THE EFFECTIVENESS OF STORY-FRAMED INSTRUCTION IN MATHEMATICS

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PROJECT SUBMITTED IN FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF EDUCATION in CURRICULUM AND INSTRUCTION

THE UNIVERSITY OF NORTHERN BRITISH COLUMBIA

July 2004

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Abstract:

The purpose of this study was to measure the effectiveness of story-framed instruction as an effective teaching method. I designed and taught two mathematics units on each of the topic areas of integers and fractions - one using story-framed instruction, and one using non story-framed (traditional) instruction - to two grade seven classes. Students in the first year of the study were taught integers using story-framed instruction and fractions using non story-framed instruction, whereas students in the second year of the study were taught fractions using story-framed instruction and integers traditionally.

The final exam results from the two grade seven classes for the two mathematical units indicated that a statistical difference in learning outcomes was evident using the Integer story frame mathematical instruction and the unit taught using traditional instruction. There was no statistical difference between fractions taught with story framed instruction and non story-framed instruction. The qualitative components of the study suggested that students preferred story-framed instruction over non story-framed instruction providing certain conditions were present. Those conditions also point to a story-frame model that must have three dimensions consisting of a structure, delivery, and connectivity to the target audience in order to be effective.
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Acknowledgements

I would like to greatly acknowledge and thank Dr. Judith Lapadat for her unending patience and guidance in the completion of this project. Her support and stewardship have made this project possible. Many thanks must go to Cathy McGregor for her assistance in helping to focus my thoughts into a concise form. A great debt is owed to Dr. Fred Egglestone for piloting this project through the rocky waters of statistics.

Lastly this project is dedicated to my late father Sidney Howard Clark and my mother Sadie Clark both of whom gave unwavering encouragement and support from the beginning to the end of this journey.
Theoretical Background

*Why Teach With Stories?*

Stories in the past were used to entertain, to teach, to explain, and to pass culture from one generation to the next. Society of today is awash with stories, from television programs, books, commercials, radio talk shows, video games, audio cassette books, comic strips, theatre, movies, stupid jokes a neighbour tells over the fence to ripping yarns. People are storytellers. Parents teach their young with stories. Teachers use stories to help student learn. Narratives or stories are part of human culture. Children begin to connect their world to the greater world when they begin to communicate. In fact simple stories are embedded in the fundamentals of communication. Narrative is part of learning language (Hoff, 2000). As children grow and learn language, they begin to tell their own stories. Their demonstrated understandings are their stories. We have stories with us from early childhood to preschool and through our formal education. For example, music teachers may use mnemonic memory aids like micro-story-structures to teach music. For example, the spaces are "FACE", and the lines are "Every Good Boy Deserves Fudge". Stories are with us as soon as we are born. In short, a story, even a tiny one, can be powerful teaching tool. It is a universal strategy that can be used to remember, entertain, teach, inspire, create and know (Raines & Isbell, 1994).

A literature search shows that story-framed structures or stories may be found in many venues of teaching and instruction and that the inclusion of a story adds to the effectiveness of the teaching. The effectiveness of story telling is often associated with memory benefits (Edwards, 1997; Egan, 1986, 1992,
A second topic that has been widely discussed in research literature is the influence storytelling has in cultures and societies (Baker and Greene, 1987; Basso, 1988; Egan 1997; McCabe, 1997; McGowan, 1987). Scholars and researchers make the case that storytelling has a long established history as an effective teaching and learning tool. The advantage of storytelling for better learning in the classroom should be one of the primary reasons for its implementation. Abrahamson (1998) argues that storytelling develops a context for active learning and personalising ownership of the learning, both in terms of process and content.

There are two main uses to storytelling in education. One application is to tell a fictional story to students, and the other application is to use elements of a story frame to make lessons in math, science, or history, or whatever more meaningful and imaginatively engaging (IERG website, 2003). Why teach with a story? Because, in theory, it works.

Perhaps when one first connects formalised teaching to learning the first memory is of primary reading circles with big over-sized books. However, because stories are found in a wider variety of venues than just education, and because storytellers employ a variety of story related techniques, it is important to briefly discuss the broad range of educational uses in and outside of education. For example, stories are used even in the field of medicine to help diagnose illness. “The narrative provides meaning, content, and perspective for the patient’s predicament. It defines how, why, and in what way he or she is ill” (Greenhalgh & Hurwitz, p.23 1999). Health care providers listen to stories as patients explain an illness. “Episodes of sickness are important milestones...
in enacted narratives of patients' lives. Thus, not only do we live by narrative, but often with our doctor or nurse as witness” (Berger, 1967, p.24; cited Greenhalgh & Hurwitz, 1999).

Stories are also used in therapy sessions to help repair psychological or physiological damage, or both. "Therapeutic stories can be used in combination with any therapeutic technique, at any stage of the therapy process" (Davis, 1988,p.49). Stories are used in counselling sessions dealing with a milieu of health related issues, such as: fear reduction, abusive parents, divorce, sexual abuse, multiple personalities, fragmented thinking, to list only a few (Davis, 1988). Stories or narratives are used to inform, to diagnose, and to heal. These uses of stories are far removed from the vision of a primary reading circle. However, it is the educational implications that people recognize when they use stories.

To briefly tie the theme of health to education, consider that story-framed instruction is used in the Personal Planning part of British Columbia’s curriculum, which includes health education. For example, on one end of the spectrum of Social Responsibility, which is personal responsibility (health), *Teaching Through Stories* by Goodwin and Jenkins provides lesson objectives, activities using stories, fables, myths and legends (Goodwin & Jenkins, 1997). On the interpersonal skills of the Personal Planning (social responsibility) end of the spectrum is social education, story-framed instruction can be used to teach social values. Stories allow teachers to use characters, plot, settings, themes, and relationships in selected works of children’s fiction to develop activities that promote citizenship skills (McGowan, 1987). Successful teaching of tolerance can be achieved through the use of
stories. However, the discussion so far is not intended to extensively explore all uses of stories in and out of all education, merely to point out that stories are not restricted to learning to read circles with big books.

Research does support that stories in education is effective. One study that speaks to the effectiveness of stories is Jenner and Anderson's (2000), *Experiencing mathematics through literature: The story of Neil*, which describes how a boy, pseudonymed Neil, was able to participate in a classroom mathematical discussion focusing around a book called *Caps for Sale*. Neil, who found learning in general difficult, was able to relate to the teacher's creative use of the book. The setting gave Neil the safety net of an imaginative story that allowed him to take risks, to use his developing knowledge, to explore his thinking, and to be successful.

Another study supporting the effectiveness of stories was conducted by Colesante and Biggs (1999) with graduate and undergraduate students. They found:

... that students gave the teacher higher approval ratings, perceived the teacher as more attractive and remembered more about the presentation when he explained conflicting positions on issues using stories than when he used arguments. Students perceived the teacher as most attractive and remembered most when the teacher used stories to explain pro and con positions (Colesante & Biggs, 1999, p.28).

Clearly, the use of stories in instruction seems to have a quality or characteristic that permits the learner to retain more favourable impressions about the subject being taught than lessons without story
In a more traditional, perhaps more familiar association with school, stories have been used to teach reading--the most fundamental of academic skills. Educators have and draw upon a cornucopia of printed material to use because listening to, talking about, and telling stories fire student's imaginations, build oral communication skills and establish language experiences (Dewey, 1994). Children increase vocabulary at least partly through listening to stories even before they know how to read (Bracey, 1994).

Stories are inexorably associated with education and teaching. However, this does suggest that story use in teaching is passively accepted as an effective method of instruction. For example, much educational rhetoric over the last 50 years has foregrounded science over narrative. Similarly, it has been argued, when speaking of history, that when narrative of events takes first priority, students fail to learn the very heart of doing history: analysis, synthesis, evaluation of evidence, and historical argumentation (Karras, 1999). This position would appear to be in opposition to Colestante and Biggs who found that stories were more effective than argumentation. Karras does not suggest that narratives should not be used in instruction; rather that narratives should be subordinate in importance to argument (Karras, 1999). Karras's view provides an interesting caveat to story telling and instruction. He is arguing that the message of the story must not be consumed by the medium of the story. Karras's and Colestante's discussion of the merits of using story-framed instruction is important. To me, Karras's comments raise an important point. A story-framed lesson should have as a primary dimension a design structure that will teach a concept. If a story-framed lesson does not do that,
then perhaps the story-frame is ill suited and superfluous to the concept.

A good example of the message not being consumed by the story is provided by Egan (1992) who builds a narrative structure, a story frame, linking the rise and fall of civilization based on the use of trees (Egan, 1992, pp.125-133). Although amusing and somewhat whimsical at first, Egan's civilization - tree tale elicits a much deeper appreciation of cause and effect relationships found in environmental studies or science. Egan's "argument" was made possible by the use of a narrative or a story. Both Egan and Karras would agree that stories can be used to advance an argument or a concept. Where they differ is in emphasis. Egan would see the story-frame as being necessarily an important vehicle to make the argument, whereas Karras does not. Egan would frame an argument in a story where Karras might put forth an argument with a story.

Although Egan and Karras may differ in storytelling technique, I feel that both scholars see the basic story frame as potentially effective. Just as a range of educational techniques, methods, and styles can be found in nearly all educational institutions, the intent is the same: to educate students. In order to educate students, a teacher must capture and hold their attention. Stories can capture and fire the imagination of students and the use of the imagination can be associated with the creative elements of learning (Baker & Greene, 1987; Egan, 1986, 1992, 1997; Lauritzen & Jaeger, 1997). Neil Mercer (1995), in Guided Construction of Knowledge points to the importance of gaining learner attention when he writes:

It is perhaps too often forgotten in the analysis of teaching and learning, that one legitimate goal for a teacher is to make
information memorable. Think back through your own experience: is any of the academic information you recall embedded in a narrative? (p. 27).

Mercer (1993) recounts the story of Darwin’s voyage and the important part it played in his biology education. “Chemistry,” he laments, “in contrast, seemed to lack such voyages of discovery and I remember much less of it. Narratives -- interesting ones -- can provide effective ways of formulating knowledge so that students can reconstruct it later” (Middleton & Edwards, 1990; cited Mercer, 1995, p.27). Mercer’s comments regarding chemistry gives rise to an interesting consideration.

Mercer’s conclusion is that narratives that are interesting can prove to be effective as a learning tool. Mercer raises the question why do some subjects lack narrative or story content. He implies that because his Chemistry classes lacked the narrative content of his biology class, that his memory of chemistry classes is less. The cautionary caveat derived from his writing is that a narrative or story alone may not be enough to transmit knowledge or understanding.

Two possible reasons come to mind why this may be so. Firstly, is that perhaps the chemistry teacher did not include a narrative component because he held the view that facts and procedures demand a traditional text-based approach. Secondly, perhaps that the nature of certain subjects, like chemistry, physics, or mathematics, because of their structure and content matter are less “story friendly”. However, Chemistry, like Biology, is a collection of inventions and discoveries made by humans, each of which is a story. By humanising the content, argues (Egan, 1992), a teacher can add
narrative voyages to chemistry by connecting the content to the story of the
inventor or discoverer. This approach, if it had been used, may have held
Mercer's interest and captured his imagination. The results could have ended
with Mercer having the same regard for chemistry as he has for biology. If
Egan is correct, then subjects not normally associated with stories should be
made more interesting, more memorable, and perhaps more "learnable".

In sum, the amount of literature in memory, language development,
motivation, and culture that mention the potential effectiveness of stories and
narratives, led me, at first, to the assumption that story telling should be an
effective instructional method regardless of topic. However, according to my
project research, subjects like Mathematics and Chemistry may differ from
subjects like History or English Literature. These to me would seem to be
inherent stories of humans, that may be made more easily learned with the use
of story-framed instruction. My Internet search and physical search of my
school library led me to observe that there is a generous amount of teacher
material produced wedding stories and mathematical instruction that
presumes and relies on the tenet that teaching with stories is effective.

In fact, education and huge commercial systems rely on the assumption
that stories can enhance learning. From my search, I grouped teacher
resources for Mathematics into two broad categories: stories about
mathematics and stories with mathematics. Stories about mathematics may
be used to invoke interest in a topic or to "humanise" mathematical constructs.
The intent or objective of these books or math stories is to place the abstraction
of math into a less abstract human context. Stories with mathematics attempt
to embed a concept into the plot of the narrative. I found several book reviews
of mathematical stories. However, most reviews are obstreperously silent with respect to mentioning studies that support story telling as an effective teaching tool or method. Most reviews tended to talk about font size, readability, pictures, and other visual characteristics (see Appendix A).

Some stories with mathematics claim to marry mathematics with "good" literature. Johnson (1997) reviewed *Math and Stories* by Marian Bartch. Johnson claims that an effective connection between mathematics and literature is made with the use of some of the best award winning books available.

