

**A TEACHER'S REFLECTION
ON THE IMPLEMENTATION OF
JOURNAL WRITING IN MATHEMATICS**

LINDA ADDISON

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Dedication

This project is dedicated to my husband and best friend:

Frank Addison

Thank you for giving up so many summer holidays
and for all your support during the last five years!

Abstract

Mathematics is often a challenging subject for students. Historically, mathematics has been a subject in which less written work has been completed than in other content area subjects.

Writing can be used in mathematics classes to open additional lines of communication between student and teacher. Writing involves students actively in mathematics. In order to write about a topic, students must be able to reconstruct their knowledge of the topic in a form that is understandable by someone reading the material.

Student journals are one form of writing that may offer teachers an additional "tool" for teaching students mathematical concepts and evaluating mathematical knowledge.

Students in this project responded in journals over the course of a three week mathematics unit. The students answered free response, summary, comprehension and problem solving questions in their journals. The teacher responded to all student entries and kept a personal journal of the process.

The rewards of the project for the teacher included an increased awareness of student comprehension of concepts, feelings and attitudes towards mathematics. Opening another line of communication with the students offered the opportunity to stay in touch with even the most quiet and reserved student. The personal journal offered the teacher a place in which to reflect upon the successes and challenges of

teaching mathematics.

There were challenges to implementing the program. Time tended to be an obstacle to having students write thoughtful entries in their journals. Assessing student understanding through the student responses was another challenge.

In preparing students for the mathematical challenges of the twenty-first century, it is important that teachers use a variety of teaching methods. Journal writing in the mathematics class is one method that appears to offer great potential.

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Chapter 1

Beginnings

Mathematics is like a closed door: all the information is there only I don't have a key. (one student's metaphor, quoted in Buerk, 1993, p.78)

Teachers are often frustrated by students' fear and/or dislike of mathematics. These fears are obstacles some mathematics teachers and students never overcome. This study focuses on alternative ways to probe student understanding in mathematics that may help to improve mathematics programs in schools. The goal of this research project is to explore one way to open that closed door for a few more students.

In a recent NCTM (National Council of Teachers of Mathematics) Assessment Document (1995), the council envisions a shift in the way in which mathematics should be taught and evaluated. The shift is away from memorizing and repeating mathematical concepts, to investigating, representing, reasoning, and applying strategies to problem solving.

As an educator interested in mathematics instruction, I wanted to research new approaches in the teaching of mathematics which were consistent with the goals of the NCTM.

"Teaching only occurs to the extent that learning occurs"

(Reys, Suydam, & Lindquist, 1984, p. 41). No longer would the rote "pour-in" method of teaching suffice.

In a previous independent study, Addison (1994), I investigated methods of communication and active student participation in the mathematics classroom. A study by Romberg and Carpenter (1985) had typified the average classroom as one in which teaching methods used by teachers were receptive, or passive in nature. The students received the information (usually in a lecture format) and then completed sets of paper and pencil assignments to test their comprehension. Acquisition of knowledge became the end in itself. Romberg and Carpenter found mathematics classes were often quiet except for the occasional student-teacher interaction.

I wanted students to take a more active role in mathematics and researched ways students could be active and expressive in mathematics. Speaking, writing and acting were three areas studied more thoroughly as possible ways in which to improve communication in the mathematics classroom.

I further researched writing as a form of communication in mathematics. What could I do as a classroom teacher to improve communication lines between all students and their teacher? What methods would allow for even the most quiet of students to have the opportunity to express feelings, difficulties, accomplishments and understanding? Writing in the form of journals seemed to offer one avenue that might open a few doors for some students.

In a study with first year algebra students, Miller (1991), found that students who were unwilling to ask questions in class would often be willing to express their frustrations or confusions privately in written form.

I used journals very briefly in my classroom as part of an independent study, but I wanted to complete a more extensive research project on the use of a journal writing program in mathematics. I became interested in journal writing as a method of encouraging two-way communication in the mathematics classroom. I wanted to investigate the rewards and challenges of implementing a journal writing program. I was interested in opening lines of communication with every student and learning more about his/her attitude toward mathematics. I also wanted to investigate whether a student's writing would demonstrate his/her understanding of mathematical concepts.

Preliminary Research

I began this project by reading any article I could find on writing in the mathematics classroom, the connection between language and mathematics, using math journals, and reflection as a way of learning. Countryman (1992) summarized much of what I had read:

Knowing mathematics is doing mathematics. We need to create situations where students can be active, creative, and responsive to the physical world. I believe that to learn mathematics students must construct it for themselves. They can only do that by exploring,

justifying, representing, discussing, using, describing, investigating, predicting, in short by being active in the world. Writing is an ideal activity for such processes (p. 2).

The work of Countryman encouraged me to investigate whether journal writing in mathematics could offer my students a creative, active way to express their ideas, demonstrate their understanding (and misunderstanding) and explore their mathematical knowledge.

Writing involves many thought processes that teachers would like to foster in students (Miller, 1991). It forces students to conceptualize what they have been learning and reconstruct that knowledge in a form that is understandable by themselves and others. Miller's study researched many different ways writing could be implemented in mathematics classes. Journals were one means that had been successfully used with high school students. I wanted to try a similar project with grade four students.

The Project

I designed a unit on fractions and decimals at the grade four level in the rural school in which I teach. I had a very small class of nine grade four students. They all took part in the project as I received parental permission from each family (see the permission letter in Appendix 1). Every day for sixteen days, the class completed lessons and activities on the topic. As many classes as possible were hands-on or group

activity based, but there were days when the students completed book or worksheet assignments.

At the end of each forty minute lesson, I allowed approximately ten minutes for the journal writing activity, based upon that day's activities. I designed four types of journal writing questions:

- [1]. Free response (open ended questions)
- [2]. Summary questions (asking for a summary of the content of the lesson)
- [3]. Comprehension questions (asking students to use the concepts presented in the lesson)
- [4]. Problem solving (new problems to solve that related to the lessons taught)

The questions that were used are found in Appendix 2. The journal writing activities rotated through the four types listed above. Each student had the opportunity to complete four questions of each type in the sixteen day time period.

I wrote back to each of the students every night, attempting to probe their understanding, encouraging them to write more, praising their accomplishments and offering extra help where needed.

I also kept a journal of my own, detailing the lesson activities, problems encountered in class, rewards and challenges of the journal writing process (see the example in Appendix 3). After I had responded to the students' journal entries, I wrote an additional reflective entry on the process

of communicating with the students through journals.

At the conclusion of the project I collected the students' journals.

The Research Questions

As a researcher, I was interested in searching for information on how difficult it would be to implement a journal writing program and how an educator could use journal writing in mathematics. The project was designed to investigate the following research questions:

- [1]. What are the rewards of implementing a journal writing program in a Grade 4 mathematics class?
- [2]. What are the challenges of implementing a journal writing program in a Grade 4 mathematics class?
- [3]. What are the advantages and disadvantages of the four types of journal questions used in this study?

To analyze the data collected, I conducted a content analysis, such as the one described by Borasi and Rose (1989). I re-read and studied the nine student journals (each containing sixteen pages of entries) and my fifty page personal journal. I looked for recurring patterns that might be used to answer the research questions. The remainder of

this project is an attempt to address the questions through the findings.

Chapter II

A Review of the Literature

There has been a great deal of research completed on communication in the mathematics classroom. I studied the areas of writing and mathematics, the use of journals in mathematics and reflection as part of the learning process.

Writing and Mathematics

Much of the written work used in mathematics classes involves solving sample questions, writing equations and answers or solving word problems (sometimes showing methodology). What does this reveal about the student's cognitive processes?

Being able to do something is one thing: knowing how one does it is quite another (Skemp, 1971, p.57).

Skemp explains that written communication must convey meaning to someone else. The correct answers on a paper may not mean that the students really understand the concepts.

Miller (1991) found that too often mathematics classes involved students manipulating ideas and/or processes without an understanding of the concepts taught. At the end of a unit on two-digit subtraction with regrouping, Miller found that the students quickly realized that most of the problems they would encounter would be subtraction problems, involving the skill just mastered. Thus students were able to complete the problems accurately. Did students understand how and why they

solved the problems using subtraction? It is this researcher's contention that this type of word problem is not really a problem at all, and is a poor use of a student's time. Problem solving is

...finding the unknown means to a distinctly conceived end. To solve a problem is to find a way where no way is known off-hand (Polya, a reprint of work from 1957; 1980, p.1).

Polya's definition would be much closer to real life problem solving. Writing might be used as a tool in determining if students understood how they had solved a problem.

The use of writing assignments in mathematics could help the students improve language skills, knowledge of mathematical terminology and comprehension of concepts. The students would be actively involved in "doing mathematics", not passively receiving information and memorizing it for future repetition.

Ideas are perishable unless one has communicated them to someone else or recorded them for future use (Skemp, 1971). Skemp's ideas seem well ahead of his time. Communication in a mathematics classroom has largely been one-way, teacher to student. Yet writing is one important method that could convey valuable information back to the teacher from the student.

Writing in mathematics has not been viewed as a mode of learning until quite recently. Bell & Bell (1985), Ford (1990) and Stehney (1990) found that the writing lessons learned and the writing habits acquired in other subject areas should also

carry over to mathematics classes. The researchers explained in their articles that writing was not only a method of expressing what one had learned, but was a mode of learning in itself and should be used as such.

The writing process can be used to reinforce concepts being taught. Pimm (1987) found that students clarified and organized their thoughts while writing and often became critics of their own thinking processes. The students attached their own words to mathematical concepts in order to communicate them to someone else. As students attempted to express their ideas in writing, they actually came to understand the concepts more clearly. Richards (1990) also found that writing offered students the opportunity to reflect on, clarify, record and demonstrate their learning processes.

Capps & Pickreign (1993) state that teachers should be aware that the language and symbolism of mathematics is not reinforced outside the mathematics classroom. Concrete ideas are given for mathematics teachers who wish to develop lessons that provide the opportunities to reinforce and strengthen the students' understanding of mathematical language, symbols and concepts. Without comprehension of the substance behind those symbols, memorization becomes meaningless (Hurwitz, 1990). Hurwitz contends that writing can restore meaning to the symbols used in mathematics. Writing can also help students take that step from the concrete world of their experiences to the world of symbols in mathematics. Mathematics can not be

taught without the use of language, yet using writing in mathematics is still relatively uncommon.

The NCTM Standards Council (1989) states that writing is a skill too infrequently used in mathematics classes, yet it offers children who are uncomfortable with oral situations, a less public alternative in which to express their ideas. In this way, the child who is not an eager participant in class, can still demonstrate his/her understanding (or misunderstanding) of the day's lesson. How many teachers realistically have the chance to communicate orally with every student in every math class? A writing assignment could offer another opportunity for such communication.

Writing is also one more technique that can be used to help child "talk mathematics" (NCTM 1989, p.26). Since children learn a lot through verbal communication, developing numerous ways in which the children can communicate their understanding of mathematics is essential. Talking to one another is one effective method, but there are others. Having a child write his/her explanation of a subject (eg. - What is a fraction?) for another child to read and understand is another method. Oral reading of a written explanation is a third.

There is power in being able to use mathematical language and symbols with confidence. Writing adds to that power. Talman (1990) states that teachers often ignore the power of written language as a tool for investigation.

Writing about mathematics forces construction of understanding, because we cannot write coherently about something we do not understand (p. 107).

