Communicate orally in a clear, coherent manner, using appropriate organizing strategies and formats to link and sequence ideas and information (*2.3 – Speaking to communicate – Clarity and Coherence*)
- Use a variety of appropriate visual aids to support or enhance oral presentations (*2.7 – Speaking to communicate – Visual Aids*)

Strand: Writing

Grade 5 Curriculum

- Generate ideas about a potential topic and identify those most appropriate for the purpose (*1.2 Developing and Organizing Content – Developing Ideas*)
- Determine whether the ideas and information they have gathered are relevant, appropriate, and adequate for the purpose, and do more research if necessary (*1.6 Developing and Organizing Content – Review*)
- Vary sentence types and structures, with a focus on using conjunctions to connect ideas, and pronouns to make links within and between sentences (*2.4 Using Knowledge of Form and Style in Writing-Sentence Fluency*)
- Make revisions to improve the content, clarity, and interest of their written work, using a variety of strategies (*2.7 Using Knowledge of Form and Style in Writing – Revision)*
- Produce revised, draft pieces of writing to meet indentified criteria based on the expectations related to content, organization, style, and

use of conventions (*2.8 Using Knowledge of Form and Style in Writing – Producing Drafts*)

- Spell familiar words correctly (*3.1 Applying Knowledge of Language Conventions and Presenting Written Work Effectively – Spelling Familiar Words*)
- Use punctuation appropriately to help communicate their intended meaning, with a focus on the use of: a comma before *and* or *but* in compound sentences to join principal causes; quotation marks for direct speech; and the placement of commas, question marks, and exclamation marks inside quotation marks in direct speech (*3.4 Applying Knowledge of Language Conventions and Presenting Written Work Effectively – Punctuation*)
- Use parts of speech correctly to communicate their intended meaning clearly, with a focus on the use of: common, proper, and abstract nouns (*3.5 Applying Knowledge of Language Conventions and Presenting Written Work Effectively – Grammar*)
- Proofread and correct their writing using guidelines developed with peers and the teacher (*3.6 Applying Knowledge of Language Conventions and Presenting Written Work Effectively – Proofreading*)
- Use a range of appropriate elements of effective presentation in the finished product, including print, script, different fonts, graphics, and layout (*3.7 Applying Knowledge of Language Conventions and Presenting Written Work Effectively - Publishing*)
- Produce pieces of published works to meet identified criteria based on the expectations related to content, organization, style, use of conventions, and use of presentation strategies (*3.8 Applying Knowledge of Language Conventions and Presenting Written Work Effectively – Producing Finished Works*)

Grade 6 Curriculum

- Generate ideas about a potential topic and identify those most appropriate for the purpose (*1.2 Developing and Organizing Content – Developing Ideas*)
- Determine whether the ideas and information they have gathered are relevant, appropriate, and adequate for the purpose, and do more research if necessary (*1.6 Developing and Organizing Content – Review*)
- Create complex sentences by combining phrases, clauses, and/or simple sentences (*2.4 Using Knowledge of Form and Style in Writing-Sentence Fluency*)
- Make revisions to improve the content, clarity, and interest of their written work, using a variety of strategies (*2.7 Using Knowledge of Form and Style in Writing – Revision)*
- Produce revised, draft pieces of writing to meet indentified criteria based on the expectations related to content, organization, style, and

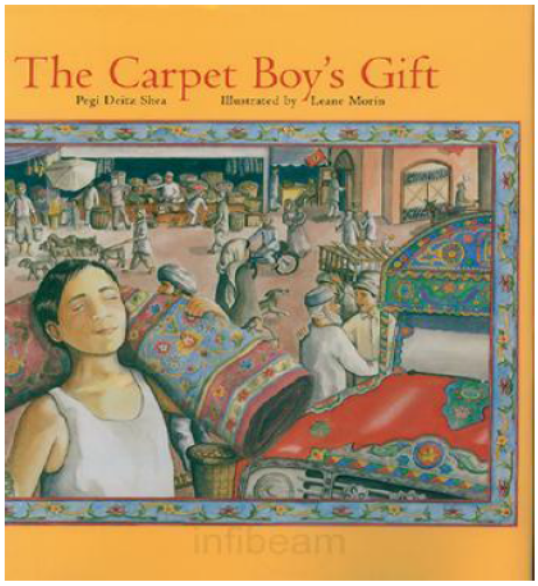
use of conventions (*2.8 Using Knowledge of Form and Style in Writing – Producing Drafts*)