Each manual has twenty eight story units, which include related NCTM standards and concepts, a detailed story synopsis, discussion questions, two mathematics activities, and language arts activity related to each story. (Johnson, 1997, p. 1)

Using stories with math may be as deep as a novel or as incidental as an analogy. Using a commonly known story as a reference point for a math analogy is also a way of pairing math and literature. For example, a teacher might use a brief discussion of *Goldilocks and the Three Bears* to establish a criteria for evaluating area with relative sizes of area of bowls and beds indicating too big, too small, or just right. (Ameis, 2001). Books not specifically written for math, but that have a math potential, must be carefully mined for mathematical applications. According to Whitin (2202), teachers do not always mine the rich mathematical potential of good stories. Instead, some teachers, perhaps because of their own math-anxiety, fall into the trap of turning mathematics class into another reading class. Also, some books are poorly written. Such stories are characterised by stilted rhymes, insipid illustrations,
or contrived story lines (Whitin, 2002). Whitin’s warning about seductively advertised stories being aligned with NCTM’s Standards as a disturbing practice is sage advice to teachers wishing to incorporate stories into their instruction. A book or a story that claims to match a set of official standards doesn’t necessarily mean that the material is of quality or substance or appropriate form use as an instructional aid.

Consider this last example of commercially produced material I found online. *Project Happy Child* is a series of mathematical stories. Some lesson aids are historically referenced, some are literature referenced, and some are story-framed with characters solving mathematical problems by coming to terms with mathematical understandings. *Bart and Miss Walker*, by Penny Midas Rollo (2001), characterises the type of story-framed math unit that I employed in this project. *Bart and Miss Walker* used story telling and math in a specific narrow focus. It provided a frame or setting of a simple plot that used a mathematical concept or idea in a story episode. The mathematical concept then became part of the plot. The story frame was used to convey the mathematical understanding. The narrative presented the story of Miss. Walker explaining to Bart how to add fractions. As the story progressed, Bart learned how to add more complex fractions. In the end, it matters not an iota if a student uses the story to compute a fraction question or not. The story frame is a scaffolding device to bridge the instructional level to the mastery level. Like scaffolding used on construction of a building, it is not meant to remain in place after the building has been constructed. The building must stand alone, not unlike an understanding.

After reviewing a sample of material, I encountered many products
available to teachers blending stories with instruction. The spectrum of commercially produced products range from poor to good. There is, however, a disparity between the volume of mathematical material that promote the use of stories as a means of instruction in Mathematics and research that specifically supports the effectiveness of story telling as a method of instruction in Mathematics that is of interest. Book publishers have made millions on the assumption that stories in Math are based on effective principles of instruction. Educators assume that the same basic tenets of effective instruction are at work when they present a Math story book to a child or class to teach a concept. The purpose of this project was to examine the effectiveness of story-framed instruction as a strategy for teaching mathematics in upper intermediate grades and to test the assumed bridge between theory and reality.¹

Method

My project involved comparing various indicators of student learning following a math unit taught with story-framed instruction with a unit taught using a traditional method. In order to control for differences in outcomes due to the content of the two math units of Fractions and Integers, I used data from two math classes -- one taught in 2002 and one taught in 2004. In 2002, I taught Integers using story frames and Fractions using traditional methods. In 2004, I reversed the story-framed units, and taught Fractions using story frames and Integers using a traditional text based method (see table 1).

¹The term "story-framed instruction" means placing the content of what is to be learned within the context of a story. I use the term "story", "narrative", and "story-frame" interchangeably. The term "traditional method" means a teaching method that does not use a story of any form. The teacher stands in front of a class and delivers the lesson relying on the suggestions of a text book. In this study the traditional lessons were based on Math Power 7: Western Edition.
Table 1
Sequence of instruction for Integers and Fractions.

<table>
<thead>
<tr>
<th>Year</th>
<th>Integer Unit</th>
<th>Fraction Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002</td>
<td>story-framed</td>
<td>traditional</td>
</tr>
<tr>
<td>2004</td>
<td>traditional</td>
<td>story-framed</td>
</tr>
</tbody>
</table>

Both years, I taught the units in the order of Integers first, then Fractions. This design enabled me to control for possible variance arising from differences in content of the two different math units, as well as for variance due to the two different cohorts of students. In the remainder of this section I describe the participants, the curricular story-framed materials that I developed, and the instructional process that was followed.

Participants

Two grade seven classes were used to study the effectiveness of story-framed instruction. The group studied in 2002 was a class of 30 students, composed of 18 boys and 12 girls. Three students on Individual Education Plans (IEP) were excluded from the study as their learning capacities were far below the conceptual level of the selected math unit. This left the class of 2002 with 27 eligible participants, 17 boys and 10 girls, who participated in a research based assignment as part of my Discourse of Education mini project that I completed for my graduate courses. The number of eligible students who wrote the final exams in 2002 were 25 for Fractions and 26 for Integers. The difference of one was due to an absence at exam time. There were 23 completed student questionnaires at collection time. I subsequently obtained permission to reexamine data for the current project.
The class of 2004 consisted of 27 students: 16 girls and 11 boys. Three students were excused from the project as they were on Individual Educational Plans (IEP's) and inclusion in the study would have been at variance with their educational programs. Two new students were excluded from the study as they arrived in the last week of the project. The participating class was composed of 12 girls and 10 boys. Twenty two eligible participants wrote the final exams in each unit. Twenty-one student questionnaire were handed out at the end of the unit with one student absent. Gender was not considered as a factor in the project and no calculations were made to account for it in the findings.

Although data from two different grade seven classes were used in this research, there was a remarkable similarity between the two groups. They were similarly normed in terms of high to low achievement. Both groups came from predominantly middle class urban backgrounds and from the same socioeconomic demographics. All students received the same instructional pattern: concept introduction, practice, scored exercises, and examination. Only data from students who had returned letters of permission were included in the studies of 2002 and 2004, although all members of the class, aside from those on IEP's participated in the instruction.

**Measures and Procedures**

Human behaviour is complex, and in the context of classroom instruction I found that the influencing factors and potential variables were difficult to manage all at once. I considered the statistical power of the test itself. With a sample sizes of 25 to 30, making generalisations from an experiment is done with an awareness that the statistical power is relatively
low. Hurlburt (2003) points out that statistical power of behavioural research has typically a statistical power of less than 0.4, around 0.3. According to Hurlburt this means that there is a two in three chance of making a type II error, that is to say, claiming something is there when it is not. This issue moved me to my decision to use a mixed design. Utilising both qualitative and quantitative analysis, I believed would help offset the low power of the statistical quantitative component in my analysis. I used a researcher's journal, student questionnaires, and two nondirectional t-tests.

*Research journal.* In the project I used a researcher journal to record contextual information, and to potentially reveal any bias that may occur during the study. After each lesson, reflections were recorded how the lesson unfolded and I recorded my observations of participants. Observations such as signs of body language that indicated participant interest, enjoyment, disinterest, displeasure, or other overtly expressed feeling were monitored. I watched for such signs as leaning in, maintaining eye contact, reading or doodling, and so on, that indicated a level of attentiveness. These notes were important to determine if participant behaviour was any different during the story-framed Fraction unit and other non story-framed Math units. For example, a student who constantly doodles in Math, or any other subject for that matter, may doodle during the Fraction unit as well. This would not suggest any change in behaviour. However, should the same student stop doodling or doodle significantly less during the Fraction unit, then a change in interest may be indicated. The observations were analysed after the unit was completed. The journal entries were compared to the student response sheets and served to establish the greater picture and help to check any "undue
researcher influence or bias" that may have arisen unintentionally during the unit.

_Student questionnaires._ To interpret the results of the statistical comparisons between cumulative student scores and units with or without storytelling, I felt a student survey was the best way to ascertain if storytelling was a positive instructional influence on student learning. The student questionnaire used a four point Likert scale and an open response section to provide students with an opportunity to comment on math instruction with storytelling. The student questionnaire varied slightly between the two groups. The 2002 group was exposed to two different story-frames in their Integer math unit. The 2004 group had only one story frame for the entire Fraction unit. The two questionnaires differed in the questions regarding the stories. As the 2002 group had two stories they were asked to comment on two stories. The 2004 group having only one story only had one story to respond to. Student enjoyment of story-framed instruction was not my primary concern; rather ways in which students used story-frames to develop an understanding of the math concepts and procedures was the focus. The questionnaire addressed the scaffolding intent of story-framed instruction specifically by asking students to comment on the utility of story-frames in learning mathematical concepts.

_Two tail t-test._ Lastly, the students' final cumulative unit exam scores were used from the 2002 and 2004 classes for Integers and Fractions, in order to compare the outcome of instruction with and without story frames. Two nondirectional t-tests were used to compare story-framed Fractions to non-story-framed Fractions and story-framed Integers to non story-framed Integers.
The t-tests were used to determine if a significant difference existed between units with storytelling and units without storytelling.

Instructional Procedure

Story-framed instructional materials were developed for Integers in 2002 and for Fractions in 2004. When constructing a story frame, I took care to focus the content of the plot on the mathematical concepts; otherwise the mathematical objective of the story might become overshadowed by the events of the story itself. There is a natural rhythm of a story that need to be adhered to. Warnings to watch for story frames that are stilted, overly contrived, or that have excessive numbers of extraneous items of interest that might over burden a story line should be avoided. If the story becomes too grand or too obviously contrived, the principal objectives may become lost in the telling. An elaborate plot may risk confusing rather than clarifying; hence to achieve the curriculum objectives, a simple story seemed be both logical and appropriate. Irrelevant items or those items of “interest” that do not move the story along “lets our engagement sag a little. “Most stories,” Egan (1989) writes, “can obviously bear some of this, but too much and the story is lost” (p. 25).

A story frame should place the mathematical construct in a familiar setting and add a contextual dimension that is otherwise lacking in a traditional directional or manual-like step-by-step method of instruction. For example, a pirate chopping a coin into pieces of eight has a different tone and employs more vivid imagery than dividing a circle into eight equal wedges. A pirate is a character of fanciful conjuring. A pirate comes complete with a persona: dangerous, courageous, daredevilish, and appealing whereas a circle does not.
In 2002, I developed a story-framed Mathematical unit on Integers, in which I used a battle scenario to introduce concepts of addition and subtraction of Integers, and a story frame about families of fish to introduce multiplication and division of Integers. The mathematical unit for Integers with story frames was divided into three parts, each representing one week of instruction. Part one was the introduction of Integers and the introduction of addition and subtraction of Integers using the skirmish story frame. Part two introduced multiplication and division using the fish family story frame. Part three was a review, exam, and student feedback, using the questionnaire that I developed.

All units followed the same pattern of instruction: introduction, practice, and test. This patterned approach of instruction was used in the mini research project using Integers as the story-framed unit. The data collected from that mini project of 2002 was used in the comparison. The student feedback sheet was given after all lessons where taught and the unit was completely finished, but before students were aware of their final unit grade. The timing of the student questionnaire was to avoid students from forming their responses commensurate to their unit mark.

All the math units from 2002 and 2004 took nearly the same amount of time to complete. As with any elementary school there are days of interruption or non instruction due to field trips, unplanned for special days, and so on.

The basic pattern of introduction, practice, scoring, review, scoring, and examination was again followed. In the introduction phase, the concepts were introduced to the class. In the practice phase, sample questions were worked with as demonstration, then followed by individual work. These scores were
not recorded as part of the student grade. The scoring section followed the practice section. These questions were scored and then entered as part of their grade. A review of the concept followed the scoring phase to address any areas of concern. A second scoring phase occurred, then I entered the scores as part of their grade. Lastly, the operation concept exams were completed, scored, and recorded it is these final exam scores that were used in the calculation of the t-tests.

The 2002 group had Integers taught to them using stories; one for addition and subtraction and one for multiplication and division, while the 2004 group had Fractions taught through one story of a pirate. Addition and subtraction in 2002 used a story called Integer Warfare and multiplication and division was taught through a story about fish. (see Appendix B).

The next part of the Integer unit, multiplication and division, was then introduced and the same pattern of instruction was followed. The final part was completed when all operations were reviewed, practised, then tested. This followed a pattern of instruction in place since the start of the school year and was consistently followed. The difference in the instructional method was the use of a story frame to instruct a mathematical concept, rather than a text-centered traditional lecture style of presentation.

The week following the final exam, students were given addition and subtraction questions and asked to write out a story using the numbers. The following day I assigned multiplication and division questions along with the same task, of writing out a story using the numbers. On the third day students completed questionnaires. The entire unit took four weeks to complete. Each daily Math lesson averaged 45 minutes. There were three days
of interruptions during the unit due to special school days and events. However, these interruptions did not seem to affect the overall unit instruction.

The Fraction unit was a traditional text-based unit using the same pattern of instruction: introduction, practice, and test. This unit took five weeks to complete from introduction to final exam. Addition and subtraction were covered first then multiplication moving from simple to complex concepts, as is my standard practice with all Mathematical units.

In 2004, the units of story-framed instruction was reversed. The Fraction unit was story-framed and the Integer unit was textbook taught. The unit of Fractions was chosen instead of Integers to control the possibility that Integers may be more story friendly than fractions, and also to account for the possibility that there could be a difference in inherent difficulty. From January to March the 2004 group was taught Integers and Fractions. The Integer unit was taught from the textbook using manipulatives, board examples, and teacher direction and explanation as needed following a traditional teacher transmission model. The Fraction unit was taught using a story frame. Manipulatives, board examples, and teacher direction and explanations were used and incorporated and linked to the story frame as much as possible.