Writing has another value. It helps the child clarify his/her own thinking (NCTM 1989). By deciding what to communicate a student takes on the responsibility of determining how much and what to say in his/her writing. Articulating his/her own thinking gives the student the opportunity to connect what is being taught to what is already known. (Clarke, Waywood & Stephens, 1993)

Kenney (1990) argues that through writing the student becomes the owner of what is written since he/she must put the ideas into his/her own words. Through the process of writing, the student gradually makes the idea part of his/her own knowledge. Taking responsibility for what is learned is a valuable skill that teachers would like to foster in any subject area.

Since the new mathematics curriculum being developed in Alberta (Alberta Education, 1994) places a great emphasis on students being able to apply mathematical concepts and skills to real world problems, teachers must develop ways in which to foster such application in their classes. Writing could be used to apply skills to real life. Asking students to explore and write about the ways in which they solved a problem, would begin to encourage students to see math as more than the search for the one "right answer". Having students share and explain their written work to each other would be

another extension of the activity. This would cause students to think about their own solutions and consider the solutions of other students.

Mathematics must be more than a search for an answer; it must be the journey to get to the answer. This journey is the missing component of many mathematics classes.

We learn to write by writing, and we learn a given subject by writing, speaking and thinking (Kenney, 1990, p. 17).

From a research standpoint, it seems clear that as teachers, we must find ways to incorporate writing into our mathematics classes. This project is an attempt to use writing in mathematics and then discuss the results.

Journals in the Mathematics Classroom

Journals are only one suggested alternative to increasing the amount of time spent in writing in the mathematics classroom, but their use is relatively new and seems worthy of further research.

Stix (1994) completed a study on the use of journals that involved pictorial as well as written information. For the earlier grades (three to eight) pictures, numbers, symbols and manipulatives were used to help students understand math concepts. The journal became the vehicle in which the students recorded and assessed the verbalization and visualization processes that occurred in the learning process. Stix found that the journals gave the students the opportunity to sort

out information, construct information and make concepts meaningful to themselves. By using journals, students could demonstrate their understanding of mathematical concepts in a variety of ways. Those who might be more hesitant to try to frame their understanding in words could use pictures and symbols. Stix found that those who wanted to challenge their understanding would try to demonstrate their knowledge in written language alone. Many students would use both, while some progressed from one mode to another. The journal would be a record of the journey.

According to Stix, the journals could also be used as an assessment tool by the teachers. Example assessment forms were included in the article which allowed the teacher to evaluate the methods (words, pictures, numbers) that were used by the students in their journals. A simple rating scale offered the opportunity to assess the ideas and understanding displayed by the students.

The mathematics journal has the potential to become a continuing means for students to monitor and take responsibility for their own understanding of mathematical concepts. Teachers could encourage students to take a few minutes to think about new material and answer questions in their journals such as: "Do I understand this?" "Could I explain this concept to someone else?" "What puzzles me?". This could form the basis of an ongoing conversation between the teacher and student.

Miller (1991) found that journals could act as a stimulating way to dialogue with those students who might otherwise miss out on the teacher's time. Wadlington, Bitner, Partridge & Austin (1992) found that journals offered the students a way to clarify thinking and the students' writing offered the teacher insights into students' thought processes.

Countryman (1992) used journals with her classes and found that journals were a good place to help students think about themselves learning mathematics. It was a place to make connections between their own experiences and what was being offered in class. Reys, Suydam, & Lindquist (1984) also speak about the necessity of helping students make bridges between the real world (or their world) and the world of textbook mathematics. Journals give the students the opportunity to reflect on anything that they feel is relevant or significant to them and might be one way to begin construction of the bridges.

Journal writing offers the students the opportunity to try out their "mathematical tongue". That is, writing develops their use and understanding of mathematical language (Richards, 1990). Mathematical language is complex and dense and students need extra time to read and re-read material for understanding. Writing would add one more medium in which the students could practice becoming mathematically literate. If the teacher were to write back to the students, the opportunity exists to rephrase and reshape the student's

language with the more technical terminology of mathematics. This modelling and continual communication in a very non-threatening environment (the journal) would offer yet another way in which students could learn to use the language of mathematics proficiently.

Creativity is another exciting aspect of journals. Journals offer the students a vehicle in which to be creative. Countryman (1992) found her students' journals included personal anecdotes, passions and biases about topics in class, questions, playful writings, etc. Even when students wrote about something other than mathematics, she had a glimpse into their feelings and frustrations. This is another advantage that traditional assignments can not offer. The students' backgrounds, previous experiences with mathematics and personal prejudices may be evident in journals. Students may feel free to write about their feelings, rather than verbalize those feelings in front of fellow class members.

Writing in a journal allows a teacher to emphasize the importance of being able to communicate mathematically with someone else. In English classes, students are taught the value of an audience. Students write for someone (even if that someone is oneself). Teachers stress the importance of being able to communicate with someone else in a form that is legible and understandable. Yet in mathematics there is little opportunity to reinforce the importance of being able to communicate ideas and concepts clearly to someone else. The

journal could be used to encourage such communication. It is easier to place a value on what and how to communicate with others if the student has a vehicle in which to practice such communication. Students may see no real need to learn the mathematical terms "circumference" or "difference" unless there is an opportunity to practice explaining one of these terms to someone else. In order to communicate meaning to another person, the student must understand what the term means. Writing to explain to someone else what the circumference of the Earth means, would demand that the student think about his/her comprehension of the term.

Teachers might also use the journals as a source of valuable information which could shape the lessons to follow. If a misunderstanding is evident in the journal writing of a number of students, this might mean that the topic needs reviewing or presentation in an alternate way. It would be far more effective and efficient to have such information on a regular basis, rather than wait until a major examination demonstrates a weakness in the learning of many students.

Although a teacher may feel overwhelmed with the amount of reading and writing that journals could require, it is important to realize that not all students will go to great lengths to write about their experiences. Some will be reluctant to write at all and others may write only limited amounts. With teacher encouragement, as the term progresses, students may write more. Teachers may then have to choose to

write back to a certain number of students every night, or to all class members only once a week. The logistics of a journal writing program will be addressed in the following chapter.

The Role of Reflection in Learning

The new mathematics curriculum suggests problem solving become the vehicle in which to teach mathematical concepts, skills, etc. The final step in problem solving has usually been to "go back and check to see if the answer makes sense." Many students never progress past the point of putting down an answer and going on to the next question. Teachers must make a real effort to include the reflection stage in problem solving and in all mathematics classes.

Krulik & Rudnick (1994) maintain that there are five steps that a student should be taught in reflecting upon finished work. Students should: test the reasonableness of the answer, write about the problem and its solution, find other solutions, change the conditions of the problem and extend the problem to a mathematical formula, concept or generalization. The journal would offer a place in which the student could reflect and try the steps listed above. With the encouragement and probing of the teacher, students could be expected to think about their work and how they arrived at an answer. Students could be taught to search for and create other situations in which the same solution would apply.

A journal could offer the students a logbook in which samples of the types of questions that have caused them difficulty could be kept and referred to at a later date. Thinking back to senior level mathematics courses in university, a journal of this type could have been an effective time saver when reviewing for exams.

As students record their questions, reflect, and muse about the work, my students give me insights on how they make sense of mathematics (Countryman, 1992, p. 87.)

It is such reflection that makes the students more independent and responsible for their own learning. Furthermore, in the NCTM Assessment Standards document (1995) it is stated that if students are to become independent learners, they must reflect on their progress, understand what they know and can do, and determine what they still need to learn. Journals offer an opportunity to accomplish the above.

Clarke, Wayward & Stephens, (1993) probed the nature of mathematical writing and researched the use of journals in mathematics. The researchers found that students usually progressed in their journal writing from an initial "recount" mode - which was simply a list of events that had happened, to a "summary" mode - where a personal summary of understanding and problems were addressed, to a final stage of "dialogue" where students began to pose questions and hypotheses about the mathematics in which they were engaged. As students' use of journals increased so did the progression from one mode to another. As students began to locate themselves in the

summaries of the mathematics covered, they were beginning to make a transition towards becoming a reflective thinker. The approach to the "dialogue" phase marked a point at which the students had begun to relate mathematics to the world around them.

When writing in the Dialogue mode, students are involved in creating and shaping mathematical knowledge. (Clarke, et al., 1993, p.249)

This ability to dialogue with oneself is what we would like to see all students accomplish. At the lower elementary grades, students might not achieve the "dialogue" stage, but an early introduction to journal writing could make journals a valuable tool in the upper elementary and later years of instruction. Careful modelling by the teacher and repeated practice seem to be key elements in encouraging students to become reflective writers and thinkers.

Teachers as Reflective Thinkers

One use of journals that seems to hold great potential to teachers is using the journal for personal reflection. The teacher, by keeping his/her own journal can begin to take a look at teaching strategies, positives and negatives in the classroom, challenges that still need to be met, and what needs to be accomplished in the future. By using and then sharing excerpts from a journal, the teacher also models for the students what might go into their own journals. There exists the opportunity to emphasize that teachers do reflect

on their own work.

Countryman (1992) found that she looked at the students' concerns and questions with new eyes and ears as she described (in her own journal) the mathematics classes and the students' encounter with journals for the first time. She was surprised by the willingness to write that many of the students displayed. She also found in her own journal a place in which to question practices and issues which had occurred in class.

Reflecting on your teaching is a way to make you aware of how you teach. It is a method of self-assessment. If we don't reflect, we are "teaching in the dark" without knowing if we are effective and if we should modify our teaching (Hart, Schultz, Najee-ullah, & Nash, 1992, p. 40).

* This awareness and self-assessment are vital aspects of becoming more effective mathematics teachers.

For teachers interested in their own continuous, thoughtful and creative evolution, the journal offers an alternative that has not yet been thoroughly explored. By reflecting upon and re-thinking lessons and concepts, one becomes more willing to accept challenges and failures as a necessary part of the journey towards becoming more effective and successful in the classroom. Teachers can actively seek alternative approaches and continue to evolve and grow with the students they teach. There are rewards to becoming a more reflective practitioner. The positive feedback that comes from the students is one reward. Becoming more aware of one's own potential as an educator is another reward.

Chapter 111

The Process and Results

Setting up the Project

The grade four students had made a few math journal entries (for practice purposes) earlier in the year, and seemed to understand some of the purposes for writing in mathematics. The first response elicited for the purposes of this project was a "Free response" question in which the students had the opportunity to describe what they liked and disliked about the opening lesson on fractions and decimals. The class had completed a brainstorming activity to focus on prior knowledge and then had proceeded to a hands-on manipulative exercise using coloured cubes to make shapes of various colors to represent different fractions (eg. - Make a block that is $\frac{3}{10}$ white.).

The nine grade four students and two grade three students took part in the activities and wrote in journals over the three week period in May, 1995. Although I responded and encouraged the grade three students as I did the grade four students, the project is based upon the responses and entries from the grade four students only.

This chapter will deal with the rewards and challenges that occurred in the journal writing program with this grade four class. The uniqueness of this class should be recognized, as it is rare (except in rural schools such as this one) for

a teacher to have the opportunity to work closely with such a small number of students for two consecutive years. It might also be important to recognize that all of these students (with the possible exception of one child who was new to the class in September) had achieved an acceptable level or higher on their grade three mathematics provincial examination.

The journals immediately became something important to the students. "May we color and decorate the cover?" "Is this mine to keep?" were some of the questions that the students offered. This display of ownership was a first tiny step in getting the students to realize that important work would be completed in the journal.