- Spell familiar words correctly (*3.1 Applying Knowledge of Language Conventions and Presenting Written Work Effectively – Spelling Familiar Words*)
- Use punctuation appropriately to help communicate their intended meaning in longer and more complex sentences, with a focus on the use of: commas to separate words in a list or after an introductory word or phrase; quotation marks in dialogue; and some uses of the colon, semi-colon and brackets (*3.4 Applying Knowledge of Language Conventions and Presenting Written Work Effectively – Punctuation*)
- Use parts of speech correctly to communicate their intended meaning clearly, with a focus on the use of: personal subject and object pronouns; indefinite pronouns, conjunctions; subordinate clauses; adverb phrase; and present, past, and future verb tenses (*3.5 Applying Knowledge of Language Conventions and Presenting Written Work Effectively – Grammar*)
- Proofread and correct their writing using guidelines developed with peers and the teacher (*3.6 Applying Knowledge of Language Conventions and Presenting Written Work Effectively – Proofreading*)
- Use a range of appropriate elements of effective presentation in the finished product, including print, script, different fonts, graphics, and layout (*3.7 Applying Knowledge of Language Conventions and Presenting Written Work Effectively - Publishing*)
- Produce pieces of published works to meet identified criteria based on the expectations related to content, organization, style, use of conventions, and use of presentation strategies (*3.8 Applying Knowledge of Language Conventions and Presenting Written Work Effectively – Producing Finished Works*)

Appendix K

Sample Lessons and Problems
Excerpt from Margerm (2010), pp. 6-7

Questions related to *The Carpet Boy's Gift* (Shea, 2003)



Questions:

1. If the exchange rate is $0.02 Canadian for 1 rupee, how much is Nadeem's fine in Canadian money?
2. How much is Nadeem's fine of 100 rupees in Canadian money?
3. It takes Nadeem six months to pay off the 50 rupee fine. At this rate how long will it take him to pay off a fine of 500 rupees?

Possible follow-up problem

Before (getting started):
Context to be developed and linked to the story.

Pencil Problem A:
10 pencils cost $1.80.

- How much do 5 pencils cost?
- How much do 20 pencils cost?
- How much does 1 pencil cost?

10 pencils	5 pencils	20 pencils	1 pencil
$1.80	$1.80 ÷ 2 = $0.90	$1.80 × 2 = $3.60	$1.80 ÷ 10 = $0.18

During (Working on it):

Pencil problem B:
A school needs to by 22 400 pencils. Here are the prices for pencils at 3 different stores

Store A sells 60 pencils for $1.80 Store B sells 30 pencils for $0.99 Store C sells 15 pencils for $0.55

- Which store has the lowest price?
- What is the cost of the pencils at the lowest price store?

After (consolidation):

Anticipating Student Responses:

Solution 1
180¢/ 60 = 3
99¢/ 30 = 3.3
55¢/15 = 3.667
Store A sells 1 pencil for less than the other stores.
$0.03 rather than $0.033 or $0.03667
$0.03 ×22400 = $672.00

Solution 2

60	180¢	30	99¢	15	55¢
1	3¢	10	33¢	3	11¢
11	33¢	10	33¢	9	33¢

Store A gives you more pens for $0.33 (11 pens) than the other 2 stores (10 and 9 pens).