The story frame of the Fraction unit revolved around a character trying to solve a problem or attain a goal that involve the four operations of addition, subtraction, multiplication, and division of fractions. The story-framed unit followed a typical narrative design sequence of problem/goal, attempt to resolve or attain, and denouement. (see Appendix B).

As the career of the pirate unfolded the captain faced different goals or problems that required the four operations to come into play. On one
adventure the pirate crew dug up another pirate's treasure and discovered chests of pieces of eight, quarters, halves and whole coins. Counting the loot involved multiplying and addition. Sharing the loot entailed division and subtraction to complete the task or solve the problem. Another adventure had the captain's daughter getting kidnapped by his privateer nemesis. The pirate captain had to pay a ransom to get his daughter back. All his men contributed a share to meet the ransom. However as they all "chipped" in according to their rank, some gave eights, some gave quarters, and some gave halves; the captain had to figure out if he had enough money to pay the ransom. Again, in order to solve the problem, the orders of operations were used.

The Fraction unit using a story-framed unit took place over four weeks. The same operational concepts were covered as the previous unit: addition, subtraction, multiplication, division, and order of operations.

The comparison unit for 2004 for Integers did not involve a story frame. It was taught using a text centred approach. Real world examples and manipulatives were used as examples, as suggested by the teacher's guide. The procedures for the four operations followed a step-by-step explanation.

The Integer Unit was divided into four weeks. One week was a short week and the basic concept of an Integer was introduced. The remaining three weeks covered the four operations of addition, subtraction, multiplication, division, and order of operations.

At the end of each unit the final student grades for 2002 and 2004 were recorded using the school's computerised grade book program called Class Master. This assured that all assignments and exams were weighted the same. All groups had their units taught to them using the same pattern of
Story-framed Instruction

instruction: introduction, practice review, and examination for each higher and lower level operation. This ensured a consistent pattern of instruction. As teacher, instructional pattern of introduction, practice, review, and test was and has been a constant pattern of instruction for many years; and the same method of grading using the same assignment weights with the same grade book program was and is still current practice; it provides a consistent marking or assessment routine. The benefit of comparing two classes from two different years was an opportunity to have a longer termed comparison.

In the questionnaire both the 2002 and 2004 groups were asked to comment on which type of lesson structure they preferred, either story-framed lessons or non story-framed lessons. Both groups were also asked what they did not like about the story-framed lesson. Nondirectional t-tests were used to compare the aggregate learning results from the four math units for the classes of 2002 and 2004 for story-framed units and non story-framed units.

The qualitative data was collected first and examined for themes and trends. The quantitative data was collected and analysed last. The researcher journal was an ongoing process in 2004. The 2004 student questionnaire was handed out before final grades were known by the students. This was consistent with the 2002 study protocols. The results section reports the qualitative data first, then the quantitative data, which is in the order data collection occurred.

Limitations

Data for the missing class for the year of 2003 was not nor could not be considered for this project. There are several mitigating reasons. I had a student teacher at the beginning of the year. I missed six months of the school
year due to a knee injury. The remaining time left with the class of 2003 was insufficient to proceed with the study. Therefore the two sets of data available for comparisons are from the class of 2002 and the class of 2004. The time differential between the two study groups may also have been a mitigating factor in the test results for the two classes.

Another variable that may have affected the results was the timing of the units. In 2002 the Integer unit was begun shortly after the permission forms were sent home and returned. The students of 2002 may have had a heightened awareness that the Integer unit was part of a study therefore their awareness may have caused higher levels of attention to the story and resulted in higher t-test scores as well as more positive responses on the student questionnaire.

The 2004 group had the story-framed fraction unit second and their awareness therefore may not have been as acute as the 2002 group. This may also have effected their sensitivity to the unit and resulted in lower ranking of the story-framed unit on their questionnaires and t-test results.

Story-framed instruction in this project did not account for cultural differences where story telling has been a model of instruction for centuries. Further study along these lines may produce significant results and offer potential solutions to teaching to cultures that have a strong story telling background.

The units themselves are made up of different concepts. The very nature of an Integer and a Fraction being different may account for differences in results.

Results
I did not keep a journal as part of the study in 2002 as it was not an integral part of the initial study and would have been beyond the scope of the planned mini research project. A graduate course in qualitative analysis alerted me to the many issues surrounding researcher bias. This awareness moved me to conclude that some form of record keeping would be needed as a reference check for researcher bias. The intent then of the journal in 2004 was to allow me to monitor my influences, if any, and provide me with a reflective perspective as the study progressed. Each journal entry briefly summarised the lesson and my thoughts and reflections at the time. I drew upon the journal entries in the analysis stage to provide qualitative contextual information about the project. The journal added human insight about this project and allowed me to monitor my own perceptions of the unit. The questionnaires provided a point of view of a student while the journal provided a point of view from the teacher.

The journal entries were particularly useful as the class and I moved from the non story-framed Integer unit to the story-framed Fraction unit. During the Integer unit I conscientiously tried to maintain and use the examples, explanations, and suggestions contained in the math text book. However, I was beginning to feel constrained when students would ask for clarification or needed a reteaching of a particular concept and I had exhausted the suggestions contained in the book.

I felt restricted by the textbook's approach. Although I thought the analogy straight forward, it was very obvious by the number of raised hands for assistance, that students only understood parts of the lesson. They had difficulty conceptually linking the visual
representations of the text to the mental activity of subtract or add
(Journal entry, 01/26/04).

This feeling generated by the textbook was echoed in comments written in 2002
by some students who had used the same text book as part of their Integer
unit. “It (story-framed Integers) helped me a lot because it was fun and easier
to learn than the text book. I picked 4 because in the book the examples make
no sense and it was hard to learn” (2002 student).

However, as the unit progressed more and more emphasis needed to be
placed on the text book’s use of manipulatives in the form of blue and red
colour chips and or drawings of the same to achieve an understanding of the
concepts behind the four basic operations. The effectiveness of using
manipulatives was noted and obvious when students could be heard
expressing their “A-ha” moments: “Oh! This is how it works,” and, “I get it
now” (2004 observation).

The following anecdote illustrates one of the difficulties I faced in
teaching from the textbook. Several students raised questions about the
diagrams in the text book. The textbook lesson covered the notion of adding
negative numbers, which was a fairly straight-forward concept. The student
concerns had to do with the diagrams of number lines rather than the notion of
working with negative numbers, it was with the visual layout of the number
lines themselves. I noted from the journal entry how the diagramming of the
book served to confuse rather than clarify (see Appendix C). The explanation of
the number line workings presented more of a challenge than did the original
mathematical concept. The students, however, seemed to understand the
notion of adding integers in spite of the confusion surrounding the number line
diagrams (Journal entry Jan, 28/04).

Other than the text book's insertion of a new diagram in the work sheets, not used or introduced in the corresponding lesson in the text book in the initial unit lesson, the unit as a whole progressed from one day to the next fairly smoothly. I was struck by the monotonality of my notes during the text based Integer unit. Although reporting the progress of the lessons, the tone of the journal entries seemed devoid of emotion other than when the text book introduced a new concept in the form of an errant example. I was struck by the flatness of my entries. They appeared clinical, sterile, and business-like.

The journal entries for the story-framed Fraction unit provided a sharp contrast to the business-like tone of the Integer unit. At several points during the presentation of the unit I could feel my excitement at the commencement of the unit. At points when I felt that the story was being interrupted by school events or at the length of time the review and practice lessons took, I would experience some angst and disappointment that parts of the story did not flow as smoothly as I had hoped. During a lesson when I reviewed how pieces of eight could be put together to form full coins and how the share tree worked for dividing up treasure, I experienced an anxious time. I was telling the story from memory. I made an error in the division of the treasure. I committed the mistake I had just warned the class to be wary of. I neglected to divide the treasure in half twice in order to allocate each lower rank their proper share. Finally a student pointed out my mistake. We started over again. During this lesson, the class had three interruptions: two students were sent to the office for fighting in class, a maintenance worker lectured the class on the cost of chair and desk repairs, and a special needs child started to wander the room.
It was obvious I had lost my audience and myself. Instead of stopping the lesson, I continued, thinking I had only a limited number of lessons to get things done. My division error, besides being embarrassing, served to confuse the class instead of clarify. I felt I had lost the story. Telling the tale from memory was an error. As the lesson and class unravelled, so too did the story. I pondered the possibility that a bad teaching day could have the same deleterious affect on learning as a poorly delivered story on the very outcome I was trying to study.

I felt I had no choice but start over at the beginning and read the story to the class up to and past the damaged part of the day before. I called it a review. The lesson looked at different ways to express the same thing. This was a foreshadowing of skills to come. Student were being introduced to the concept that dividing by X has the same affect as multiplying by the reciprocal of X, that is reciprocation.

The reading of the script seemed to reestablish the story. The reading kept me focussed, and without any interruptions, this time, the students were attentive. I noted, as I read, that some students sat back in their chairs and seemed to settle in to the story. Very few questions were raised about the manipulation of X or 1/X. Questions tended to come from the same student who had difficulties with Integer concepts and along with had difficulties in math in general.

The rough start, sometimes typical of newly created lessons, was indicative of units going through a premiere usage. At first I tried to tell the story like a bard of old but my bardic skills needed remediation. I let that idea
drop after the first lesson. I backtracked and read from the script. I felt this would work as the script would keep me on track despite what ever emotions I may experience or not on any given day. At the same time I was trying not to have a math lesson turn into a reading session. This trying start may have accounted for the emotive undertones of the story-framed journal entries. As the unit progressed, my concern for the unit’s success was evident.

The anxious feelings I had throughout the unit at the time revolved around answers to “if you had to do it over again” type of questions. I was worried about the pacing of the story as some readings seemed to be very short before the practice and review sessions, and other lessons seemed to move the plot along but not the math. I made what I considered corrective changes to the story plot as we progressed in an attempt to keep the momentum of the story going. I was worried about the length of time between reading of the story and the working of the math. Although my journal entries indicated concerns for the story-framed Fraction unit, they also reflect a conscious effort not to deviate too far from the basic plan. If longer reviews and reinforcement activities needed to be made at the expense of the story, then so be it. Ethically I could not attempt to protect the integrity of the story at the expense of my students’ learning. As it turned out, my concerns with the story-framed Fraction unit were not unfounded. The student responses helped clarify what was out of alignment with the Fraction story frame.

Student Questionnaire Responses

The 2002 group was aware that they were part of a university project, as they were told at the beginning of the project that I was looking at learning differences in instructional methods. The class of 2004 was told the same
information. However, as I began the Integer 2002 unit with a story-framed lesson, I felt that group awareness "of what's going on" was more acute than in the 2004 group (see limitations). The 2004 group began the first part of the study with the non story-framed Integer unit. With both groups, the unit sequence was the same: first Integers, then Fractions.

Because there was a break between the groups studied of one full school year, there was an extremely small chance that any discussion among participants occurred. Therefore sharing of information between groups that might lead to a skew of the data was not a concern.

There was a difference in the student questions on the questionnaires. (see Appendix D.) The 2002 group was asked to rank and comment on about the second story frame. The 2004 group did not have a second story; therefore no question ranking the stories helpfulness could be asked. However, in 2004, the second question asked the group if they used the stories to assist them to compute fractions. As the questionnaire was administered at the end of the study, this difference in the questionnaire would not have affected students' grades nor the outcome of this project.

Overall, the 2004 group was critical of the story-framed Fraction unit. When responding to the question, "What did you not like about the story-framed unit?", students commented on the length of the story. The comments about story length describe how the story lengthened the math lesson and therefore was something many students did not favour. One student wrote, "I did not like how long the lessons were with the stories." Other students wrote: "I didn't like how in some parts they got really boring and I just wanted to do the work" and "It takes too long to explain so there is not enough time to do the
work in class.” This sentiment was echoed in 2002 by a student who wrote: “I did not like writing out the stories, it took too long.” However, notably fewer comments were made by the 2002 group regarding the length of the story instruction.

However, both the 2002 and 2004 groups described the stories as entertaining and enjoyable. The descriptors of “fun” and “funner” were consistently used to answer the question: “Which do you like better -- a regular math lesson using examples on the board or from the textbook, or examples using stories?” Students found story-framed units to be entertaining, interesting, and fun. When asked which type of lesson they preferred, a story lesson or a regular lesson, students tended to respond in general ways with respect to the method of deliver: “Stories are more interesting,” or “I like to use stories it helps us a lot,” Specificity occurred in the “What did you not like” question. Task oriented students, although mentioning the fun factor of story-frames, were critical of the time it took for the story to be told.

Students who had difficulties with math tended to link the story parts to conceptual difficulties experienced in math rather than to a dislike of a theme or topic. I interpreted the comment, “Warfare was a little confusing” as referring to students’ difficulties with the operations of adding and subtracting Integers. Similarly, “How he kept cutting up the coins. It confused me” referred to students’ difficulties with understanding the concept of equivalent fractions.