At the end of the first lesson, I allowed about fifteen minutes to write in the journals and decorate the cover. I collected the journals at the end of the session and placed them in a visible spot in case students wished to go back and add anything else. The students were not to take the journals home during the course of the three weeks, as I did not want to lose one and affect the outcome of the project. Leaving the journals at school did not seem to bother the students.

I used a very active lesson, a free response entry, and assigned no homework on the first day. The students appeared very enthusiastic. They had enjoyed working with the cubes, liked the bright (neon orange) covered journals and were excited about what other activities we might complete in the following classes. Getting such positive response to this

first journal writing activity was necessary to encourage the students to continue to write, even when lessons were not quite as interesting or based upon a hands-on activity.

I was attempting to establish a pattern that would continue until the project was complete. The lesson was first, followed by activities and/or assignments, and the journal writing was completed last. I chose this pattern so that students could respond to the lesson just completed. At that time I also insisted that students go back and re-respond to any prompts or questions I had written in their journals the previous night. Having a flexible time table allowed me to devote a few more minutes to mathematics when necessary.

The Rewards of the Project

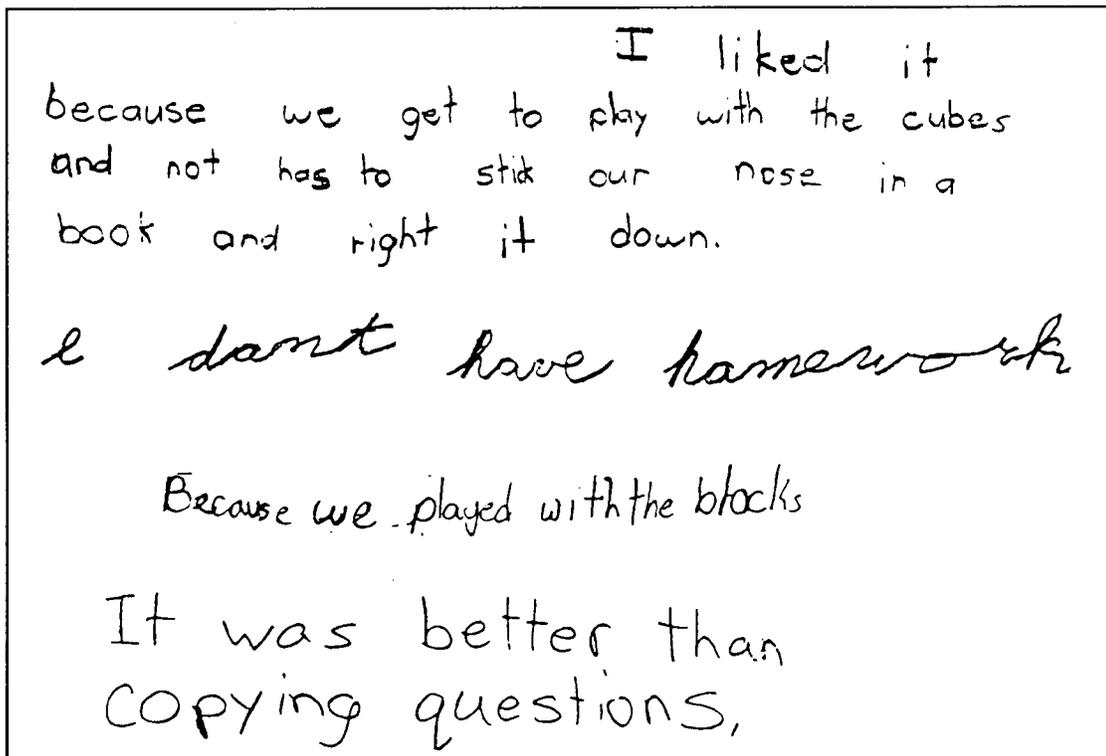
This section of the study attempts to answer research question number one, "What are the rewards of implementing a journal writing program in a Grade 4 mathematics class?"

The first reward was the fact that I never had a student refuse to write or complain about writing in the journals. Students accepted the journals as part of the mathematics classes and even reminded me about writing in them if time became short at the end of a lesson. Getting the students to accept writing as a natural part of the mathematics program was a hurdle I did not have to face. The children accepted the journal as "theirs" and yet had no concern in sharing the journal with me. I was clear at the outset why I wanted to

have them write and the students seemed satisfied with my explanation.

The comments collected the first day were quite general, but did allow me to acquire a feel for the kinds of mathematical activities the students liked best. The following is a sample of the student entries to the free response question on that first day.

Day 1: Describe what you liked about today's activities.



It was easy to see that the students liked active, participatory classes and did not seem thrilled by paper and pencil assignments. Upon further probing as to how the hands-on activity had helped, one student replied that it was more

like real life. All of these comments helped me further design the lessons that were in the rest of the unit.

I made use of this aspect of their journals immediately. The opportunity to re-think and re-shape some of the activities so that the students were excited and involved in learning was evident right from the start. I did not change the content of the unit, as it followed the Alberta Curriculum Guide (1994). I worked, however, on alternate delivery methods that combined activity with paper and pencil assignments. I included more group work and still gave the students opportunities to be independent. The students' comments allowed a glimpse into the teaching methods they preferred.

In a few days the routine of writing was well developed. How quickly students settled in to writing surprised me. By Day 3, I commented in my journal, "After being so active in class, they seemed to settle down to the journals very easily" (Addison, 1995, p.10).

I also enjoyed the opportunity to open up communication with all of the students. I do have a small class, so students have the opportunity to contribute regularly, but there is still the occasional student who is quiet and lets the other students answer most questions. In the journals, I could probe for further information or clarification. Students who were sometimes reluctant to participate in group activities would meet the challenge of solving a problem independently in their journals. The journals seemed to offer that less public forum

that Miller (1991) discusses in his paper. Journals also permitted the opportunity to communicate with all of the students. Each student would take the time to read what I had written back to them. Many would comment on the responses that I had written.

In writing back to the students, I used a very encouraging, positive approach, even when they had errors in their thinking or computations. "Sorry, try again with the use of your fraction kit," would be one way I'd encourage the students to re-do a problem. I'd acknowledge that a question was difficult or re-affirm a child's concern. Some of the types of concerns that the students expressed are evident in the following entries that students made in response to a problem that involved equivalent fractions. I had asked why the students had found the problem difficult.

Tough becuse they
were eights.

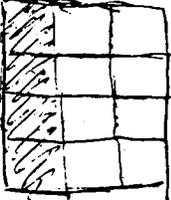
It was tough because
I could not figer it out

Har d
it was in 8th

I acknowledged that the problem was difficult and then suggested that the students use the fraction kits to compare the fourths and the eighths. In the journals, I did not mark answers right or wrong. Through writing back to them, I probed, suggested alternatives and encouraged them to try again. I found that it was essential to be encouraging and supportive if I wanted the students to continue to write.

Day 12 - "I tried to be very positive about their answers and used simple comments to remind them of errors. I have attempted not to be negative or critical in order to get the students to write more and feel good about it" (Addison, 1995, p. 43).

The journals offered all of the students an opportunity to demonstrate what they understood. On free response pages, some students would draw pictures to show what they had learned about fractions. Others would ask me a simple question so that they could "play teacher." I would answer their questions and allow them to mark my work. Students would sometimes model their questions after ones we had done in class, but some did show an extension to their thinking, as evidenced in the following entry. The question that follows was developed by a student before we had completed the section on equivalent fractions. My answer and his marking of my work are also shown.

Student -  if I ate $\frac{2}{6}$ what would you have left to eat?

Teacher - Tough problem!
Would you have $\frac{8}{12}$ or $\frac{4}{6}$ left?

Student - $\frac{8}{12}$ ✓

Another student asked a simpler question, but her marking of my answer was interesting.

Student - what fraction of the class have animals

Teacher - Good question!
I bet $\frac{11}{11}$ ✓ of the class have animals.

Student - good Job

A reward of the journal writing project was the opportunity to rephrase and correct mathematical language or terminology problems the students demonstrated. I attempted to use the correct terminology in my replies, in order to model the language that we were using in class. In a reply to a student who had given an example of a fraction of a set, but

had not included a written explanation as requested, I re-used the language:

"...explain what a 'fraction of a set' means..."

During the classes, I paraphrased and reframed the student explanations in correct mathematical language, but found that the journal could also offer a place to emphasize the terminology we had been using in class (eg.- counting back change, two and four hundredths, etc.).

Journals offered an avenue in which to have the students do more than simply solve a question or problem. I asked them to explain in words how to solve questions, such as:

Day 12 - "In order to add the decimals below, what must you remember to do first?"

Add 2.3, 3.04, 4.1, and 15

The objective was to have students state that the ones, tenths and hundredths needed to be lined up before adding. Six of the students completed the question correctly, but only three could explain that they needed to line up the numbers in written form (Only one student used the correct terms - hundredths, tenths and ones). It brought back to mind the statement by Skemp (1971) that there is a difference in being able to solve a question and knowing how you did it. I wanted the students to be able to explain their solutions, not simply present an answer. Through probing and further modelling, some students became more accurate in their explanations. For example, when asked how decimals and money were related the

following shows the initial response from a student, my prompt and his second response.

	Money is related
Student -	to decimals because it works the same way
Teacher Prompt -	What way is that?
Student -	hundredths, tenths, wholes

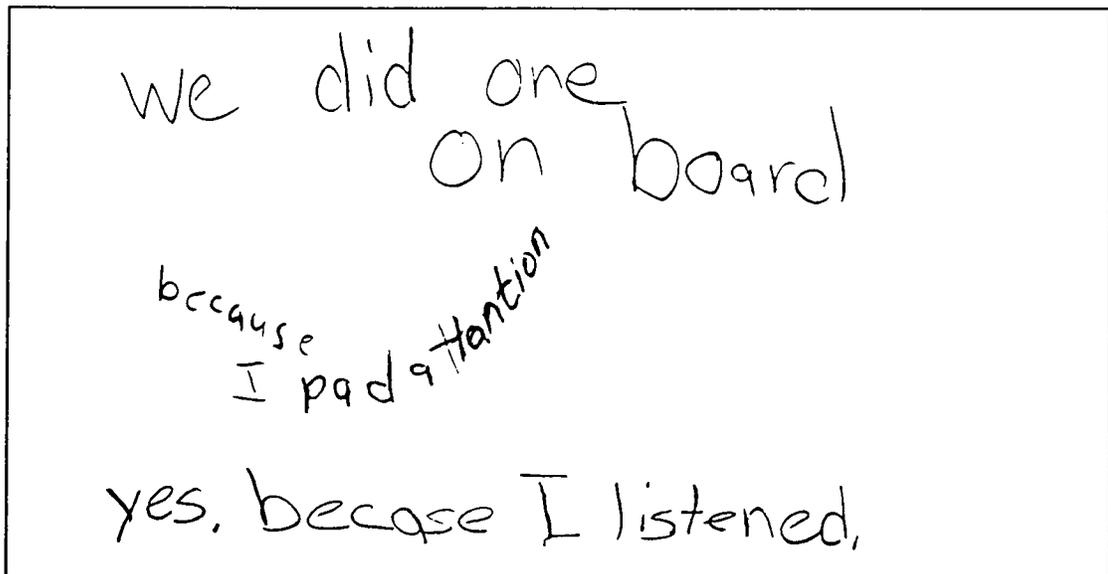
When asked what method(s) had been used to solve a money problem farther on in the unit, the following were examples of replies:

	<u>I used a calculator</u>
	<u>I bid it</u> in my
Hed	then I chekt
it	with the cakelater
	<u>I estimated</u>

The students were beginning to demonstrate understanding of how they solved problems. As stated by Fernandez, Hadaway, &

Wilson (1994), students who analyzed their problems tended to be more successful. This project did not go beyond a simple implementation of journal writing. One of my future goals would be to develop better problem solvers through written analyses of problems. Writing explanations in a math journal demands more from the students than simple completion of paper and pencil assignments.