Solution 3

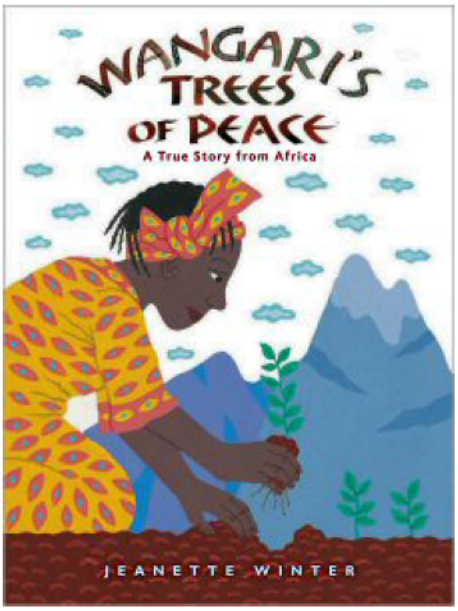
60	180¢	30	99¢	15	55¢
22 400	**$672.00**	**22 400**	**$739.20**	**22 400**	**$880.00**

Store A's price would be $672.00 less than the other 2 ($739.20 and $880.00)

Coordinating Discussion for Student Learning:
Why might solution 1be chosen first for student discussion, followed by solutions 2 and 3?

- Solution 1 – unit rate cost; that is the cost of 1 pen in cents
- Solution 2 – common whole of 33 cents store A gives 11 pens for $0.33, whereas the others only give 10 or 9 pencils for $0.33.
- Solution 3 – ratio table comparatively shows the cost of 22 400 pens.

Questions related to *Wangari's Trees of Peace* by Jeanette Winter (2008)



Questions:

1. If Wangari planted 9 seedlings a day, how many days will it take for her to plant 425 trees?
2. Wangari asks other women to help her plant seedlings. If each woman plants 9 seedlings, how many trees will 72 woman plant?

Follow-up problem

Before (getting started):
Context will be set by the teacher prior to present the problem.

Lemonade recipe problem A:
Write ratios to describe different combinations of water and lemonade concentrate: (1 cup, 2 cups, 3 cups, 4 cups).
How do you know that you have listed all possible combinations?

CUPS	1	2	3	4
1	1:1	1:2	1:3	1:4
2	2:1	2:2	2:3	2:4
3	3:1	3:2	3:3	3:4
4	4:1	4:2	4:3	4:4

During (Working on it):

Lemonade recipe problem B:
Which lemonade recipe has a stronger lemonade taste?
Recipe 1 1 cups lemonade concentrate, 2 cups of water
Recipe 2 2 cups lemonade concentrate, 3 cups of water
Recipe 3 3 cups lemonade concentrate, 5 cups of water

After (consolidation):

Anticipating student responses:

Solution 1 Ratios of lemonade to water:
Recipe 1 1:2 = 0.50:1
Recipe 2 2:3 = 0.67:1
Recipe 3 3:5 = 0.60:1

Solution 2
Recipe 1 lemonade to water = ½ = 30/60
Recipe 2 lemonade to water = 2/3 = 40/60
Recipe 3 lemonade to water = 3/5 = 36/60

If all recipes were made with 60 cups of water, there would be the most lemonade in recipe 2.

Solution 3

1	2	2	3	3	5
3	6	4	6	9	15
15	30	20	30	18	30

Recipe 2 has the greater ratio of lemonade.

Coordinating Discussion for student learning:
Why might solution 1 be chosen first for student discussion, followed by students 2 and 3?

- Solution 1 – calculates unit rate of number of units of lemonade to 1 unit of water; recipe has more lemonade for the same amount (1 unit) of water
- Solution 2 – common whole is represented here in the denominator (60) so it says, like the others, that recipe 2 has more lemonade in it (40 units) than the other 2 (36 and 30 units)
- Solution 3 – uses the ratio table to re-present calculations used to get the whole; recipe 2 has more lemonade (20 units) in 30 cups of water than the others (15 and 18 units)