Responses to the question that asked if students used the Fraction story to help them compute fractions indicated that they dropped the story element once the concept was understood. Comments such as: “I understand how to do fractions without the stories. But it helped me understand subtracting
fractions better,” and, “I just work with numbers” strongly suggests that the scaffolding element of learning was at work. That is, students used the strategy of the story plot until the mathematical concept and procedure become automatic, and then story plot no longer plays a role in the cognitive processes necessary to preform a calculation. However, this is not to suggest that this would be restricted to story telling. I would fully expect similar answers to be given if I asked the same type of question from a non story-framed lesson. For example, the use of manipulatives creates a visual scaffold to develop a mathematical concept. Once the concept is understood, it would be unlikely that students would produce a manipulative to use to calculate a fraction or integer question. Subsequently, it would be unlikely that any student would respond by saying that he or she would dutifully go through every step and subsequent sub routines of a mathematical equation, without taking any shortcuts, before arriving at the answer, after being taught a mathematical calculation in meticulous detail. How often have teachers heard the question “Do I have to show my work?” Perhaps the best revelation to do with the scaffolding nature of detailed explanation with or without story framing was written when a student wrote “Once I got it I didn’t need it.”

The most notable difference between the class of 2002 and the class of 2004 was the response to the question asking students to rank how story-framed units helped them learn the concepts. The majority of the 2004 group indicated that their story-framed unit on Fractions only helped them “A Bit.” Whereas the majority of the 2002 group indicated that their story-framed unit on Integers “Helped A Lot” The groups ranked their story-framed units with divergently skewed opinions (see figure 1). The 2004 Fraction group indicated
their view that their story-frame was less helpful to their learning their unit. The 2002 Integer group indicated their view was that their story-frame was helpful to their learning of their unit.

Figure 1
Student responses to how stories helped learning.

■ Fractions 04 ■ Integers 02

Quantitative analysis The student exam score data from the 2004 group and from the 2002 group for Integer and Fraction units with and without story-framed instruction, were entered into nondirectional t-tests for each unit. The two tailed t-test for the comparison for Fractions indicated that the null hypothesis must not be rejected as there was no statistical difference between the groups. 

\( M = 84, t\text{-stat} = 1.85, t\text{-Crit two tail} = 2.01, \alpha = 0.5 \)

The t-test for Integers indicated that the null hypothesis could be rejected as there was a statistical difference between story-framed Integer instruction and non-story-framed mathematical Integer instruction. 

\( M = 89, t\text{-stat} = 3.24, t\text{-Crit. two tail} = 2.01, \alpha = 0.5 \)
For Fractions since the t-stat (1.85) < t Critical two-tail (2.014) we fail to reject $H_0$. The students who received traditional instruction did not score significantly higher than the students who received story framed instruction for the fraction unit (see table 2).

For Integers since the t-stat (3.268) > t Critical two tail (2.013) $H_0$ is rejected (see table 3). The students who received story-framed instruction scored significantly higher than the students who received traditional instruction for the Integer unit. The mean score of the story-framed Integer unit was statistically significantly greater than the direct text modelled instruction for Integers, a difference of .95 standard deviations (see table 4). In fact the average story framed Integer student can be expected to have an Integer Unit test score greater than 83% of the students who learn Integers by the traditional text based instruction. Story framed Integer instruction is associated with higher test scores on the unit test.

The t-tests indicated that Integer story-framed instruction can better class scores, while the Fraction story-frame used for instruction can not be said to better class scores. However the results may only cautiously and conditionally support the assertion that story-framed instruction is advantaged over a traditional method of instruction with respect to learning outcomes given the relatively lower power of behavioural research (Hurburt, 2003).
### Table 2

**t-Test: Two-Sample Assuming Equal Variances for Fractions**

<table>
<thead>
<tr>
<th></th>
<th>Fractions 02</th>
<th>Fractions 04</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>without story</td>
<td>with story</td>
</tr>
<tr>
<td>Mean</td>
<td>84.08</td>
<td>72.95455</td>
</tr>
<tr>
<td>Variance</td>
<td>106.8267</td>
<td>783.474</td>
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<tr>
<td>Observations</td>
<td>25</td>
<td>22</td>
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<tr>
<td>Pooled Variance</td>
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<tr>
<td>Hypothesized Mean Difference</td>
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</tr>
<tr>
<td>df</td>
<td>45</td>
<td></td>
</tr>
<tr>
<td>t-Stat</td>
<td>1.851347</td>
<td></td>
</tr>
<tr>
<td>P(T&lt;=t) one tail</td>
<td>0.035344</td>
<td></td>
</tr>
<tr>
<td>t Crit. one tail</td>
<td>1.679427</td>
<td></td>
</tr>
<tr>
<td>P(T&lt;=t) two tail</td>
<td>0.070689</td>
<td></td>
</tr>
<tr>
<td>t Crit. two tail</td>
<td>2.014103</td>
<td></td>
</tr>
</tbody>
</table>
Table 3:

**t-Test: Two-Sample Assuming Equal Variances for Integers**

<table>
<thead>
<tr>
<th></th>
<th>Integers 02 with story</th>
<th>Integers 04 without</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>89.076923</td>
<td>76.272727</td>
</tr>
<tr>
<td>Variance</td>
<td>117.35384</td>
<td>261.06494</td>
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<tr>
<td>Observations</td>
<td>26</td>
<td>22</td>
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<tr>
<td>Pooled Variance</td>
<td>182.96108</td>
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<tr>
<td>Hypothesized Mean Difference</td>
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<td></td>
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<tr>
<td>df</td>
<td>46</td>
<td></td>
</tr>
<tr>
<td>t-Stat</td>
<td>3.2677614</td>
<td></td>
</tr>
<tr>
<td>P(T&lt;=t) one tail</td>
<td>0.001027</td>
<td></td>
</tr>
<tr>
<td>t Crit. one tail</td>
<td>1.678658</td>
<td></td>
</tr>
<tr>
<td>P(T&lt;=t) two tail</td>
<td>0.002054</td>
<td></td>
</tr>
<tr>
<td>t Crit. two tail</td>
<td>2.0128936</td>
<td></td>
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</tbody>
</table>

Table 4:

**Means & Standard Deviations of non-story-framed and story-framed units**

<table>
<thead>
<tr>
<th>Unit</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fractions 02 with no story frame</td>
<td>84</td>
<td>10</td>
</tr>
<tr>
<td>Fractions 04 with story frame</td>
<td>72</td>
<td>28</td>
</tr>
<tr>
<td>Integers 02 with story frame</td>
<td>89</td>
<td>11</td>
</tr>
<tr>
<td>Integers 04 without story frame</td>
<td>76</td>
<td>16</td>
</tr>
</tbody>
</table>
Discussion

My discussion follows the chronological order of the study. I will discuss the qualitative data first, then the quantitative data, and then conclude with a brief summary and ramifications for the future. The journal entries and student questionnaires provide an interesting view of “two sides of the same coin.” Therefore they will be discussed in tandem as it is difficult to discuss one without the other.

The debate between the merits of qualitative and quantitative research is an ongoing debate. One of the arguments revolves around researcher bias or influence. A proponent of qualitative methodology will argue that the purity of numbers transcends the messiness of human interactions. At the heart of the issue is objectivity vs subjectivity. Truth, they will say, is in the numbers. A proponent of qualitative approaches will argue true meaning is immersed in the messiness of human interaction, and that all human actions are contextual and; without context, there is no truth. However, I believe the merits of a mixed design is that the quantitative and qualitative aspects should complement each other and that strength of truth in a mixed design is found in the convergence of data.

Researcher role.

Regardless of design the issue of the researcher’s role always needs to be addressed. Because I was both the researcher and the teacher, my actions necessarily influenced the success or lack of success of one method over another. My professionalism obligations as a teacher would oblige me to positively influence learning outcomes regardless of instructional approach, and justly should. Improving learning outcomes is, after all, the goal of
teaching, regardless of topic or method of instruction. Efforts to improve learning outcomes was constant and therefore not a concern related to this research design. The outcome of the study was also not considered as an influencing factor. The process of doing the study is a requirement of UNBC's Master's program; but particular results were not necessary to achieve a passing grade, therefore it did not influence my behaviour during the study. To intentionally or carelessly influence the outcome of the project would have been to render it unworthy and would have been in conflict with teaching professionalism and research integrity.

Lastly, the traditional approach to instruction is one I am familiar with and have used for many years, whereas instruction with story-framed instruction is new to my instructional repertoire. My journal entries reflected my angst during the story-framed Fraction unit of 2004 and the calm, almost emotionless flatness I experienced during the non story-framed Integer unit of 2004. My not having the luxury of redrafting or developing familiarity with the new approach to instruction with the Fraction unit through successive years of modification may have contributed to the lack of non statistical significance between the two classes. The old saying, "you never know if works, until you try it" applies to the Fraction unit.

Effect of Story-framed Instruction on Learning.

In order to better interpret results of the statistical comparisons between student exam scores and units with or without storytelling, I felt that the best way to ascertain if story telling was an instructional influence on student learning was to ask the students directly. The second measure used in this project then, was a student questionnaire using a 4 point Likert scale along
with an open response section which provided a perspective of the students' views of story-framed math instruction. The questionnaires addressed the scaffolding intent of story-framed instruction specifically by asking students to comment on the utility of story-frames. The majority of the 2002 group described the story-framed unit as "helping a lot", whereas most of the 2004 group described the story-framed unit as "helping a bit." (see figure 1). Some students were critical of the story-frames because they lengthened the lesson, but almost all of the students in both years described the story frames as "fun" and "enjoyable." (see Appendix C).

A cross reference of the 2004 students to their comments produced some interesting observations. Most students who wrote comments about the story frame prolonging the math lesson and thereby causing them to have to wait before being able to get on with the work, were student who were task-oriented high achievers.

Students who had difficulty with the story-framed Fraction unit tended to be those students who had difficulties with Mathematics in general. Several of these students wrote that the story was confusing in parts, or that the length caused them to tune out and then get lost or confused. Oddly, however, some students, who experienced a high degree of difficulty in math, wrote the most favourable reviews. One interpretation is that although the educational thrust of the story may have missed its mark, at least they were entertained by the it.

The results of the t-tests did not support what I had expected, that story-framed instruction would improve learning outcomes regardless of mathematical topic. Rather, learning outcomes were mixed with both approaches to instruction. The student questionnaire responses led me to
expect that because many students preferred story-framed instruction, their learning outcomes also would improve. Furthermore, student responses clearly indicated that story-framed instruction was enjoyed as a preferred method of instruction, nevertheless. However, the t-tests indicated a statistical significant difference for Integers with story-frames only, and no statistical significance with Fractions.

Students also made it clear that, although they found story instruction entertaining, efficiency ought to be considered if a teacher wishes to use a story-framed lesson. The length of the story needs to be considered. It must be interesting but not prolonged. The 2002 group rated stories higher in enjoyment than did the 2004 group. Perhaps the difference can be accounted for because the length of the Fraction story-frame was too long to hold their attention. In short, they became bored and to them a boring story is no different than a boring lecture. The 2002 group were taught with two short stories. This leads me to find that both delivery and structure are important dimensions to a story-framed model. The structure of the story-frame must support the content and the delivery of the structure must gain and hold the attention of the audience. Missing the audience with a theme would end with the audience’s attention drifting off. The length of the pirate story used to teach operations of fractions may have attributed to the low rating by students and contributed to the nonsignificant difference in teaching instructional method. Perhaps four different stories could have been used to teach each of the four mathematical operations. More students in 2004 found the story too long. This may suggest several things. There may be a threshold or tolerance level that students have towards story-framed instruction. Shorter stories may
be better matched to “learnable chunks” of concepts. Perhaps too much of a good thing becomes simply too much.

Students clearly like to be entertained yet at the same time they don’t want to see their work time lengthened, prolonged, or just delayed. It is possible that the design of the story-frame inadvertently lengthened the math time of the students. Issues of relevancy come to mind. Instruction, story-framed or not, must be seen as valuable to the listener. It is, after all, the content, story-framed or not, that must be seen as valuable by the student. Perhaps if students can not “get into” the story, they also can not “get into” the concept.

The 2004 group made it clear that the “carefully crafted” story I had written was “careful crafted” only from my point of view. What was obvious to me when I wrote the story was not obvious to the class when I read the story. Students pointed out my literary over confidence when they ranked the pirate story as only a two and wrote “I didn’t really understand what the story was trying to do to our math assignments. I learned from the examples” and “I found the story very long and boring, it helped a little bit but it was sometimes confusing.” My story received a unfavourable low ranking; yet when the same group was asked which type of lesson they preferred, they indicated a story-framed lesson was preferable: it was entertaining; it was interesting; it was fun, or “funner”. One implication is that some form of pilot testing a story would have helped. Pilot testing “bits” of a story or chapters may help reduce potential difficulties with the story-frame. However, in the real world of teaching not having the luxury of time to pilot a new story is a reality that needs to recognised. The parameters of the research study illuminated the
option of just dropping the story at any point. During a unit, where a teacher feels that a particular approach is not as effective as one hoped, there is always the option of switching to a different approach. I was beginning to feel that may have to be an option, but to do so would have been to stop the research project and potentially lose valuable information and insights.