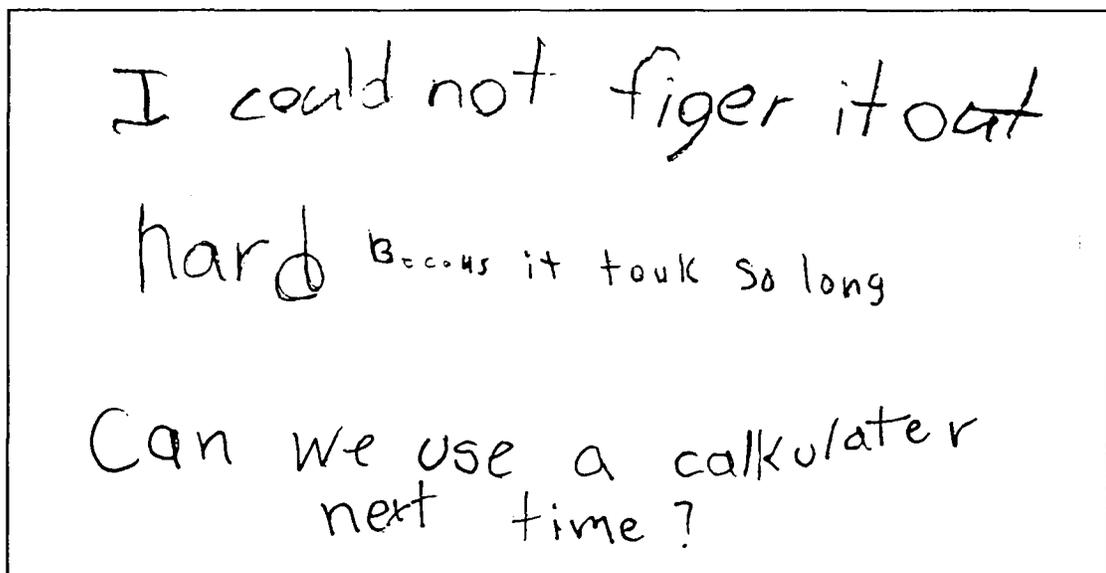
I did receive a rare glimpse into the thinking of a few students when I would ask questions such as "Was this problem easier to solve than the last one? If yes, why?" Students were beginning to explain the reasons why they could solve certain problems and were becoming more aware of their own thinking. The following were examples of some of the replies:



Being able to articulate reasons why they were better able to solve a problem was a positive that I might not have been able

to discover unless I had used journal writing.

A final benefit to using journals that I noticed would be the opportunity for the students to ask a question or clarify their own thinking. Skemp (1971) states that students should be given the opportunity to ask their teachers questions, since "...an answer has more meaning to someone who has first asked a question" (p.35). Not many of my students used this opportunity, but an occasional comment or question was posed that opened an avenue for further discussion.



I could not figer it out
hard becous it took so long
Can we use a calkulator
next time?

The student comments provided an avenue to continue communication in the journal or discuss the questions in the class.

Summary of Question One Findings

To answer research question one, the rewards of the

project that I felt were most important were the following:

- [1]. Journals offered an avenue for two-way communication with all students and there was an opportunity to probe for understanding of terms and concepts.
- [2]. Students accepted writing as a natural part of the mathematics class so writing could be used as another method of communication in mathematics.
- [3]. Journals offered a glimpse into what the students liked and disliked about mathematics classes.
- [4]. Students could receive immediate and more detailed feedback about difficulties they were experiencing.
- [5]. The journals were a place in which to correct mathematical language and give suggestions to students.
- [6]. Journals were a place in which students could state feelings or ask a question privately.

This journal writing project offered many rewards. I feel that teachers should make use of any and all opportunities to extend the students' knowledge and interest in mathematics. Using journals in mathematics seemed to accomplish both of these goals.

The Difficulties of the Project

The next section of this project attempts to answer research question two, "What are the difficulties of implementing a journal writing program in a Grade 4 mathematics class?"

There were many minor housekeeping details that I would change in the future. I'll deal with these minor problems first. The students' journals were simply run-off pages stapled together at the end of the unit. I added each new page as the class was ready for it. There were questions at the top of the page and blank space below. At the grade four level, providing lines on which the students could write would have been more efficient. I was trying to encourage creativity, but found that students could fill the space up with huge pictures and do little writing. I would have liked to have found a way to leave room for drawing yet provide lines for writing.

I would also make sure that there was space for written comments back to the students and an area in which students could write a second reply or ask a question. Coil-bound notebooks might be one solution, but then students would have to copy any questions or prompts that a teacher wished to provide. The format of the individual journals was designed to ensure exposure to the four different types of questions I gave. Free response, summary, comprehension and problem solving questions each appeared four times on a rotational basis. If used over an entire year a less structured format

might be warranted. More flexibility in the use of journals would allow teachers to meet the needs of particular students.

Having only a small number of students with which to correspond made this project feasible in my classroom. In a class of twenty-five to thirty-five, a teacher would simply not be able to touch base with each student every night. Responding weekly or taking in a few journals every day would be the only method that I envision as logistically possible.

The time factor became a difficulty that I found frustrating at one point.

"The students seem "antsy" today. They seemed to rush their entries and hand them in quickly. It is important to pick a time when journal writing is part of the class and not seen as a "tag-on" at the end" (Addison, 1995, p. 35).

There were occasions when the class went overtime and the students were anxious to move on (especially if the next subject were Drama as on Tuesdays and Fridays). I found the journal entries on those days to be less detailed and shorter than on days with ample time to finish. Sometimes the activity part of the lesson took longer than anticipated and time constraints would cause me to push the students to complete their entries quickly. Hurrying the students was not conducive to getting the type of entries I envisioned. In the future I would consider placing journal writing at a different time in the mathematics class, such as at the beginning or as a bridge from activity to assignment.

Getting some students to write was a major hurdle. Out of

nine students, there were two who insisted on writing as little as possible. These two students often failed to write a reply to summary or comprehension questions and usually solved the problems without detailing their method. Of the two, one student usually succeeded in solving problems correctly on the first try. The other student had more difficulty and often needed prompting or help in order to solve a problem.

Learners such as these students appear in every mathematics class, and although I tried to remain positive and encouraging, I was unable to persuade these students to respond in more detail than the "recount" mode (Clarke et. al., 1993). I did seek the students out the following day and have them go back and work on previous entries, but sometimes had little success. Writing about mathematics was apparently difficult for these students, and alternative methods of responding might have been more successful than the journal writing process used in this project.

Knowing that these two students were also likely to write very little in Language classes may have caused me to expect the same limited performance in a math journal. It is difficult to separate the child's work in mathematics from his work in all other subject areas. Preconceived expectations sometimes tend to lead in the direction of "what you expect is what you receive."

These students may have responded more thoroughly had I

allowed them freedom in the types of responses they could have written in the journal. Having choice and control of their writing may have encouraged the two students to take more responsibility. Certain types of stories that these students had written in Language class during the year were creative and well written, but usually only when they had the choice of subject matter and format.

Having these students share their responses with each other or the class might have prompted more detailed work. The act of sharing a passage with another student might have made them realize the limitations of their responses. Modelling by the teacher and other students might have encouraged them to become more detailed. These two students may have benefitted by using a tape recorder to tape their ideas instead of writing the ideas down. This alternative could be incorporated into a journal writing program.

If there had been an evaluative component attached to the journal, these two students' responses may have been different. The students in this research project knew that the journal was not going to be evaluated for their report cards. The project was designed without a structured evaluative component in order to encourage 100% participation. There were no consequences for those who did not respond.

These two students (and sometimes others) were mainly interested in solving questions that I asked. Their entries did not give enough information to make assessments of their

understanding of the mathematical concepts we were addressing. For example, when asked to explain in words and through examples how decimals and money were related, the following answer appeared:

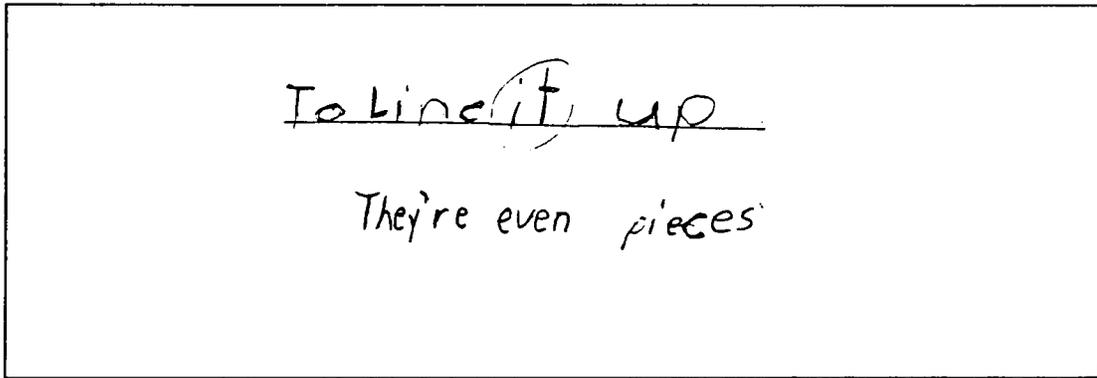
$$\text{\$ } 0.70 = 0.70$$

This entry does not give enough information to tell if the student really understands or just wanted to put an answer down and get on to something else. Unfortunately, with this student, further probing and encouragement to write more or be more specific, had little effect.

Participating successfully in a class activity was one thing, but getting some students to show that they understood in written form was often more difficult. Possibly some learners are more successful in oral work than in written work, as many students could orally explain what they meant, yet had difficulty writing their ideas in the journal.

Students' difficulties in expressing their ideas in written form would be a limiting factor in using journals as a means of determining student understanding. Journals add another "tool" in a teacher's repertoire of teaching methods which must still accommodate all types of learners, even those who find writing a challenge.

Getting some students to use the mathematical terminology correctly was also a challenge. This can be seen in the comments that follow. In the first entry the student meant that you should line up the ones, tenths and hundredths before adding decimals. In the second entry the student meant that the pieces in equivalent fractions were equal in size and shape.



I stressed the correct terms in class, but I found that many students did not use the mathematical terminology in their journals. This is a case where teachers all need to model the correct terms constantly so that there is not a tendency to slip into the "jargon" of the students.

There were times when the students' answers were correct but written explanations did not give enough information to test comprehension of the concepts. Students were given pictures that showed $\frac{1}{3}$ and $\frac{1}{4}$. The objects were congruent, simply cut into three or four pieces. I asked students to determine which fraction was greater and then to explain how

they had decided which fraction was greater. Some replies were:

because it has less squares
~~There's less in $\frac{1}{4}$~~

The first response was definitely true for congruent shapes and fractions with numerators that were equal. Could I be sure this student understood the concept of comparing fractions? I drew an example comparing $\frac{2}{5}$ to $\frac{5}{10}$ and asked if this method would always work. The student solved the second problem correctly and answered "no" to my question. At the grade four level, the students are only required to do comparisons between fractions with common denominators, or numerators of one. I was trying to stretch their comprehension and extend their knowledge of equivalent fractions, which we had covered.