The other reason accounting for the apparent disingenuous view point about story-framed instruction between the 2002 group and the 2004 group, could be that I had crafted a story that may have overemphasised plot at the expense of mathematical connectivity. In Egan’s (1998) words, I lost the story. My journal entries pondering the lapses of timely story-framed lessons and math relevancies point to this as a likely possibility. The following journal entry indicates that I was questioning the strength of the story frame and the mathematical concepts I had tried to construct.

As I planned out the remaining lessons, I noted that the pattern of story lesson, then review classes, has several lessons of supplementary and or review work without moving the story along. These reinforcement practice lessons are void of the story. I am wondering if the non story math classes are causing the story thread to become incidental to the unit rather than integral to the unit (Journal entry 02/26/04).

Clearly I felt there was a good probability that either my story frame was flawed, or my delivery was flawed, or both. I can not recall feeling as anxious about the Integer story-frame in 2002. Perhaps the stress of “finally doing the Masters project” was influencing my feelings at the time. Nonetheless, the comments from some of my students clarified the real unexpressed concern I was journalling about. My concern was not so much about the time that
review and practice lessons were taking, causing story frame malfunctions; but that my story-framed math instruction had indeed been so crafted that plot and character motivation were incidental to the unit rather than integral it. This would have meant that I was reading a story in a math class rather than reading math into a story. The brutal truth of the matter could be just that. However, in point of fact, the t-test showed no statistical significance to story-framed instruction of Fractions as taught. That led me to surmise that learning was occurring and will occur regardless of instructional method. This assumes, of course, that instruction is carried out to the best of ability by the presenter. Whether my Fraction unit or my Integer unit will be remembered by my students several years later is another question.

The confusion about the number line diagrams and the error made in the sharing of the loot example, although causing some concern at the time, was adjusted for by the students. In the long run, errors were addressed, compensated for, then moved away from or discarded. This, to me, speaks to the resiliency of a young mind.

The t-tests reflection of no difference between story-framed instruction and non story-framed instruction for Fractions may be an indication that concepts involved with the operations of Fractions are inherently harder than those of Integers. It is also possible that some Mathematical units are more “story friendly” than others. I feel this is an extremely important point that requires further research to fully address. However, the t-test results for Fractions may also point to other factors why story-framed instruction did not result in a significant difference. Several reasons may account for this. My skills as a story teller might not be sufficient to have had an impact upon the
2004 students. Delivery of the story-frame was an underdeveloped dimension in my story-frame, as the telling of the tale can be as important as the tale itself. My story-frame for the 2004 year was insufficiently developed in a structural dimension that did not allow the transmission of conceptual understanding to the students. I might have created the wrong type of story frame to use with the Fraction unit. My understanding of story frame construction might be inexpert such that the complexities of Fractions were beyond my capacities to create the appropriate story-frame. Equally possible is that the structure of the story frames for Fractions and Integers were different enough to cause the Fractions story-frame to be noneffective, whereas the structure of the Integer story frame caused it to produce a significant difference in test scores. The Integer story frame personified the Integer unit itself much like a character found in a cartoon. In the Fraction story frame, the protagonist was observed doing operations with fractions as the plot unfolded. Perhaps the immediacy of Integers to plot compared to Fractions can account for a structural difference between the two story frames and thus the success of one story frame over the other. The Integer operations were the plot while Fraction operations were just in the plot. The structural composition of story frames needs to be further explored in greater depth as a effect dimension.

The intent of this project was to measure the effectiveness of story-framed instruction. Although the students showed a mix of statistically significant and nonsignificant gains in learning with story-framed instruction there was no decreasement either and the students appeared to enjoy it for the most part. The results indicate that the notion of teaching with stories is not
as easy as it sounds. That research supports its effectiveness in areas such as memory techniques, transmission of culture, and other aspects of formal education is not enough to assume that story-framed instruction will be effective in any and all areas of education. In order to avoid story-frames that are stilted, overly contrived, or have excessive amount of "items of interest" that overburden a story line and cause the learner to lose interest in the story, requires further study particularly in curricular areas not normally thought of as rich with stories, such as Mathematics. In addition, further experimentation that tries out particular techniques of story-framed instruction may help develop effective story-framed instruction. Teachers will need time to practice these methods of instruction to enhance their on familiarity and develop expertise.

This study represents the efforts of only a single researcher using a teacher as researcher approach to test the possibility that story-framed instruction is an effective method of instruction in mathematics. It is possible that the more complex the mathematical concept the less "story friendly", it becomes. It is also possible the story-frames used in this project were not suitable for the Fraction unit of this study. A different story-frame was needed or that it needed to be refined. These can be seen as limitations of this project but can also be seen as indicators of further study.

There is another possibility that as a teacher, I find particularly appealing. The qualitative data suggested that story telling was a preferred method of instruction and provided insights for teachers to what students would require to make story-framed instruction more effective. The t-tests, can be interpreted as suggesting that at worst, it doesn't matter if a teacher teaches
with a story or not--the results will be the same. Perhaps good teaching is just that--good teaching. The method, in this case, is not the medium; the teacher is. If a teacher has a particular interest in using a story to teach a Math, then it should be used -- the students will learn the concepts. They will have more “fun” and the lesson will be more interesting.

Conclusion

In sum, this project points to three dimensions that need to be considered when developing a story-framed unit or lesson. The first dimension is the delivery. It is important that the presentation of the story-frame be as smooth as possible. The flow of my Fraction story-frame at times was interrupted at critical points. Errors in presentation necessitated reteaching of concepts. My journal entries underscored the importance of a good delivery as an important dimension in the a story-framed unit.

The second dimension is connection of the story-frame to the audience. My story-frame of a pirate did not resonate with the 2004 group as I thought it would. Comments suggesting alternate themes by the students indicated that the connectivity of the story-frame to the audience was not strong; at best it was neutral. The length of the story indicated a weak connection. Shorter stories may better suit more complex math concepts.

The third and perhaps the most difficult dimension of story-framed instruction is the structure of the story-frame itself. The results suggest that the Integer story-frame was operating on an operational level, whereas the Fraction story-frame was operating on a conceptual level. The Integer story-frame animated the operations of Integers. The Fraction story-frame contextualised the operations within the plot. I firmly believe that the
effectiveness of a story-frame may be dependent upon the complexity of the concepts being taught. There may be a significant difference between mathematical procedural operations and mathematical conceptual understandings to necessitate different story-frames. In the story-framed Integer unit a student did not need to know what an Integer was in order to do the operation. The goal was to learn the operation. In the Fraction story-framed unit understanding of what a fraction is, and why reciprocation works was part of the learning objectives. It becomes a possibility then, that, certain concepts within mathematical units can be story-framed while others may not as exemplified by the pirate story-frame that could only served to make the Fraction unit novel; but the story-frame could not at the same time act as an effective scaffolding device.

This third dimension of story-framed instruction requires further study to explore this query. Can story-frames be developed to better suit complex conceptual understanding: or are complex multi layered concepts simply not able to be framed?

This study indicates further research as being necessary to better gage the appropriateness of story-framed instruction as an effective teaching tool. It does work. However, a story-framed instructional model's own story is yet to be fully told.
References


database


Story-framed Instruction


Appendix A

Consider *The Story of Numbers and Counting*, by Anta Ganeri as reviewed by Pothier in *Teaching Children Mathematics* (1998) and by Marchand (1998) in *Mathematics Teaching in the Middle School* as an example of blending of story and instruction. Ganeri's book presents historical informational items about the development of counting numbers and numeration systems by various civilizations. Both reviewers share some opinions of the book and its interest level, albeit with some disagreement existing about grade level appropriateness. One wonders who is the target audience for the book. Upper elementary children could read the book but would need to search other sources for more information about the development of numeration and number systems (Pothier, 1998). Marchand reports that an eighth grade student found the book more appropriate for fifth or sixth graders because of the large print size and lack of depth, which was a similar concern expressed by Pothier. In spite of concerns about grade level appropriateness, both reviewers recommend the book. Pothier purports one gets a sense of the time elapsed from the beginning of recording numbers to the development of the numeration system we use today. Marchand claims the strength of the book is its interesting layout with a variety of print sizes, fonts, colours, and photographs. She claims it shows the historical relations of mathematical concepts and modern developments. Perhaps it is the motivational aspect of interesting displays and presentations that capture and hold the student attention (Pintrich & Schunk, 2002) and not the actual story.

Next, consider another example of storied instruction. Whitin (2001) reviewed *The Story of Clocks and Calendars: Marking a Millennium* by Betsy
Maestro and illustrated by Giulio Maestro. Not unlike *The Story of Numbers and Counting*, Whitin comments that this book provides an informative way to demonstrate how the concept of time developed from a human need. It has generous, colourful illustrations, accompanied by brief descriptions, that complement and enrich the historical narrative. It is important to note that both these books are recommended, yet neither of the recommendations refer to the effectiveness of placing the mathematical concepts in to a story frame.

Most reviews found were long on presentational aspects of stories and very short with respect to referencing the effectiveness of teaching with stories. It is possible that the assumption is made that stories are effective instructional devices that no mention is made of specific studies that support that very assumption.
Appendix B


*Story Frames for Integers*

The following sample story frames were used to instruct the math operations of addition, subtraction, multiplication, and division.

**Addition & Subtraction** for 5+ - 7 = -2

In the universe of Math there exists the world of Integers. In the world of Integers there are two realms: One is in a state of constant war; while the other has found peace and love. First we shall look at the realm of turmoil. This is known as the realm of Addition and Subtraction.

When Integers interact with each other they do so under very strict laws. There are two kinds of Integers, the Reds, who wear plus signs; and the Blues, who wear negative signs. When a Red and a Blue meet they have an overwhelming urge to attack each other. However, each Red and Blue are evenly matched and they eliminate each other. So one Red and one Blue equal nothing or zero. Zero is neither red or blue. This can be illustrated as (+1-1=0). This law of the realm is never broken.

**Part I**

Here is a story of a battle that looked like this +10 + 5 -16 -12 + 7 = -6 (Positives are written with red chalk, negatives in blue). Ten positives were walking along a path when they came across a group of five. Because the group of five were positive, they joined forces. Now they numbered 15.

As the group of 15 positives continued their journey they came across a group of sixteen. Because this group was negative a huge fight ensued. They
paired up a duelled. Each red was eliminated for every blue. At the end of the fight only one blue remained. The single blue decided to go home. As the one negative trudged home it came across a group of 12. Because these 12 were also negative they welcomed the single negative into their group. Now they numbered 13. The 13 negatives returned to their castle.

On the way home they came across a group of seven. Because the group of 7 were positives, they began a melee. They paired up and fought. Six negatives remained after the skirmish. The six negatives retired from the field and made it home safely.

Part II

After awhile both the Reds and the Blues tried to cheat. They developed a double sign. There are four combinations of double signs. (--, -+, +-, ++).

Unfortunately each side knew the code to the disguise. The first sign always indicates is (+) or is not (-). When you see a double sign, that is two signs with no number in between them, they are considered as spies. Why spies? Because they hide behind a sign. For example: ++5, - - 6, + - 7, - + 4.

First let’s look at ++5. Remember the first sign means either is or is not. Positive means is and negative means is not. So ++5 means is +5. - - 6 means is not -6. If it is not -6 then it must really be +6. + - 7 means is -7. If it is -7 then it is -7. - + 4 means is not +4. If it is not +4 then it must be -4.

Let us look at a battle script of --4 ++5 --6 -+4. The first number is not minus 4. So it has to be +4. The second number is plus 5. The third number is not minus 6. So it must be +6. The last number is not +4. So it must be -4. The script really is +4+5+6-4. So the 4, 5, & 6 all join forces because they are
really on the same team. They number 15 positives. They come across 4 negatives. They pair up. They have combat. 11 positives are left. Therefore \(-4 + +5 --6 - +4 = +11\).

Part III.

A mixed battle script may look like \(+7 -+6 -12 --14 +5\). This mixed script would be read as follows:

A spy 6 tried to trick a positive 7. However, the 7 knew the code. “Six you is not a plus 6. (The word ‘is’ is used as it is associated with the word equal or equal to) Therefore you are negative.” So they fought. One positive was left. Next the positive crossed paths with 12 negatives. 11 negatives walked away. The minus 11s saw a 14 dressed as a minus-minus. They too knew the code the 14 is not a negative. Therefore it is a group of positives. The minus 11s immediately attacked. They lost everybody. Only 3 positives remained. They decided to go home. On the way home they came across a +5. Thank goodness they thought and joined with their comrades. Now the group numbered 8 positives. +8 called it a day.

In each battle script there is a plot. The first number serves as the introduction. The operations serve as the middle, and the equal answer completes the denouement of the story frame.

Multiplication and Division.

Next we turn our attention to the second realm. The realm of peace and love ... and fish. These are not ordinary fish. They are Integer fish. They come in two colours only: Red or Blue. Red is positive and blue is negative. However unlike the realm of addition and subtraction, Integer fish don’t fight. They
prefer to mate. However a very strange thing happens when they do. When a blue and a blue fish produce offspring they are always red in colour. When a red and a red fish reproduce, they also produce red fish. When two different colour fish mate, they always produce a blue fish. For example Red mating with Blue births Blue. Blue mating with Red births Blue. So anytime the fish are the same colour the result will be a red fish. Anytime the fish are different colour, they produce blue fish. We show red fish as + and blue fish as -.

The story for $5 \times -3$ would be as follows:

One day while swimming along, a red fish named five met a beautiful blue fish named 3. Being Integer fish they fell instantly in love and began to raise a family. Their baby was, of course, blue. Not being overly creative they called their baby -15.

The story for $-5 \times -3$ would be as follows:

One day while swimming along a blue fish named five met a beautiful blue fish named 3. Being Integer fish they fell instantly in love and began to raise a family. Their baby was, of course, red. Not being overly creative they called their baby +15.

These short love stories illustrate the notion that either a positive number times a positive number or a negative number times a negative number will always equal a positive sign. The answer will be the product of the two numbers. Again, like addition/subtraction, the operations were placed in a story frame with a beginning, the introduction of the first fish; the rising action, where the first fish meets the second and they fall in love; and the denouement, where the new fish is created and named.

The story of division is the reverse of multiplication. The first fish
represent the offspring, the second fish is a parent, and the answer is a parent. The story for \(-15/+5\) is as follows:

One day while swimming along \(-15\) became very very lost. Not having the greatest of memories \(-15\) forgot who one parent was. (Yes, forgot. Come on they're fish). \(-15\) found +5 and was overcome with joy. Now \(-15\) could find out who both parents where by asking. "+5" said \(-15\), "Can you tell me who my other parent was?" Of course said +5. In order for a positive named five, like me, to have a negative named 15, like you, I had to have married a negative named three.
The Story of Captain Forager and Fractions

Introduction to fractions

Captain Forager was a pirate. But he was not an ordinary pirate - he was mathematically inclined. At least he seemed to be doing a fair bit of math in his adventures. It all began when he managed to commandeer his first ship. This presented him with his first math problem.

Captain Forager had two second in commands for his ship called the Golden Sovereign. Each Commander was responsible for half of the ship. One Commander (1/2) had the starboard side while the other second in command had the port side. Each of the Commanders divided their area in half again. Each of the half halves were the responsibility of the Quarter master (1/4). The Quartermasters divided their half of a half of responsibility to the crew. These were called the Eights mates. (1/8). (Show students of ship diagram)

After a day of pirating, it was time to divvy up the loot. Captain Forager had a problem. Since he was the captain, he should get the largest share. His second in commands should get the next largest share and so down to the lowest rank. However, if he did not do it fairly he might end up facing a mutinous crew. He opened the treasure chest and took out some gold coins. He decided to give each sailor a share of booty equal to their station of responsibility on the ship. He took out his cutlass and cut one coin in half. Another coin was cut in half, then each half was cut in half again until there were four pieces. Still another coin was cut into half, then each half in half again; and yet again each half of a half was cut in half until there were eight pieces. He had 16 gold coins. Who gets what? How many full coins do the
Second in Commands get? The Quartermasters? The Eights Mates?

Soon a few other sea captains heard of the idea of pieces of eight and they too started cutting their coins into halves, quarters, and eights. This was a good idea for sharing but it did have some drawbacks. After a dashing raid in the Spanish Main, Captain Forager sailed home with a large chest taken as a prize. When he opened it, he had himself a huge problem. All the coins had already been cut. He had no idea how many gold coins he had. He laid the pieces out on the table and took note. He had 5 solid coins, 10 half pieces, 20 quarter pieces, and 40 eight pieces. He put the pieces back together. How many coins did he have?

Captain Forager had 20 coins. The Pirates’ Code says the Captain gets half of the booty, the 2nds in Command get half each of what the captain gets. The Quartermasters get half of what the 2nd in Commands get, and the Eights Mates get half of the Quartermasters get. Captain Forager keeps 10 coins and according to the Code splits the remaining 10 coins with his 2nd Commanders. They each get five coins. However, the 2nd Commanders have to give half of these coins to their Quartermasters. They have to split the 5 coins into equal halves: keep half for themselves and pay the Quartermasters half of their booty. The Commanders came up with this idea. One for me - one for them. One for me - one for them. Now they have one coin to split. They cut one coin in half and give the two full coins plus half a coin to their quartermasters. They tell the Quartermasters to pay the rest of the crew. The Quartermasters go One for me - one for them and cut the half coin in half again. They keep one full coin plus half of the half coin. They give one full coin to the two Eights Mates and tell them to split up their share evenly. How much
does each Eight Mate get?

Captain Forager developed a system to show how many coins parts he had. He thought this would save him time in the future. Full coins are shown as a number over one. (8/1). The number of half coins are shown over 2. (8/2). The number of quarter coins are shown over four (8/4). The number of pieces of eight are shown over eight (8/8). (Show examples 8/4=2 full coins etc.)

Several episodes later:

There was a lot of loot before them. Captain Forager knew he would have to share the loot with the crew other wise he would be risking a mutiny. He had a problem. He needed a thousand coins to pay the ransom. Can he pay the ransom from his share of the treasure? He needed to know how many coins the treasure contained. His crew were used to sharing according to pieces of eight. This treasure was based on pieces of sixes. There were 4800 pieces of coin in the right chest. How was the loot divvied up? How much did Captain Forager get? The Commanders? The quartermaster? The Eights Mates? (work through example with class. Assign work problems)

After dividing the treasure the Captain and crew set sail from the treasure island. According to the ransom note he needed to sail to Kingston. Along the way Forager tried to figure out a conversion method of dealing with sixes and eights. He knew that six pieces of sixes equalled one full coin. He also knew that eight pieces of eight equalled one full coin. He knew that a coin could be cut into halves, or quarter coins or eight pieces of eight. Piecing together pieces of six he discovered that two pieces of six equalled a third of a coin. Yet when he tried to match thirds with quarters or eights with sixes, the pieces never matched up. There must be something common between eight
and six. But what?

At this time there was a knock on the door. The cook entered and said he had 24 rations that needed to be eaten before they turned bad. The cook asked if the captain wanted eight men to get three rations each or six of the best sailors to eat four rations each as they had the longest watch ahead of them. A bit annoyed at the intrusion he waved the cook away and told him to solve his 24 by 8 or 6 problem. He had a bigger problem to solve.

Solve indeed, the cook gave him the answer. The common thing between 8 and 6 was 24. Captain Forager drew a circle and then drew a line cutting the circle in half. Then he halved the halves. This made quarters. Then he halves the quarters into eights. Then very carefully he cut each piece of eight into three equal pieces. Now he had a circle covered with very fine lines. This would be difficult to cut if it were a real gold coin

Draw a line showing a half coin.

On another coin draw a piece of six.

On a coin draw a piece of eight.

How many pieces of eight will equal the same amount of coin using pieces of six?

\( \frac{4}{8} = \frac{3}{6} = \frac{1}{2} \text{ coin} \)

or \( \frac{12}{24} = \frac{4}{8}, \frac{3}{6}, \frac{1}{2} \text{ coin} \)

Using the 24 piece coin, figure out, in 24ths, how much will \( \frac{2}{8} + \frac{1}{3} \)

equal. \( \frac{6}{24} + \frac{8}{24} = \frac{14}{24} \). Take two pieces of 24 and group them together. This would give you 12 pieces. If a coin were cut into 12 pieces, how many
12ths would 14/24 equal? (7/12). Using a system of common numbers Captain Forager could now solve almost any money problem that came his way. At least for a time.

Next Captain Forager played around with 1/8, 1/6, 1/4, 1/3, & 1/2. This is what he observed. 1/8 of 24 pieces = 3 pieces. 1/6 of 24 pieces = 4 pieces, 1/4 of 24 pieces = 6 pieces, 1/3 of 24 pieces = 8 pieces, and 1/2 of 24 pieces = 12 pieces. (24/8=3, 24/6=4, 24/4=6, 24/3=8, 24/2=12). Then he noticed that 2/8 of 24 was the same as 1/4 of 24. This made sense because 2/8 is the same as 1/4. He noted that (2 x 24)/8 = (1 x 24)/4. So as long as he was working with a fraction and a whole number all he need do was multiply the numerator of the fraction by the whole number then divide by the denominator. He wondered if this always worked.

Now he wondered how much 1/3 of a piece of eight would be. He drew out a piece of eight then cut it into 3 equal pieces. He had a piece equal to one
piece of 24. So $1/3 \times 1/8 = 1/24$. Numerator times numerator over
denominator time denominator. $(1 \times 1) / (3 \times 8) = 1/24$. (Review with overhead
and paper coins)

The last thing on his mind was how to deal with whole coins and bits left
over. He wondered how he would solve one half of $3$ and $1/2$. If he had three
full coins and one half of a full coin and he needed to share it with his
Commanders how much would each commander get? $1/2 \times 3$ and $1/2$ or
dividing $3$ and $1/2$ by $2$. This what he did. He cut each of the full coins into
halves. He divided the newly cut halves into two piles. Each pile had $3$ half
coins. Then he took the left over half coin and cut it into half. Each pile got
half of a half or a quarter coin. Then he put the coin parts back together. He
ended up with $1$ full coin, one half coin, and one quarter coin. He knew that a
half coin equalled two quarter coins so he knew he had a total of $3$ quarter
coins. His grand total was $1 \& 3/4$ coins. This method would take forever if he
had a large sum to deal with. He liked dealing with fractions so he changed the
$3 \& 1/2$ into all halves. This gave him $7/2$. He applied the numerator x
numerator / denominator x denominator rule to see if it would work. $(7/2 \times
1/2= 7 \times 1/2 \times 2=7/4=1$ and $3$ quarters left over or $1$ and $3/4$).

(Student reenact this part). He still wanted to know how to divide using
fractions. He drew a picture of a coin. He cut the coin in half. He then divided
the half into four equal parts. He noticed that he had created one piece of
eight. $(1/2)/4=1/8$. This made sense. Taking a small piece, like a half and
dividing into more parts would make more even smaller pieces. One half cut
into four more parts would make smaller parts equal in size to a piece of eight.
Captain Forager wondered if the opposite would happen. If he took a half then
cut the half into quarters. How many quarters would he get out of a half. He got 2 quarter sections. \(\frac{1}{2}/\frac{1}{4}=2\). What Captain Forager noticed was that dividing a fraction by a number produced the same results as multiplying by its reciprocal. For example \(\frac{1}{2}/\frac{1}{4} = \frac{1}{2} \times 4 = 2\). So dividing a half coin into quarter coins was exactly the same as dividing by 2 or multiplying by \(\frac{1}{2}\). Captain Forager wrote down a fraction ditty.

If addition or subtraction need be
Find a common denominator between two pieces of coin.
Convert each to the common “d”
Then by all means the fractions do join.

If multiplying need being done
Change all to fractions for fun
Multiply top by top, bottom by bottom
Then by George you now have got’em

Dividing is a pain
Then multiply again
All fractions you must make
The second reciprocate
Multiply top by top, bottom by bottom
Then by George you now have got’em

(discuss meaning of ditty. Show examples with each verse.)

Captain Forager was very pleased with himself he had now written what he thought was the definitive workbook of fractions. Land ho, Kingston Town
dead ahead was heard from above. Kingston at last. Now all he had to do was find his daughters kidnappers, pay them off, get his daughter back, find the kidnappers again, retrieve the ransom, separate them from their loot, and go home.

End of story

The plan almost went off like clock work for Forager and his crew. Unfortunately one of the Eight Mates slipped in the mud and her flintlock went off with a roar before Captain Forager and his crew were in place. The jig was up. Forager and his men were captured without a shot being fired. Hubris loomed large in front of Captain Forager. He held up the treasure map taken from Forager. “I been looken for this. We had a bad time in a storm awhile ago. I lost one of me long boats. Seems yer daughter put the map in a bottle and pitched it over board when the long boat broke free and she was left unattended. So nows that I haves me map back I have no uses for your daughter or you for that matter.”

Before Hubris could utter another word, Forager interrupted him. Through swollen lips he told Hubris that because he had shown him and his crew such kindness and now that he had the map back it would be a true mark of a gentleman if he would let his daughter go. As for himself and the crew, they would be prepared to take what the Fates decreed. Forager hoped his appeal to Hubris’s vanity about ever wanting to be known as a gentleman would do the trick. Hubris just laughed. He said in a loud voice that reverberated off the walls, that he would give Captain Forager a test. If he passed the test not only would he let his daughter go but he would let them all go free. The only condition was that he had to get the whole test completely
correct: not one mistake. One error and it would be their last ... all of them! (Pass out exam to class). If you get the test correct Captain Forager, his daughter, and his crew go free. Make one mistake and nobody goes home. Oh, by the way you are one of Captain Forager’s crew. Script was changed at the end. The highest score on the exam will be the Captain and get half of the treasure. The next to highest will become the Commanders and get the appropriate share of the treasure, and so on down to the Eights Mates. (Students wrote the exam and a bag of chocolate coins were divided up according to rank and score. Every class member received at least one gold covered chocolate coin.
Appendix C

Project Journal indicating contract between Integers and concern for the Fraction story-frame.

Week One

Wednesday: Jan. 21/04

Lesson:

Began Integer unit from Math Power: Students were, as they usually are, fairly attentive to instruction. The introductory lesson described how integers occur in every day life. Win vs loss, temperature rise vs decline, etc. Examples given on the chalkboard. Then in class assignment given. Assignment asked students to describe what information was needed to solve a particular word problem.