The second response gave me virtually no information about the student's understanding of comparing fractions, yet the child seemed to know which one was greater.

Another student looked at a picture representation for 2.30 and correctly identified the decimal, but wrote two and thirty tenths. Did this student understand place value in

decimals? Did she make a simple mistake or was there a deeper misunderstanding? When prompted to try again, she corrected her work the next day.

Students often manipulated numerals easily, yet seemed to find expressing the answer in written form more difficult. Traditionally, mathematics has not required that students be able to form an answer in words. Most exercises required that the student answer computational questions and complete word problems based upon the mathematics lesson. As stated before, this is not really problem solving as intended in our new curriculum.

Errors and an inability to use mathematical language and terminology correctly, did affirm my belief that we need to put more time into written work in math. Students need more opportunities to express their understanding in written form. This project was an attempt to introduce one form of writing into the mathematics class. Through more practice and class writing projects, students can become more comfortable with the mathematical terminology and concepts they are using. Students need to become more than manipulators of numbers.

As teachers model the language and types of responses they expect, students may become more comfortable with their own mathematical writing. I feel that I did not clearly model the types of responses that I expected. We did complete a sample entry on the board, but I did not read the students any of my journal entries in which I struggled with difficulties

in the teaching or the journal writing. One sentence responses were common, and had I shown the students the length of each of my entries, I might have encouraged a few students to expand their ideas.

Upon re-reading the journals, I found that I did not reply to the students in descriptive, specific language. When a student answered a question correctly, I might reply, "Good thinking!" or "You seem to understand the term equivalent fractions." Being specific as to why something was correct or describing what I liked about the solution would have allowed the students to know exactly what they were doing accurately. Instead of saying "Good thinking!" I should detail exactly how the student's solution was correct. "I'm pleased to see that you lined up the ones, tenths and hundredths before you added." If a student had simply guessed and achieved the correct answer, he/she would have had the opportunity to read how the question should have been solved.

I struggled with the length and kinds of responses to make to each student. With the pressures of all the other subjects that needed preparation and time, I must admit that there were nights when the journals became a burden. Those nights were rare, but they did occur and demonstrated the real magnitude of the project I had undertaken. Writing back to each student every night and completing 2-4 pages in my own journal was very time consuming.

Even though I have outlined some difficulties with

implementing a journal writing program, I would be ready to try journal writing again with a future mathematics class. This project was simply a "testing of the waters" and now that I am aware of some pitfalls, I would be able to make better use of the students' journal entries in the future.

Summary of Question Two Findings

I noticed several difficulties associated with the implementation of a journal writing program. A few considerations for a future journal project would be the following:

- [1]. Develop many types of journal questions and alternative ways of responding so as to encourage all types of learners to respond.
- [2]. Blend assessment of class activities, seatwork and journals to give an overall view of the child.
- [3]. Provide sufficient journal time and sharing time.
- [4]. Respond to students less often but in a more specific manner so that the feedback is both descriptive and detailed.
- [5]. Practice journal writing with the students so they become comfortable with the expectations of the journal writing program.
- [6]. Model the types of entries that are expected

and emphasize the correct use of mathematical language and terminology.

The strategies that are articulated here primarily address management of a journal writing program in mathematics. The greater difficulty of accessing students' understanding of mathematics through their writing remains a topic for further research.

In the next chapter, I will take a closer look at the types of questions used and the potential for each type to serve as a way of looking at the students' learning of mathematics.

Chapter 1V

Examining the Journal Responses

Student entries often did not give enough information to make assessments about their understanding of mathematics. Probing for more complete understanding was difficult to achieve in this project. I would ask questions such as "How did you get this answer?" but when I would not receive a response to that probe, I found it difficult to decide exactly what to do next. A lack of a reply might be indicative of an area in which that student was still experiencing difficulty, or it might indicate that the student was experiencing difficulty in articulating understanding in a written form, or it might simply mean the student could not be bothered to respond.

At the beginning of a lesson, I would often include a mini-lesson as review of what I perceived to be a problem area. Many of the seatwork assignments that the students handed in seemed to indicate that they could work with fractions and decimals, but the written answers in the journals sometimes led me to believe the students had not achieved a complete understanding of the topic. This lack of written evidence of understanding remained a concern throughout the entire project.

"The written part presents the main stumbling block for students. They can often tell me or show me what to do, but writing a set of instructions tends to be more

difficult" (Addison, 1995, p. 40).

The types of journal writing questions chosen for this project did provide a variety of useful information about the students and their mathematical attitudes, feelings, and reactions to the unit on fractions and decimals.

The four types of journal entries that were included in this project were: free response, summary questions, comprehension questions and problems to solve.

Research question number three asks, "What are the advantages and disadvantages of the four types of journal questions used in the project?" The remainder of this chapter will attempt to address that question.

Free Response Entries

Free response entries were the first type of journal entries that the students completed. Students were given the opportunity to respond freely and I received the longest and most creative responses on these days. I used free response questions to give the students a sense of ownership of their journals and to permit the students to freely discuss anything related to mathematics. Free response entries required more time and I found that there were periods in which I felt I was limiting a student's creativity because I had to encourage him/her to finish up so we could move on to another subject.

Free response entries provided the best information about the types of activities that the students enjoyed, the kinds

of math assignments that they disliked and what they would do if they could teach the class. This was valuable information and I used it in the development of activities and lessons.

Free response pages gave the students a voice and tended to be the pages that let me peek into the frustrations (not always related to mathematical learning) that some students were experiencing. For example, when asked if there was anything students didn't like about a hands-on manipulative session (where the students worked in groups), one student wrote about his/her partner:

[NAME, was]
Hoging The Shapes

I hadn't detected this problem but acted upon the observation and made alternate arrangements for the next class. Free response entries such as this one gave information about students' feelings that I would not likely have noticed during the class activities.

One student commented that using fraction kits was more like "real life" which led me to believe that book work or paper and pencil seat activities were not "real life" in his

eyes. I used this information to design a blend of hands-on activities with book work. A blend of activities allowed students the opportunity to talk, read and write about mathematics.

When asked what types of methods students would use to teach a unit on fractions and decimals, I received some insight into what the students seemed to like to do themselves:

Just like you-
I would use some
of the same methods

40 pages of ^{Bookwork}

I would draw them on the
board

I would give them problems because they'd
understand the problem.

The variety of suggestions was as diverse as the variety of

learning styles present in the class. The visual learners suggested using a visual method to teach others. The students who liked quiet seat work chose that method, and one student who liked the challenge of solving problems chose that method. It was valuable information to me, as his teacher, to realize that he related problem solving to understanding the mathematical concepts.

I learned that no one teaching method would suffice (even in such a small class) and realized how very important a variety of teaching styles and techniques can be in the mathematics classroom. I tried to use a variety of styles in the lessons to accommodate all learners.

It was clear that the students liked the actual application of the concepts utilizing an active form. We set up store fronts and bought and sold "merchandise." The objective was to see if the students could calculate and then count back change to someone else. The free response comments after those lessons were all very positive. The students liked the activity of buying and selling (using play money) and felt that they learned how to count back because someone else (the buyer) was making sure it was done correctly. The following are examples of student free response comments when asked if they had liked the class in which merchandise was "bought and sold":

I made lots of
money.

I like it because we got
to use money.

It was very fun.

The class obviously liked working with real life situations. When the class used manipulatives, the students felt that mathematics seemed easier. Students were excited and didn't always realize that they were learning mathematical concepts through the use of the fraction sets, coins, base ten blocks, etc. One or two students expressed that the active classes were more like real life, but most simply felt the classes were fun, interesting and better than book work. I began to feel that sometimes teachers insulate students from the real world by using textbook approaches, and that students do not relate activity based classes to learning mathematics.

I learned much from the free response entries. The following summary highlights the main advantages and disadvantages of the free response entries.

- [1]. I discovered which teaching methods students enjoyed and what kinds of activities might be blended to mix with less active seatwork.
- [2]. Free response entries reflected and identified small problems in class which could be attended to quickly.
- [3]. These entries established an open line of communication with the students.
- [4]. Free responses entries tended to be longer and more creative.
- [5]. There was increased interest and ownership of the journal writing program.
- [6]. Free response entries were a useful outlet for developing, explaining and sustaining the application of concepts.
- [7]. Students required more time to answer free response questions, so time became a factor.

Summary Questions

Summary questions asked for a recounting of the day's activities or a concept that had been addressed. I used these entries to ask the students to repeat a definition that we had introduced in class, or demonstrate an example of fractions or decimals in pictures and words. Summary questions emphasized the importance of the daily work in the mathematics classroom.

Summary questions provided knowledge as to whether the

students understood the mathematical terminology and could reproduce examples from the activities that they had completed. I was concerned that the students could use the correct terminology (such as "fraction of a set" or "hundredths, tenths and ones") and felt that the class needed an avenue in which to practice. The journals offered an opportunity for students to demonstrate their competence in mathematical terminology and gave me the opportunity to model the correct use of the terms for the student.

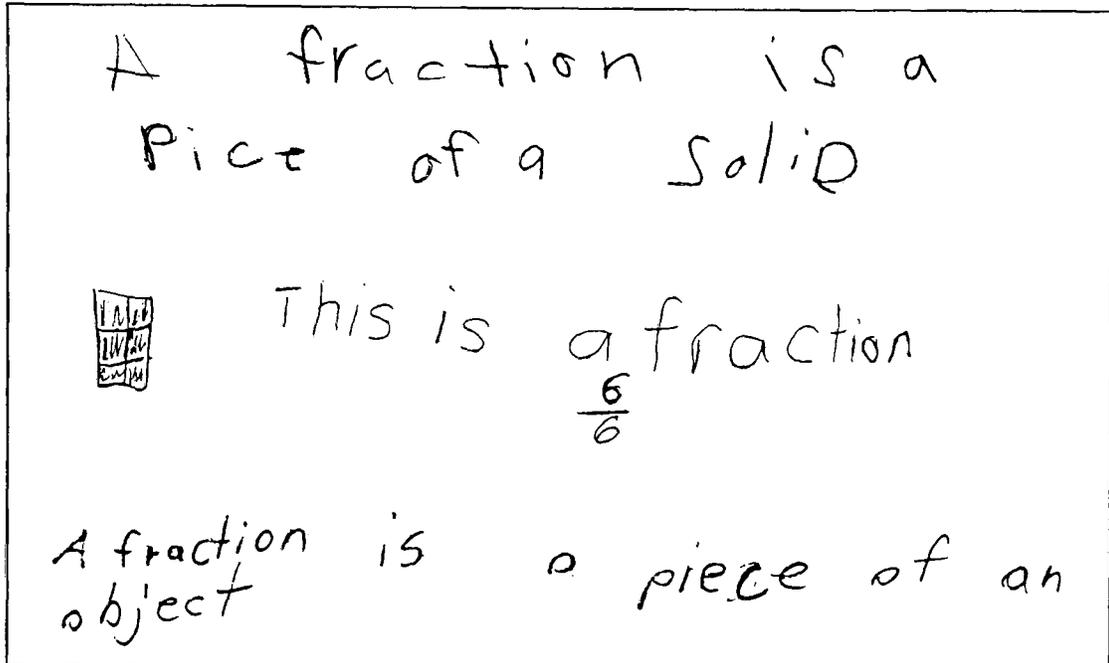
When students could draw a picture or express an answer in numbers only, I then had the opportunity to write the correct definition in words or probe the student to write a more complete answer. After two unsuccessful attempts, I would often use their responses as information that this was an area that required further review and modelling. I posted examples and wrote the definitions on the board so that the students could access the information whenever they needed it.

Summary questions also enabled me to identify those students who seldom paid attention to definitions. There were two students who wrote little in their journals on those days. I used extra probing but was often frustrated by their lack of written work.

As summary entries were the ones that usually required the most detailed written replies, students often commented in class that they did not enjoy summary questions.

On the day students were asked to use pictures and words

to explain what a fraction was; the written part was weak:



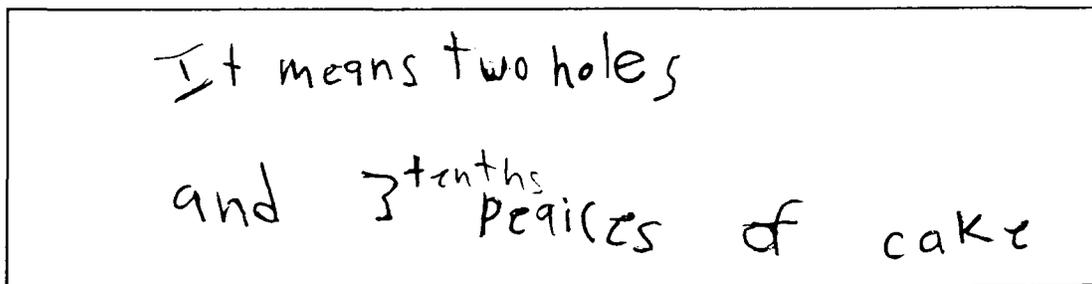
Most students were able to draw and shade a fraction of an object, but many had difficulty using the words. Writing definitions for a fraction and for a fraction of a set allowed me to note the students having difficulty expressing understanding in written form.

One student drew a set of 4 candycanes all patterned differently and correctly stated that $\frac{1}{4}$ of the candycanes had spots. Yet her written definition for a fraction of a set was that the candycanes were different colors but the same kind. I began to realize how often students could "do the mathematics" but could not express their understanding in words. I could not get this kind of information from a set of exercises on fractions since my students could identify and

write fractions easily.

I spent more time with individual students to help them with mathematical terminology and definitions that were being used in class. I found that almost half of my students had difficulty in repeating definitions correctly (information I used in designing future lessons).

When I detected a misconception in their written responses, the journals provided a means of correcting that misconception quickly before "sloppy language" became a part of students' mathematical background. Summary responses provided the best information in the use of mathematical terminology. For example, one student responded to a picture of two and thirty hundredths as:



It means two holes
and 3^{tenths} pieces of cake

This student was having difficulty in expressing her answer in hundredths, but had remembered an activity we had completed that proved $3/10$ was equivalent to $30/100$. Her answer gave me an insight into how I had probably progressed too quickly from one concept to another (tenths to hundredths in two classes) and hadn't ensured sufficient time for this student (and maybe others) to grasp the concepts thoroughly.

Summary questions also offered an opportunity for assessment. I used the entries to check students' understanding of the day's material, as well as a check-up on my own lessons. Where students had difficulty with terminology, I realized that I needed to spend more time using the language and modelling correct use of the terms.

Based upon the brevity of student responses, comments made while students were responding, and student body language during summary response days, it appeared that students did not seem to enjoy summary questions. However, I feel that summary questions would remain a part of any journal writing program I would use in the future. The following repeat observed advantages and disadvantages of summary questions:

- [1]. Summary questions provide insight into teacher pacing of lessons.
- [2]. Summary questions provide insight into student use of mathematical language and the level to which such mathematical language affects student understanding.
- [3]. Summary questions provide an opportunity to make informal assessments of student understanding of the concepts presented.
- [4]. Summary questions are of less interest and enjoyment to the students.
- [5]. Students require more response time to complete summary questions.

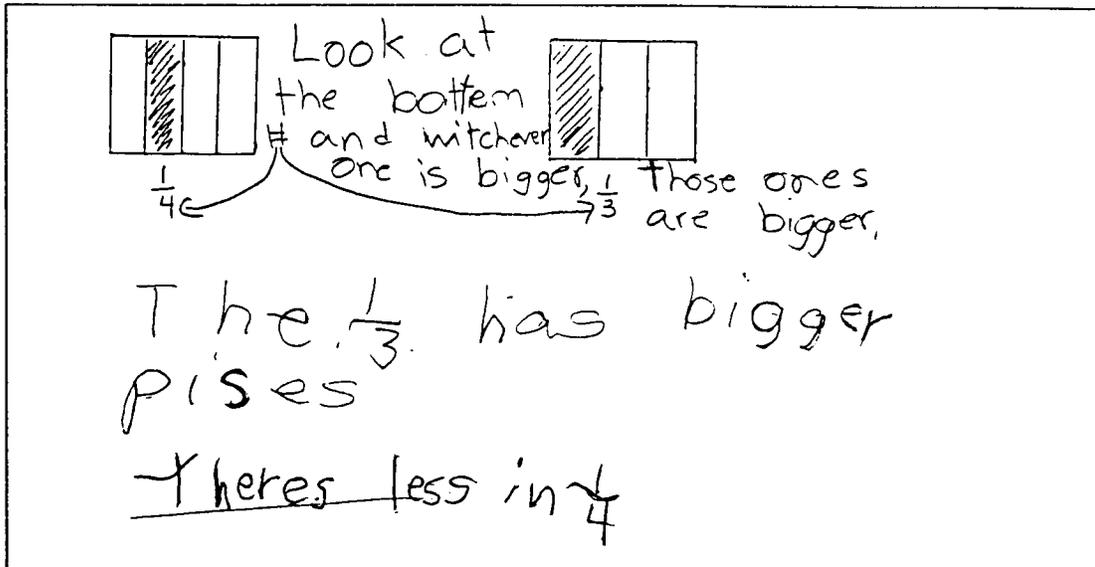
Comprehension Questions

Another opportunity for assessment arose from the comprehension questions which required students to apply the knowledge or understanding that they had acquired in class.

Comprehension questions were difficult for some of the students as the questions often asked students to "explain why..." This type of question demanded that the students have a facility with the English language as well as a familiarity with the mathematical concepts.

I used comprehension questions to find out whether students understood the concepts that were addressed in the lessons. I often found that comprehension questions needed extra probing and two attempts on the part of the students.

When asked how to decide which fraction of two pictured was greater, (the fractions pictured were $\frac{1}{3}$ and $\frac{1}{4}$) most students could correctly identify the larger fraction, but few students could explain clearly how they had decided upon that answer. Some of the students' explanations as to why $\frac{1}{3}$ was greater than $\frac{1}{4}$ are shown in the following journal entries:



I then realized that more time was needed in ensuring that the students didn't learn rote methods for solving questions (choosing the fraction with the smallest denominator), but rather understood the meaning of comparing fractions. The students' written explanations about comparing fractions were important information to have as the teacher of this class.

I found the comprehension questions allowed me to identify students who read questions superficially and assumed they knew what question they were being asked to solve. For example, on the question where students were required to explain what they needed to remember in order to add a set of decimals, three students out of nine inserted a decimal into the numeral 15, making it 1.5. Since all the other numerals contained a decimal these students seemed to assume I had simply forgotten to write the question correctly, yet no one

asked for clarification. I realized that I needed to spend more time reading the assignments with the students and teaching them how to read and analyze mathematical material, which is by nature more complex and dense.

The comprehension questions also seemed to involve more reading (they were often longer or contained two parts) and this was an area of difficulty for students who found reading difficult at any time. I did not read comprehension questions to the students but did help if a student asked that I read a question to him/her. Journals could give the students an additional place in which to practice reading mathematical information. Reading a mathematics question with another student might assist students who have difficulty in understanding what is being asked in the question.

Teachers could design comprehension questions for the journals and actually spend time modelling how to read and re-read questions until they become comprehensible. I did not do this but feel it would have helped some of my students answer the comprehension questions in more depth. This is a teaching recommendation made in the work of Hollander (1990).

I noticed several entries in my journal similar to the following:

"Some students wrote the decimal only and did not draw the picture. My reply to each of them was to read what was asked in the question" (Addison, 1995, p.24).

It is difficult to convince students of the importance of reading and re-reading mathematical material. I envision

journals as another avenue in which I could practice this skill more thoroughly than I did.

Comprehension questions allowed me to separate the students in my class into the groups that needed extra help on a topic and those that needed to be challenged with more difficult material. When the whole class ordered a set of decimals correctly, and then found a decimal between two limits, I realized that this material needed no re-teaching. When three out of nine students added the set of numbers correctly, lining up the tenths and hundredths, I realized this was an area we needed to review. I then used the few students that understood the concept as mentors or helpers. I sometimes provided some students with calculators and more difficult problems to solve while I reviewed with the others.

Finally, comprehension questions helped me design lessons to follow and allowed me to have an immediate check on understanding. Had I waited until a final unit test, I might have lost the opportunity to re-teach and work with the students that needed extra help on a specific concept (eg. place value in decimals). I also might have missed the opportunity to design challenge questions for the superior students.

The advantages and disadvantages of the comprehension questions could be summarized as follows:

- [1]. Comprehension questions provide a more
immediate assessment of developed meanings and

understanding.

- [2]. Comprehension questions provide useful information for sequencing and reteaching in subsequent lessons.
- [3]. Teachers can develop alternate questions and materials for the students requiring extra help or needing a challenge.
- [4]. There exists the opportunity to assess student reading ability in mathematics through comprehension questions.
- [5]. It may be difficult to design comprehension questions that are useful in assessing student understanding as some students may find it difficult to demonstrate understanding in a written form.

Problem Solving Questions

I designed the problem solving questions to see if the students could apply their mathematical skills to solve real-life problems. Questions were based on the unit objectives, but I did not give the students problems that were identical to ones we had been solving. Each question had a bit of a novel twist or challenge involved.

In two different problem solving entries students were asked to discuss whether the problem was easy or difficult and explain why. In my responses to the students, I often asked

the students how they had solved the problems.

According to researchers such as Porter (1989) and Graeber (1994) problem solving questions should be an important part of a journal writing program because problem solving demands a higher level of thinking on the part of the student and provides the student with an opportunity to reflect upon mathematical ideas.

The students in this project seemed to enjoy problem solving entries. I thought about reasons that these types of questions would have appealed to so many students. I allowed the students access to manipulatives and calculators when they had to solve a problem. I asked them to show their work, but did not require the traditional three step format (equation, solution, statement answer). The above factors may have affected the students' interest in problem solving entries.

On two separate days I had the students write a comment about the problem (eg. Was this problem easier than the last problem? Why?). I included this question so that there wasn't a total absence of writing, even so, problem solving days often involved less written work than other types of questions.

On the final day of the project I gave the students a list of items at a make believe store. Their problem was to buy any three different items, and spend no more than \$10.00 -discounting GST. The students were given an additional problem that asked if they could find another set of three

items (this question was optional). Calculators were permitted. The students enjoyed working with a calculator to test out combinations and try different sets of objects. I asked several students how they had solved the problem and found answers varied from estimating and checking, to using the calculator right from the beginning, to simply adding up the three least expensive items. Seven out of nine students solved the problem correctly on the first try.