Reflection & Thoughts:

I was exited about beginning my project. As I was explaining the introductory information, I couldn’t help but think that it was flat. This was a dissemination of facts, understandings, and procedures dealing with everyday occurrences. Relevant? Yes. Interesting? Perhaps. Exciting or intriguing? Not really. I felt that the class dutifully carried out the assignment; but nothing more. Their scores on the assignments indicated a very high level of understanding.

Reflections & Thoughts.

I felt restricted by the textbook’s approach. Although I thought the analogy straight forward, it was very obvious by the number of raised hands for assistance, that students only understood parts of the lesson. They had difficulty conceptually linking the visual representations of the text to the
mental activity of subtract or add.

Tuesday: Jan.27/04

Lesson:

Students cut blue and red squares of paper. Chips were used as manipulatives to physically demonstrate the effects of adding or subtracting negatives. More comments were heard indicating understanding. “Oh, this is how it works”, “I get it now”, “Oh (smiling)”

Reflections & Thoughts.

I felt the text book’s short introduction to the conceptual understanding of adding and subtracting needed further investigation. The manipulatives physically reproduced the text books pictures. Although not overly exciting, it seemed effective.

Week Three

Monday: Feb.2/04

Lesson:

Text explained how subtracting a negative has the same effect as adding a positive. Activity combined subtraction of integers with rewriting number statements from a subtraction to an addition while maintaining the same answer.

Reflections & Thoughts.

Students seemed confused at first. Many wrinkled noses and vacant “huh” looks lead me to once more rely on the physical blue and red integer analogy to reinforce the concept. Once reviewed most students worked on the math assignment without any difficulty. About half a dozen or so asked about one part in particular: rewriting a subtraction question into an addition
question. The actual subtraction questions that just asked for solutions did not come up for query.

Tuesday: Feb.3/04

Lesson:

Students were given a supplementary worksheet for subtraction of integers. Review of previous lesson.

Reflections & Thoughts:

All student requests for assistance focussed around a set of questions asking student to rewrite a subtraction question into an addition question. About a quarter of the class asked for assistance on this concept. The rest of the worksheet was not questioned. I wonder if the text book is presenting too many concepts at once.

Friday: Feb.6/04

Lesson:

Text explanation why negative times negative results in a positive, and combinations of integers equate to either a negative or positive solution. The Integer disks where referred to and drawn on the board to demonstrate the examples in the textbook. Few questions resulted and the math assignment for multiplication proceeded.

Reflections & Thoughts:

I was reluctant to refer to the textbook's use of Integer disks to demonstrate multiplication. I feared the examples would confuse rather than clarify. The instructional page used Integer disks, yet the work page had no questions using disks. However, the class carried on with their assignment and within three quarters of their allotted time most had finished to the point
were it was necessary to move on to a different subject.

Week Five

Monday: Feb. 16/04

Lesson:

Students were introduced to the concept of a fraction as part of a whole. Story was told about a pirate splitting treasure of gold coins into parts to be shared with the crew. Finally the pirate runs out of full coins and cuts a coin into halves, quarters, and finally pieces of eight. Students where asked to solve how many coins could be made from various coin bits: eights, quarters, and halves. The operation discussed was division and remainders were identified as coin bits. ex: $13/8 = 1 & 5/8$ths.

Reflections & Thoughts:

Students did not find the story unusual. One student asked if the story was true. The students seemed to enjoy the tall tale as eyes were focussed. Most students understood the lesson and only a few students asked for clarification about how to write up remainders.

Tuesday: Feb. 17/04

Lesson:

Reviewed how pieces of eight can be put together to form full coins. Reviewed how the share tree works for dividing up treasure. I was telling the story from memory. I made an error in the division and finally a student pointed out my mistake. We started over again. During this disastrous lesson, the class had to endure three interruptions, two students sent to the office for fighting, a maintenance worker lectured the class on the cost of chair and desk repairs, and a special needs child started to wander the room muttering to
Reflections & Thoughts:

I grew increasingly aware that I had lost my audience. Instead of bagging the lesson I pressed on, thinking I had limited number of lessons to get things done. My blunder with the share sheets, besides being embarrassing, served to confuse the class instead of clarify. I felt I had lost the story. Telling the tale rote was an error. As the class unravelling so too did the story. I was trying so hard not to influence the outcome of the project outcomes by not intentionally under teaching one method compared to another, it had not dawned on me that that an unintentional screw up could have a disastrous affect. I pondered the possibility that a bad teaching day could affect the outcome rather than the event I was trying to study.

Wednesday: Feb. 18/04

Lesson:

I back tracked to the beginning and as a review read to the class the story up to and passed the botched part of the day before. The lesson looked at different ways to express the same thing. This was a foreshadowing of skills to come. Student were being introduced to the concept that dividing by X has the same affect as multiplying by 1/X. Reciprocation.

Reflections & Thoughts:

The reading of the script was a good move. The reading kept me on track, and without any interruptions the students were all eyes forward. I noted as I read that some student sat back in their chairs and seemed to settle in to the story. Very few questions were raised about the manipulation of X or 1/X. The questions tended to come from the same student who were
struggling with the Integer concepts.

Wednesday, Thursday & Friday: Feb.25 -27

No math classes. Students gone on a High School tour, and two ski days.

Reflections & Thoughts:

As I planned out the remaining lessons, I noted that the pattern of story lesson, then review classes has several lessons of supplementary and or review work without moving the story along. These reinforcement practice lessons are void of the story. I am wondering if the non story math classes are causing the story thread to become incidental to the unit rather than integral to the unit. I had not told the class that the story lesson is part of the research participation they signed on for. A few still ask when we are going to start the project. All I told the class was that I pulled this (the pirate story of fractions) off the computer and thought it might be interesting to do. I believe the class to be unaware that the story component is indeed the project.

Week Seven

Monday: Mar.1/04

Lesson:

Introduction of multiplication and division of fractions. Explaining the connection between multiplying by reciprocal and division.

Reflections & Thoughts:

A lot of information was presented to the class. Most listened attentively to the review following the story. During the story introduction a few were noted looking at each other, shrugging, then smiling. After assigning the introductory worksheets, I reread the multiplication and division part of the story. It is a difficult passage to follow and the description could have come
from anywhere, not necessarily from a math pirate story. This may have been why a few students were smiling to each other. They may have been wondering where I was coming from. There is more review coming in the next few lessons. The story gets parked again. At this point it is difficult to say how much of the story is being remembered by the class.

Week Eight
Monday March 8/04
Lesson:

Reviewed all operations of fractions. The operation rules for fractions were conveyed using the story frame.

Reflections & Thoughts:

It has been a fair bit of time since the story was last used. I sensed the class had forgotten the story or plot elements up to today's review. References to "cutting coin" and the rules in a poem form may help to reque the classes' memory.

Wednesday March 10/04
Lesson:

Final chapter of the story was read to the class. The top score becomes the captain and the next two highest become the commanders and so on. The chocolate coins will be split by rank.

Reflections & Thoughts:

Students seemed eager to start the exam.

Thursday March 11/04
Lesson:

Student questionnaire was handed out. Students were told that I would
appreciate their opinions about the story used in fractions. Two students achieved 100% on the final exam and thus two Captains were selected. The chocolate coins were dived up and passed out accordingly.

Reflections & Thoughts:

I told them that I had lifted the story from the computer. I believe they are under the impression that I pulled it from the net. Not wanting them to be influenced by knowing that I wrote the story, I did not volunteer the information. As no student asked if I wrote the story I feel that this is not a deception rather an fortuitous opportunity of omission. Had a student asked I would have been compelled to give them the information.

Friday March 12/04

Lesson: Celebration of the Fraction unit was over called for viewing of Pirates of the Caribbean.
Appendix D

Student Responses indicating themes for 2004 & 2002

*Student Responses 2004*

Question 1:
Please rate how the Fraction stories helped you learn how to compute Fractions.

1. Didn’t help  
2. Helped a bit  
3. Helped  
4. Helped a lot

Please explain rating:

• It helped a lot because I didn’t know how to do fractions.
• I found the story very long and boring, it helped a little bit but it was sometimes confusing.
• It helped a bit with the story but I still never got most areas in the math the story helped a little bit though I’d like to hear another.
• I don’t know.
• It gave me help on understanding how fractions work.
• It helped because I did not really know how to do fractions that well.
• It helped a lot because it was more interesting.
• It helped a bit because I didn’t really get how to subtract fractions so when I looked at it in a story version it helped.
• I picked this rating (2 Helped a bit) because the stories just seem to long and I can’t get a picture in my mind about the character in the story and what he was trying to do.
• It helped a bit because I already knew most of it.
• It helped because it is boring on the board.
• Because I didn’t really think of the story that much and I just about forgot
about it, but when I think about it, it helped a bit.

- It's sort of hard to understand fractions in your head at first.

*Student Responses 2002*

Question 1

Please rate how the stories about Integer warfare (including spies) helped you learn how to add and subtract Integers.


Please explain rating:

- I think Integer warfare was educating and fun. It helped because he made it really fun to stay interested and not confusing.
- The Integer warfare helped me to learn because it is easier to learn stuff if it is fun for me.
- It helped a lot because it made me understand a lot faster and made it a lot faster to do the math.
- Because the stories were easier then the text book and they were more interesting.
- I think the story helped me but when it came to the spies that's were I didn't understand the math at all.
- This helped me subtract because it totally laid out all of the sequences.
- It helped me learn before I didn't get integers.
- It helped me a lot because it was fun and easier to learn than the text book.
- It helped explaining that the + and - didn’t mean subtract and add.
- I think that the stories about Integer warfare helped me a lot because it helped get me interested in math.
• Walking through the story helped me because with the double signs using spies helped and the one test with the stories helped too.
• It helped me a lot because it was so well explained and fun.
• The best thing about the stories are they are not really math.
• It helped a lot because it made it the least bit confusing.
• I picked 3 because I got the adding right away when you taught us warfare but when I was trying to subtract it didn’t help as much.
• It explained in a clear picture how the integers worked.
• I picked 3 because it helped me understand and it didn’t confuse me.
• (Picked 4) Because in the book the examples make no sense and it was hard to learn.
• It was a fun way of learning and when you use the warfare is much easier to understand.

Student Responses 2002

Question 1 second story

Please rate how the stories about fish breeding helped you learn how to multiply and divide Integers.


Please explain rating:
• I think it helped because I stayed not confused and I liked doing because it was fun.
• The fish story helped me a bit because I knew how basically to do it. The fish helped me to understand better.
• This helped because it made me understand the rules of + and - in
multiplication.
• Because the stories were easier to understand.
• This story explained in detail that I needed to know,
• Yes it helped a bit because I figured it out myself, so it helped a small amount.
• It helped and I liked all the fish.
• For the same reason as Integer warfare, it was easier than the book.
• It helped a bit with the details of multiplication and division
• It didn’t help me because it just confused me.
• When Mr. C told me about the fish breeding I used it all the time.
• Fish helped because it was an easier way to figure out positive and negative signs of the colour the fish were orphan fish helped too.
• I helped me because every math lesson it wasn’t dreaded it was more exciting and fun to do.
• it helped a lot because it was easier to understand than in the Math Power book.
• I think breeding integers helped a lot. When you taught us first time it just clicked in my mind.
• It was a good explanation of how you times and divide integers.
• Because the book examples made no sense, this did to me

*Student Responses 2004*

**Question 2**

Do you use the Fraction stories to help you while you compute fractions.


Please explain rating:
• I understand how to do fractions without the stories. But it helped me understand subtracting fractions better.
• Because it helps us in the storys because it told us how to do the fractions
• The stories helped but it took a long time to finish the lesson and by the time the lesson was over I had forgotten the lesson.
• I used it not often but I did I only used it once before.
• I just used the numbers. I didn’t need to look at a coin to figure out the question.
• I know how to do fractions without a story because I don’t need help on understanding fractions anymore.
• I used them a lot so I would get how to do it but sometimes it just won’t work.
• I don’t usually use stories because for me it gets confusing.
• A bit because when I don’t understand something if I draw it out in a story it helps.
• I don’t really use it that much because it is more easy and less complicating than drawing everything and remembering the fraction stories.
• Once I got it I didn’t need it.
• I don’t use the story to help because I don’t remember all of it.
• I don’t need a picture in my head because I just work with the numbers.
• Because I had to go through the story in my head
• A bit because I don’t need to use fraction stories because I do math in my head.
• I know most of the fractions.
• I got mostly by asking others and you and looking at board examples, I
think.

PART TWO:

Student response 2004

Which do you like better -- a regular math lesson using examples on the board or from the textbook, or examples using stories? Please explain your opinion.

• I like to use stories it helps us a lot because the board just tell a hole bunch of numbers and the book tell just a little sentence how to do it and in story tell a hole bunch of stuff.
• Stories because they are more interesting and help explain fractions in a funner way.
• I like a regular math lesson because it's easier to understand the lesson better,
• I like the examples using the story the story was really interesting as well.
• Examples using stories because it was a lot funner to learn than a boring regular lesson.
• A regular math lesson using examples on the board, it seems to teach me math better and helps me understand.
• I like examples using stories because it entertains us and when I am entertained I can sort of do my work better.
• Story lessons because its more fun.
• Using stories because it helps me look at it as if I was in the story and had the same problem. It also gives me an idea of how to do the fractions.
• I like a regular math lesson using examples on the board or from the text book because I can see each step that the teacher is taking in the fractions and that help-s me understand it better.
• Examples on the board, my mind tends to wander with long stories.
• A regular math lesson using examples on the board.
• A regular lesson from a text book or on the board because I get the math quicker after I see it done a couple of times.
• I like using examples on the board or textbook because it is always right and the story might not be.
• A story because otherwise it would be too boring.
• Examples of the story, because then we don’t have to sit there and read the textbook and having it make no sense.
• I like using math from textbooks better.
• Personally I like examples using stories because it keeps you entertained and not doing something else, and it makes you think you are doing it for a reason and not just cause.
• The textbook doesn’t help, it doesn’t teach me as much as board examples or trying an example on a piece of paper. The stories are OK to listen to, they help a bit.

Student response 2002
Which do you like better -- a regular math lesson using examples on the board or from the textbook, or examples using stories? Please explain your opinion.
• I think using stories are a lot better than then the rest of them because using the board or text is to confusing and boring but using the stories kept me interested and getting good marks.
• I would rather use the stories than the book because stories are much funner.
• I preferred using the stories because they make more sense then looking in a
book for the rules all you have to do is remember the stories.
• Using the stories I think is the best because they were easier to do then the stuff the math book say.
• I like both the stories and the examples on the board. I don't like the textbooks because of the fact they don't explain as well.
• I enjoyed the examples (from the story) on the board because the teacher laid out the rules, without confusion, I enjoyed it.
• Stories and using examples on the board they both made it easier.
• I enjoyed the stories more because I wanted a fun way to learn to a boring way to sleep.
• I like the stories because they're more exciting than the examples on the board.
• I like story lessons better than regular lessons because it helped me get interested in the math.
• I think that using stories helps you the best because your brain will tell you to use the stories that he told you.
• I like the stories they give you a fun and easy way to get thru the concept.
• I like the math lesson on the board because it is explained more then in the math book.
• Stories, because they were interesting and helpful.
• I like the stories because they are really cool.
• I like using stories because they are less confusing.
• I liked the stories more because it explains to me easier than reading.
• I would like a regular math lesson because it makes a better picture for me.
• I picked examples using stories because when the teacher takes a part of a
math question out of the text book it doesn't explain much but doing a story on the board is way easier to understand. And there is so many examples you can use by making up a story.

- I liked examples using stories.
- I like a regular math lesson better because I think it helps me understand better than stories.
- I like stories because it is more fun and the examples in the book were hard to understand.
- I like the stories better because when your learning from a math book it just shows you examples and expects you to understand but in a story it slowly explains the steps in a fun way.

*Student responses 2004*

What things did you not like about the Fraction stories?

- I didn't like it when he tell boring stories.
- I did not like ho long the lessons were with the stories.
- The one thing I didn't like about the story was it was a little long in parts and sometimes a little boring. One way to improve the story is to find a shorter story but it would be better for me if you didn't get another story.
- There wasn't really anything.
- Using the paper coins because they are so annoying to keep around.
- I get distracted and start to daydream when I get a story read to me. Maybe a shorter story.
- I did not hate anything about the fraction story.
- Too long. May be if it was in modern times and more hands on things.
- The things I don't like about the fraction stories is how some of them are long
and that makes me bored, then I don’t listen. Then after sometimes I don’t get it.

- They often explain stuff I already know.
- Nothing, It was fun and I learned a lot.
- They seem to drag on too long and I lose the point of the story.
- It was a bit confusing.
- That we didn’t read it for a long period of time. We sort of stopped for a bit.
- I didn’t like how and some parts they got really boring and I just wanted to do the work. To improve it i would pick a subject more interesting,
- How he keep cutting up the coin. It confused me. Maybe not a pirate story with coins maybe a bakery with pizzas.
- It takes too long to explain so there is not enough time to do the work in class.
- They are hard to picture in the mind at first.

**Student response 2002**

What things did you not like about using integer warfare and fish breeding stories to learn Integers?

- I don’t have any “nots” about the story.
- I did not dislike anything about the two stories.
- I liked everything about the stories there wasn’t one thing I didn’t like.
- Their was nothing that I did not like.
- I liked the fish breeding but the warfare got a bit confusing in the end but I’m sure if I had done some Integer work in Grade 6 I might have understood it a bit more.
- I did like everything because it was amusing and fun.
• I didn't like the spies they made it confusing.
• I didn't like the fish breeding because it confused me a lot.
• I didn't find anything wrong with it.
• There was nothing that I didn't like about the two stories.
• Warfare was a little confusing
• I did not like writing out the stories it took much too long. Especially the spy stories.
• I didn't like fish breeding.
• The only thing I didn't like was when you were teaching us on warfare you went a little too fast. Other than that nothing.
• I didn't like using warfare it was a little confusing.
Appendix C

Project Journal indicating contract between Integers and concern for the Fraction story-frame.

Week One

Wednesday: Jan. 21/04

Lesson:

Began Integer unit from Math Power: Students were, as they usually are, fairly attentive to instruction. The introductory lesson described how integers occur in everyday life. Win vs loss, temperature rise vs decline, etc. Examples given on the chalkboard. Then in class assignment given. Assignment asked students to describe what information was needed to solve a particular word problem.

Reflection & Thoughts:

I was excited about beginning my project. As I was explaining the introductory information, I couldn't help but think that it was flat. This was a dissemination of facts, understandings, and procedures dealing with everyday occurrences. Relevant? Yes. Interesting? Perhaps. Exciting or intriguing? Not really. I felt that the class dutifully carried out the assignment; but nothing more. Their scores on the assignments indicated a very high level of understanding.

Reflections & Thoughts.

I felt restricted by the textbook's approach. Although I thought the analogy straight forward, it was very obvious by the number of raised hands for assistance, that students only understood parts of the lesson. They had difficulty conceptually linking the visual representations of the text to the
mental activity of subtract or add.

Tuesday: Jan.27/04

Lesson:

Students cut blue and red squares of paper. Chips were used as manipulatives to physically demonstrate the effects of adding or subtracting negatives. More comments were heard indicating understanding. "Oh, this is how it works", "I get it now", "Oh (smiling)"

Reflections & Thoughts.

I felt the text book's short introduction to the conceptual understanding of adding and subtracting needed further investigation. The manipulatives physically reproduced the text books pictures. Although not overly exciting, it seemed effective.

Week Three

Monday: Feb.2/04

Lesson:

Text explained how subtracting a negative has the same effect as adding a positive. Activity combined subtraction of integers with rewriting number statements from a subtraction to an addition while maintaining the same answer.

Reflections & Thoughts.

Students seemed confused at first. Many wrinkled noses and vacant "huh" looks lead me to once more rely on the physical blue and red integer analogy to reinforce the concept. Once reviewed most students worked on the math assignment without any difficulty. About half a dozen or so asked about one part in particular: rewriting a subtraction question into an addition
question. The actual subtraction questions that just asked for solutions did not come up for query.

Tuesday: Feb.3/04

Lesson:

Students were given a supplementary worksheet for subtraction of Integers. Review of previous lesson.

Reflections & Thoughts:

All student requests for assistance focussed around a set of questions asking student to rewrite a subtraction question into an addition question. About a quarter of the class asked for assistance on this concept. The rest of the worksheet was not questioned. I wonder if the text book is presenting too many concepts at once.

Friday: Feb.6/04

Lesson:

Text explanation why negative times negative results in a positive, and combinations of integers equate to either a negative or positive solution. The Integer disks where referred to and drawn on the board to demonstrate the examples in the textbook. Few questions resulted and the math assignment for multiplication proceeded.

Reflections & Thoughts:

I was reluctant to refer to the textbook's use of integer disks to demonstrate multiplication. I feared the examples would confuse rather than clarify. The instructional page used Integer disks, yet the work page had no questions using disks. However, the class carried on with their assignment and within three quarters of their allotted time most had finished to the point
were it was necessary to move on to a different subject.

Week Five

Monday: Feb.16/04

Lesson:

Students were introduced to the concept of a fraction as part of a whole. Story was told about a pirate splitting treasure of gold coins into parts to be shared with the crew. Finally the pirate runs out of full coins and cuts a coin into halves, quarters, and finally pieces of eight. Students where asked to solve how many coins could be made from various coin bits: eights, quarters, and halves. The operation discussed was division and remainders were identified as coin bits. ex: 13/8 = 1 & 5/8ths.

Reflections & Thoughts:

Students did not find the story unusual. One student asked if the story was true. The students seemed to enjoy the tall tale as eyes were focussed. Most students understood the lesson and only a few students asked for clarification about how to write up remainders.

Tuesday: Feb.17/04

Lesson:

Reviewed how pieces of eight can be put together to form full coins. Reviewed how the share tree works for dividing up treasure. I was telling the story from memory. I made an error in the division and finally a student pointed out my mistake. We started over again. During this disastrous lesson, the class had to endure three interruptions, two students sent to the office for fighting, a maintenance worker lectured the class on the cost of chair and desk repairs, and a special needs child started to wander the room muttering to
Reflections & Thoughts:

I grew increasingly aware that I had lost my audience. Instead of bagging the lesson I pressed on, thinking I had limited number of lessons to get things done. My blunder with the share sheets, besides being embarrassing, served to confuse the class instead of clarify. I felt I had lost the story. Telling the tale rote was an error. As the class unravelling so too did the story. I was trying so hard not to influence the outcome of the project outcomes by not intentionally under teaching one method compared to another, it had not dawned on me that that an unintentional screw up could have a disastrous affect. I pondered the possibility that a bad teaching day could affect the outcome rather than the event I was trying to study.

Wednesday: Feb. 18/04

Lesson:

I back tracked to the beginning and as a review read to the class the story up to and passed the botched part of the day before. The lesson looked at different ways to express the same thing. This was a foreshadowing of skills to come. Student were being introduced to the concept that dividing by $X$ has the same affect as multiplying by $1/X$. Reciprocation.

Reflections & Thoughts:

The reading of the script was a good move. The reading kept me on track, and without any interruptions the students were all eyes forward. I noted as I read that some student sat back in their chairs and seemed to settle in to the story. Very few questions were raised about the manipulation of $X$ or $1/X$. The questions tended to come from the same student who were
struggling with the Integer concepts.

Wednesday, Thursday & Friday: Feb.25 -27

No math classes. Students gone on a High School tour, and two ski days.

Reflections & Thoughts:

As I planned out the remaining lessons, I noted that the pattern of story lesson, then review classes has several lessons of supplementary and or review work without moving the story along. These reinforcement practice lessons are void of the story. I am wondering if the non story math classes are causing the story thread to become incidental to the unit rather than integral to the unit. I had not told the class that the story lesson is part of the research participation they signed on for. A few still ask when we are going to start the project. All I told the class was that I pulled this (the pirate story of fractions) off the computer and thought it might be interesting to do. I believe the class to be unaware that the story component is indeed the project.

Week Seven

Monday: Mar.1/04

Lesson:

Introduction of multiplication and division of fractions. Explaining the connection between multiplying by reciprocal and division.

Reflections & Thoughts:

A lot of information was presented to the class. Most listened attentively to the review following the story. During the story introduction a few were noted looking at each other, shrugging, then smiling. After assigning the introductory worksheets, I reread the multiplication and division part of the story. It is a difficult passage to follow and the description could have come
from anywhere, not necessarily from a math pirate story. This may have been why a few student were smiling to each other. They may have been wondering where I was coming from. There is more review coming in the next few lessons. The story gets parked again. At this point it is difficult to say how much of the story is being remembered by the class.

Week Eight

Monday March 8/04

Lesson:

Reviewed all operations of fractions. The operation rules for fractions was conveyed using the story frame.

Reflections & Thoughts:

It has been a fair bit of time since the story was last used. I sensed the class had forgotten the story or plot elements up to today's review. References to "cutting coin" and the rules in a poem form may help to requeue the classes' memory.

Wednesday March 10/04

Lesson:

Final chapter of the story was read to the class. The top score became the captain and the next two highest become the commanders and so on. The chocolate coins will be split by rank.

Reflections & Thoughts:

Students seemed eager to start the exam.

Thursday March 11/04

Lesson:

Student questionnaire was handed out. Students were told that I would
appreciate their opinions about the story used in fractions. Two students achieved 100% on the final exam and thus two Captains were selected. The chocolate coins were dived up and passed out accordingly.

Reflections & Thoughts:

I told them that I had lifted the story from the computer. I believe they are under the impression that I pulled it from the net. Not wanting them to be influenced by knowing that I wrote the story, I did not volunteer the information. As no student asked if I wrote the story I feel that this is not a deception rather an fortuitous opportunity of omission. Had a student asked I would have been compelled to give them the information.

Friday March 12/04

Lesson: Celebration of the Fraction unit was over called for viewing of Pirates of the Caribbean.