As I circulated during journal writing activities, I observed good use of problem solving strategies. Listening to the students talk as they solved problems also let me peek into the processes they used to find solutions. Having the students write down their methods in the journals would have been valuable. I did not do this on a regular basis and feel that I should have kept a record of the methods students used when faced with problems to solve. I could have used this information to ensure that I exposed the students to various problem solving strategies that they had not used as they solved problems. For example, one problem asked the students to tell what fraction of a chocolate bar was left, if someone had eaten $\frac{3}{4}$. The chocolate bar was shown divided into 8 equal pieces. Students had to use their knowledge of equivalent fractions to solve the problem and write down whether the problem was easy or hard. One student who solved the problem stated:

Easy because $2/8$ is the
same as $1/4$

He had applied a previous lesson on equivalent fractions and knew that if he had $1/4$ of the chocolate bar left, it would be the same as $2/8$. Having this example in his journal for later reference, might be useful if a future problem involved equivalent fractions.

Problems were one type of entry that seemed to separate the excellent math students from the "memorizers" and those simply skilled in the basic operations of mathematics. I had the opportunity to observe the ways in which superior students solved problems during these entries. I then used some students as helpers for the students who were having difficulty. I also used the information from problem solving questions to identify students who were weak in skills as well as problem solving strategies. We reviewed skills and strategies in class regularly.

I was able to see what methods students used to solve the questions and where a misconception had led to failure to solve a problem. One question asked the students to calculate how much pizza (in pieces) was left if our class had eaten 0.8 of **each** of 2 pizzas. I had suggested that the students should

draw the two pizzas. One student put down the answer "12 pieces" and wrote that it was easy because all he had had to do was subtract. I wrote back that we had eaten 0.8 of each pizza. On a second try, he solved it correctly (but still with no picture). For this student, the way in which he reads problems might be the cause of his difficulties or being in a hurry to finish might have contributed to a quick solution. But I did have the opportunity to review the steps in problem solving with the class and make sure that the students realized how important it was to have all the information correctly in place before starting to solve the problem. It was also a perfect problem in which to practice using diagrams in solving problems.

Problem solving entries provided the opportunity to model solutions the next day and use different methods for solving problems throughout the unit. We often shared solutions (a vital but time consuming part of problem solving) and this gave the students the opportunity to share their journals and hear what they had written. I also had the opportunity to see if students could explain their solutions orally to others. It was an easy way to incorporate some reading, writing, listening and speaking skills into mathematics.

When students had great difficulties with problems, I rephrased the question, underlined or emphasized certain words, referred them to another student, and/or suggested the students use manipulatives or a calculator. I was trying to

encourage students to use a multitude of possible approaches and found the journal offered one avenue in which to suggest to students additional methods which might be used in trying to solve problems.

Problem solving questions in journals offered the opportunity to focus students' attention on real life situations. When asked to make up a problem, I found that some students would write one patterned after those we had modelled in class. Occasionally the students would create a more difficult question than any we had covered. In most cases, students would use classmates' names, examples from around the school or at home, or examples that dealt with something they understood. The language of the problem would be in the student's own words but I was able to see whether or not the mathematical terminology was correctly used.

One girl drew a set of patterned bodysuits (she took gymnastics) and asked me to write as many fractions as I could that would go with that set of bodysuits. I found six possibilities (for example - $\frac{2}{5}$ of the bodysuits have diagonal stripes) and may have missed some. She checked my work and told me that I had done very well. Obviously this type of problem evolved from her personal experience, but it covered the concept of "fraction of a set" beautifully. I learned that it is essential to make use of the experiences of the students and use their worlds to create the lessons that would meet the expectations of the mathematics curriculum. Her

example was much better than the one in the textbook showing drum majorettes in a city band. Majorettes had little relevance to the students in our rural school.

Adding an optional problem at the end of a problem solving entry was an interesting way of challenging students. I would encourage those finished early to go back and try the optional problem, but there were those students who would never complete anything more than was required. There were others (usually 2-3) who tried to find several solutions.

Problem solving questions created the opportunity for designing stimulating situations for the students who needed the challenge. I had one student ask to keep his folder until storytime (when I read to them) as he wanted to take the calculator and try his problem again. He is the rare student, but the journal offered a creative arena in which to challenge this type of learner. The freedom to explore and write about their explorations was an opportunity that the journals presented to some students.

I commented in my own journal that problem solving in a journal writing program offers a valuable medium for mathematics' teachers.

"I think this (journal writing) could be an excellent evaluation tool of both understanding (of problem solving strategies) and misunderstanding" (Addison, 1995, p.45).

I wrote this comment after a problem solving question in which only four out of nine students solved a question correctly on the first try. Two students never did solve it on their own

but I did have the opportunity to observe the types of errors they continued to make (errors in skills and errors in understanding how to proceed). Problem solving entries in the journal seemed to offer the greatest opportunity to observe and collect data on the students' abilities to apply mathematics to real life situations.

I was able to see where the students came upon a mathematical "roadblock" and was able to provide them with help to carry on with the problem. For example, when one student only added up the purchases in a problem solving question and failed to calculate the change from \$10.00, I rephrased the problem and asked the student to try again. On the same problem I simply circled a subtraction error that another student had made. I was able to tailor the help to the student's problem.

Through careful selection and development of problems, the skills of mathematics can be taught, modelled, observed and evaluated. Problem solving entries should be an essential part of a journal writing program in mathematics and have the following advantages and disadvantages:

- [1]. Problem solving entries can increase student enjoyment and interest in mathematics.
- [2]. Problem solving entries allow students to integrate a variety of skills and strategies.
- [3]. Problem solving entries separate the memorizers from the learners who apply their

skills and demonstrate understanding.

- [4]. Through problem solving entries, students can be encouraged to explore alternate solutions and apply solutions to real life situations.
- [5]. Problem solving entries offer an avenue to individualize instruction.
- [6]. Problem solving entries require great thought and careful design in order to provide students with opportunities to reflect upon their solutions.
- [7]. Problem solving entries demand increased time for students to share solutions and reflect. This may be difficult to incorporate into a teacher's timetable.

Summary of Question Three Findings

I would use a blend of types of journal writing activities with my students. There was much to be learned from each type of entry. I feel that the prompts and structure of this project offered a method for beginning a journal writing program. Each type of journal writing question had its own strengths and weaknesses.

Free response questions establish the communication lines and encourage creativity in the students. Free response questions are a source of information on the types of activities students enjoy, but they do require more class time

if students are to be free to respond as they wish.

Student responses seem most difficult to encourage in summary questions. These questions provide insights into students' abilities to use mathematical terminology and are helpful in determining pacing of lessons. Summary responses provide opportunities for informal assessments of student understanding.

Comprehension questions provide information that can be used in assessing student understanding, and in developing future lessons. Teachers can develop additional questions and materials to help students struggling with concepts. Reading ability can be informally assessed. Designing comprehension questions is time-consuming if one wishes to ensure that the questions will provide students with the opportunity to demonstrate understanding.

Problem solving questions allow students to integrate their mathematical skills and understanding. These questions encourage students to explore and participate in mathematics. Problems provide interest and challenge to students, but require time and care in construction. Students also need class time in which they can share and critique each other's solutions. Problem solving questions may be difficult to use in assessing student understanding if students only solve the problems and do not write about their solutions.

After a journal writing program has been established there may be less need for formal prompts such as the ones in

this project. Countryman (1992), Miller (1991), Richards (1990) and Sipka (1990) all list ways in which to get a journal writing program started and types of questions that might be asked, for example:

[1]. Free response questions:

- a. What frustrated you about today's class?
- b. Persuade someone else that mathematics is important (This would also involve comprehension and reflection).

[2]. Summary questions:

- a. Write your mathematics autobiography.
- b. What did you learn from today's class?

[3]. Comprehension questions:

- a. Write a letter to someone explaining _____.
- b. Criticize a concept in the textbook, giving reasons.
- c. Use diagrams and words to show your understanding of _____.

[4]. Problem solving questions: (the following prompts encourage a reflective component in the problem solving questions that was not emphasized in this project).

- a. Describe the process you used to solve the problem.
- b. Make a list of all the questions you would have to answer in order to solve the problem.

As students become less reliant on the teacher's prompts, a list of possible starters might be posted in the class.

I would certainly include in the journals a sample of problems that the students solved or attempted to solve. This would be a valuable place in which students could demonstrate problem solving abilities and attitudes. Journals could also be a portfolio of work to which students could refer at a later date. Revisiting would be one way of adding a reflection component to journal writing. As students returned to their journals they would be able to re-think solutions and possibly create new ones.

Chapter V

Reflection and Future Implications

A journal writing project such as this becomes a part of the researcher. It is somewhat difficult, but very important, to step outside the project and reflect upon its value and implications.

Reflection

I learned that there is more research needed in the area of journal writing in mathematics. One area that I would like to further research is the concept of using journal writing as an evaluation tool for mathematics teachers. Journals might be used in evaluating a student's work throughout the year. Teachers might use a journal as the document in which all mathematics is recorded. Definitions, examples, written responses to prompts, and problems could all be kept together - almost like a photo album of the year's progress. Students could make continued use of their journals in future years.

Having a conversation with myself in the form of a journal helped me to focus my attention on my teaching. I could read the students' entries and review my lessons. I could remain in close contact with the students and their understanding of the unit on decimals and fractions. I used the journal entries from the students in planning and re-designing lessons for future classes. So if for no other

benefit than this, I felt that I became more aware of my teaching and its impact on my students.

I do feel that the project has merit for its process and how it served as a vehicle in which to evaluate and reflect upon my own teaching. Hart et. al (1992) states that one way a teacher can determine if his/her practice needs change is to reflect upon it. Becoming a reflective teacher might sound difficult, but I found that if I considered my teaching in the light of my students' comments, failures and successes, I became more aware of my teaching practices. I will definitely keep a journal in the future - not necessarily one of the magnitude of this one, but one in which I address questions that arose during the completion of this project. I will reflect upon the teaching methods I use and their impact upon various types of learners. I will examine the types of interactions I have with my students. I will try to view my classes through the eyes of the students and determine if the classes are relevant and interesting. Through my own journal, I will try to step outside my teacher frame of reference and see the classes through the eyes of a visitor. By using a journal to have a conversation with myself about my teaching, I hope that I will become a better teacher.

If having my students also keep a journal can help them to become more reflective about their own learning, I will continue with a journal for their use as well. One suggestion might be to combine a language learning journal with a

mathematics or content area journal so that students do not feel overwhelmed with the amount of journal writing they are expected to complete.

Suggestions Arising from this Study

As I stated before, this was a unique opportunity to work with a small group of students. The number of students in the study certainly affected my ability to communicate on a one to one basis with each student every night. I could not have attempted such a project in a class of thirty.

This study did not contain a formal assessment component, but it offered unique opportunities to make informal evaluations of student growth as well as personal growth as a teacher. I would suggest that a journal writing program include a formal assessment component.

Students are assessed for four main purposes according to the NCTM (1995). These are: promoting growth, improving instruction, modifying programs and recognizing accomplishments. I feel that the journals offer teachers the opportunity to accomplish all of the above purposes.

I tried to extend and encourage continued thinking and growth by giving the students alternate ways to deal with a question. I changed lessons to fit the needs of the class, and I gave extra help to students who demonstrated a weakness in some facet of the unit. There were times I wrote glowing responses back to someone who had solved a tricky question.

There were times when I would liked to have evaluated the students' responses (or lack of responses) for reporting purposes to their parents. There was so much information in their journals that helped me understand their work in mathematics.

I feel that authentic assessment would include an evaluation of writing within the mathematics program as outlined in the NCTM Assessment Standards Document (1995). It reports a major shift away from assessment of students' knowledge of facts and isolated skills to assessing a student's full mathematical power. The power of mathematics also comes from the students' ability to "think" and "write" mathematically. Students should be given an opportunity to demonstrate their knowledge in a multitude of ways. I see the journals as offering one more evaluation tool.

I would have liked to use the journals for assessment to see how well some students would do when given an additional forum in which to demonstrate their understanding. Evaluation might also have added importance to the journal's value in the eyes of the students.

One other aspect of journal writing which I would like to research is the concept of having students evaluate their own thinking and mathematical abilities. Clarke (1993) described a study in which journals were used with Year 7 students in Melbourne, Australia. A major objective of the study was to have the students formulate, clarify and relate concepts,

think in mathematical terms and practice solving problems. Besides being able to summarize and choose practice examples, the students were expected to ask questions about their own learning and misunderstanding. The journals were graded at 30% of a term grade. Descriptors were developed for teachers to use in assigning grades. The students became more reflective as their use of journals progressed over the year.

At grade four level, students might have difficulty in reflecting upon their own mathematical ability, but with increased modelling and continued use, I do believe some, if not all students would begin to take a closer look at their own learning. Asking them simple prompts, such as "What else would you need to know in order to solve this question?" might begin to focus students on what facts they require, or what mathematical concepts they still need to understand in order to solve a question successfully. Reflecting might move them towards becoming the independent, responsible learners that educators wish to develop.

I became concerned throughout the course of the project with the types of journal entries that I had chosen to use. I began to feel that I was not giving the students enough flexibility in writing responses. I wanted to present the students with the opportunity to try different types of questions, yet I may have limited or censored some of their ideas because the entries were tightly structured. Possibly trying to create the journal entries well ahead of time (I

tried to have all the prompts complete and run-off by the beginning of the second week of the project) limited the lessons and the natural flow of the class. I felt somewhat confined by the structure that I had imposed upon myself. I did modify and adapt lessons daily, but always felt that pressure to finish the lesson for the next objective, since the journal entry would relate to the material scheduled for that day. One suggestion that occurred to me, would be to write the prompts as I developed the day's lesson. Then the prompts would be based upon the lesson actually being delivered, not necessarily the one planned ahead in the unit plan. This would require that the students copy the prompt into their journals.

At the lower elementary grades, a teacher needs to be flexible and able to change lessons to suit the particular needs of the class. This journal writing program did not permit a great deal of spontaneity from the students.

There are many more possible types of questions and prompts that a teacher could use in journals, other than the four types that I chose. Depending upon what information a teacher wants to obtain, one would need to research and experiment with different types of entries. One possible application of journals that I would like to try would include having the students attempt to write "student authored" manuals (Hurwitz 1990) or explanations for a topic. It would have been interesting to have assigned a section of the unit

(for example - equivalent fractions) to a group of the students and request that they develop the lesson and materials needed to explain the topic to the other students. All examples, definitions and a summary of the methodology chosen could become part of their journals.

Student authored manuals would be an excellent way to assess students on what they can "do" in mathematics. This approach would include writing, speaking, listening, viewing, reading and even possibly acting as the students prepared their projects. Another example of the journey towards the "end" being as important as the "end" itself.

Another area that I feel needs further research and investigation is the area of mathematical language. Many of the students who experienced difficulty in answering comprehension questions or solving problems, may have experienced difficulties because the mathematical terminology or the language of the questions was beyond their grasp. I will continue to use a variety of methods to encourage students to read and write mathematical terms and solve problems with more complete understanding of what is being asked. Journals seem to offer an excellent forum in which to practice.

Even though I have described many challenges that I found with this project, I feel that the advantages of using journals in mathematics certainly outweigh the disadvantages.

Final Thoughts

I believe that the process of beginning a journal writing program in mathematics became more important than the actual outcome. I had the opportunity to try a novel approach to mathematics with my students and acquired some valuable insights into the way my students viewed mathematics, my own teaching and their learning.

As the journal writing project proceeded, the lines of communication between teacher and students strengthened. I had the opportunity to carry on a conversation with the students in their journals. The students had the opportunity (and were expected to use it) to respond a second and even third time. The feedback between teacher and students is one of the strengths of this project.

Teachers might want to consider incorporating writing activities into their mathematics classes. Journals offer educators an opportunity to gain insight into student attitudes and abilities in mathematics. Journals may offer an opportunity to access student understanding, but this is more difficult.

In order to get started, I would recommend reading some of the work by authors listed in the bibliography. I certainly found their research and articles a great source of support. Any extra information educators can gain about their students and their own teaching is definitely worth the additional effort.

I will use journals again in my classes making the following adjustments:

- [1]. The journals will be a part of the program, not a tag-on at the end of a class.
- [2]. The journals will have an evaluative component, carefully explained and demonstrated for the students.
- [3]. The journals will have some structure, but there will be more flexibility in the types of entries students make and the ways in which they can respond.
- [4]. I will model the importance of become a reflective writer by sharing entries from my own journal.
- [5]. Prompts and questions asked will be developed within the lessons themselves.

In order to develop the problem solvers for the future, we need to begin the preparation today. As a teacher, I accept the challenge to create the environment in which students really can develop their total mathematical potential. This project demonstrated one way teachers can begin to meet the challenge.

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Appendix 1

Dear Parent or Guardian:

I am conducting a project on the use of journal writing in mathematics. This project is in partial fulfilment of the requirements of my Master's of Education.

The purpose of my project is to investigate the challenges involved in implementing a journal writing program as part of a regular mathematics class. I hope to use journal writing as a means to help students understand math concepts.

As part of the project, I am asking the students to write in a math journal for 5-10 minutes each day for three weeks, as part of our regular mathematics classes. I will write back each night to encourage communication and to try to probe understanding.

I will keep a detailed journal of my own experiences with the journalling process and this will be the main source of my information for the project.

I would like to use your son/daughter's journal in the project. I would like your permission to have your child participate. Participation is voluntary, confidential, and anonymous. Students may withdraw at any time without penalty or prejudice.

Please note that all material collected will be handled in a confidential and professional manner. All names, locations and any other identifying information will not be included in any discussion of the results. I will not be testing or recording marks as part of the project.

Please discuss participation in this project with your son/daughter. Please indicate your willingness to allow your child to participate by signing the letter attached, in the space provided. Return the letter to me at the school.

I very much appreciate your assistance in this study. I hope to improve my mathematical teaching as a result of the project. If you have any further questions, please feel free to contact me at the school or at home. (381-1937). Also feel free to contact my supervisor of my study, Dr. A.C. Loewen at 329-2396 and/or any member of the Faculty of Education Human Subjects Research Committee. The chairperson of the committee is Dr. Rick Hesch (329-2118).

Yours sincerely,

Linda Addison, (Teacher)

Implementing Journal Writing in Mathematics

I agree to allow my son/daughter _____

to participate in this research study.

Name

Signature

Date

Appendix 2

Journal Questions

[1] Open Ended Response:

a. Describe what you liked about today's activities.

Was there anything you didn't like or understand? (If there was, what was it?)

b. Tell what you have been doing in class, or what you like, dislike and feel about fractions?

Draw a picture or ask me a question.

c. Of all the activities that we have done, which ones helped you learn about fractions? Describe them.

If you were a teacher, how would you teach fractions?

d. Make up a problem for me to solve using decimals or fractions.

Did you like today's class? Why or why not?

[2] Summary of Daily Work:

a. Using pictures and writing explain what you have learned about the meaning of the term "fraction."

Draw three ways to show $\frac{5}{6}$.

b. Using both pictures and a written explanation, tell what a "fraction of a set" means.

c. As we learned about decimals that are more than one we coloured and drew pictures like the one below. Tell me what you have learned about decimals like the one shown.

(The picture showed blocks representing 2.30)

d. Think back to the store of the past two days. What money skill were we working on?

How did being a store owner help you to learn to make change?

[2] Comprehension of Concepts:

a. Explain why the picture below does not show the fraction $\frac{6}{10}$.

(The pieces in the picture were uneven)

How would you decide which of the following fractions is greater?

(There were pictures representing $\frac{1}{3}$ and $\frac{1}{4}$)

b. Knowing what you have learned about decimals, put the following list of decimals in order from least to most.

Draw a picture to show a decimal that would be greater than 0.3 but less than 0.6.

c. In order to add the decimals below, what must you remember to do first?

Add: 2.3, 3.04, 4.2, and 15

Now solve the question showing your work.

d. Explain how decimals and money are related? Use words and examples to show how we use decimals in money.

[4] Problem Solving:

a. Look at the drawing of a chocolate bar below. It was divided into 8 equal pieces. If Terri ate $\frac{3}{4}$ of the chocolate bar, what was left for you?

Solve this using pictures and statements.

Did you find this problem easy or difficult? Why?

b. Tilly made 2 pizzas and cut each one into 10 pieces so everyone could have some pizza. If the decimal to show how much of **each** pizza was eaten was **0.8**, how many pieces were left from the two pizzas? (Hint - draw the two pizzas)

Was this problem easier than the last one? Why?

c. Dalton and Kelly went shopping. They bought the following (NO GST):

- pencils \$ 2.98
- erasers \$ 0.75
- paper \$ 1.09

If they gave the clerk \$10.00, what would be their change?

*****You may use a calculator*****

d. Lanny and Lawson went shopping at San Francisco and had \$10.00 to spend. What three items can they buy? (NO GST)

- | | | | |
|-------------|---------|-----------------|---------|
| Funny Gum | \$ 3.27 | Pogs | \$ 2.99 |
| Bubble Bath | \$ 3.29 | Comics (3 pack) | \$ 3.49 |
| Goop | \$ 4.35 | Mini Lego Set | \$ 4.06 |
| Toy pistol | \$ 3.25 | | |

Appendix 3**Sample Teacher Journal Entry**

May 17, 1995

Today, I introduced the concept of decimals. Each student received a sheet of squares with wholes, tenths and hundredths on it. We used only the wholes and tenths today.

Students coloured in $\frac{4}{10}$, $\frac{7}{10}$, etc. and practiced writing the decimal to go with the picture (0.4, 0.7...). We also practiced the words - four tenths, 0 and four tenths, 0 decimal 4. I was emphasizing the language. They orally repeated each decimal they coloured. They practiced on the board and I used a textbook assignment to check for understanding.

We also discussed how our number system was based upon 10. We drew and wrote the place values under a number.

hundreds tens ones tenths

The students used the stop watch to watch how we timed races to the nearest tenth of a second. This gave them a chance to see how tenths are used in real life. They started and stopped the watch and observed how fast the tenths moved. No one seemed to have any trouble with the assignment. There were few errors.

May 17 - After reading and responding to the students' journals.

[The students had a comprehension question to complete that required that they order the numerals from smallest to largest. Then they had to draw a and label a picture to show a decimal that would be greater than 0.3 but less than 0.6.]

Their journal comprehension questions were well done. The students ordered the decimals easily, showing the place value and relation of the decimals. All of the grade fours ordered them correctly.

When asked to draw a decimal that was greater than 0.3 but less than 0.6, all drew and identified the decimal correctly. Three students wrote the decimal only and did not draw a picture. Two pictures were not accurately drawn.

I'm trying to be very positive and encouraging in my replies. One student reacted to yesterday's response from me with "Hey, this is the best comment I've had." He then took great care with his next journal entry.

I believe communication is one way to given written, positive encouragement to the students. It also lets me see which students just assume what I had asked and did not read carefully.

The students seem to be developing a routine for doing their journals. They check back, then try the day's question. Since we've only been at it for 7 days, I feel that this is a good sign.

Today's question may have been too easy, but the journal also can show me that all the students are able to accomplish the objective of the lesson.