Using Math Journals in a Grade 3/4 Classroom

by Karen Scales

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The importance of using writing activities to enhance instruction in Mathematics is becoming widely accepted among educators. Incorporating writing activities into math lessons gives students the opportunity to communicate mathematically and to develop a deeper understanding of concepts and principles (NCTM, 1989). Writing about mathematics enables students to construct their own knowledge of mathematical concepts (Countryman, 1992). Presenting information orally or in writing is central to students' understanding of mathematical concepts (Ludholz, 1990). Writing should be encouraged as an integral part of the mathematics curriculum designed to aid students in understanding mathematics concepts (Bell & Bell, 1985; Linn, 1987; Miller & England, 1989).

Writing can aid in the development of metacognitive skills. Pugalee (1994) states that, "writing helps build thinking skills for mathematics students as they become accustomed to reflecting and synthesizing as parts of a normal sequence involved in communicating about mathematics" (p. 309). Artzt (1994) states that, "journals that include student reflections on their feelings towards mathematics and metacognitive analyses of the thought processes that lead to incorrect and correct solutions are extremely beneficial" (p. 81). LeGere (1991) describes a study in which writing about and analyzing problems helped students develop higher-level thinking skills and made them feel more involved in the learning process. Using written communication also allows students to express their feelings about mathematics, which can result in an improvement in their attitude towards mathematics (NCTM, 1989).

Pappas, Kiefer and Levstik (1999) explain that many teachers provide writing opportunities through the use of math journals. In these journals, "children are encouraged to write about the difficulties they might have with math problems, to record new learning and to compare and contrast various procedures or strategies to solve problems" (page 211). Some of the purposes of Math journals are to increase confidence, to increase participation, to decentralize authority, to encourage independence, to replace quizzes and tests as a means of assessment, to monitor progress, to enhance communication between teacher and student, and to record growth (Countryman, 1992). Using journals also decreases "math anxiety" and gives students a feeling of ownership of the material (Stix, 1994). Nahrang and Peterson (1986) have identified two basic functions of journals: to allow students to work at their own rate and to reach an understanding of mathematical concepts by using their own experiences, and as a diagnostic tool.

The purpose of this study was to examine how the use of math journals could facilitate modifications in instructional practice. The specific research questions were: Are math journals an effective diagnostic tool? Do they provide information not already provided through traditional assignments? How can they be used in assessment?

Method

Participants

I conducted this study in my split Grade 3/4 class of twenty-four pupils. I co-teach the class with the principal of the school. My teaching load includes the teaching of Mathematics. At the time of the study, there were seventeen students in Grade 3 and seven students in Grade 4. The class contained1``1` students at various levels of ability as well as several students with particular academic, social, and emotional needs.

Procedure

I sought and obtained the consent of the Principal and the Superintendent of Schools before undertaking the study. A letter explaining the project was sent home to parents and informed consent was requested. It took several days for the permission slips to be returned. Two parents did not return the permission slips. Although their children were included in the project-related activities, these children's contributions were not included in the data.

I considered the ethical issues involved in the project, particularly the importance of preserving the anonymity of the subjects. The children were advised not to put their names on their papers. Numbers were assigned to them in lieu of names. Where the children did put their names on their work, the names were removed. The only other person privy to the identity of the students was a university instructor. Upon completion of the project, the journals will be returned to the students and the data and the report will remain in the possession of the researcher.

The project took place over the course of three weeks. Various obstacles were posed by uncontrollable factors such as school holidays (Spring Break and Easter), student absences, and the illness and absences of the teacher. Interruptions typical to the school day, including rescheduling due to special projects and the Pacific Northwest Music Festival also occurred.

The data consists of Math journal entries made by the twenty-two students. Each student made a maximum of seven entries. The first entry was virtually unprompted. The students were asked simply to "write about Math." Many of the children found this assignment difficult and the results were not detailed or consistent enough to be useful. For the subsequent entries, more guidance was given. The students were asked to write about what they did in Math, what they understood of the Math lesson, what was giving them difficulty, or any other thoughts related to the Math lesson. Cook (1995) states that it is important to respond to students' writing with encouraging comments, therefore guidance and feedback was given individually in the form of written teacher-responses after each entry.

It is important to note that no emphasis was placed on the mechanics of writing. Invented spelling and developing syntax were accepted and no restrictions were placed on the length of each entry. Bereiter and Scardamalia (1987) reinforce the importance of removing concerns about the mechanics of writing. In citations of the children's work here, spelling and other mechanics have been left without correction.

Coding the Data

The Math journals were collected and removed from their covers. They were photocopied for the purposes of analysis. (Many of the children asked if they would be able to get their journals back when the project was completed). Several themes emerged as I sorted through the entries. I devised a coding system to attempt to categorize the entries and to relate them to the original research questions. Entries were coded according to the categories in Table 1.

Table 1. Coding System Used for Themes in Math Journals

Label	Definition
Understanding (yellow)	Comments which indicate understanding (or lack of understanding) of Math concepts; a + sign was used to indicate that the child was demonstrating an understanding of a concept, whereas a - sign was used to indicate a lack of understanding. These comments sometimes were characterized by the use of mathematical language. Occasionally a child would include a diagram or examples which indicated his or her degree of understanding. These representations also were coded.
Descriptive (orange)	Comments which are primarily factual, for example a description of the work done that day.
Attitude (blue)	Comments which reveal the student's attitude towards Math. Often these comments are characterized by the use of the words "like," "favourite," and "don't like."
Self-Assessment (green)	Comments that indicate that the student is thinking about his or her own learning. I originally intended to label these responses as evidence of metacognitive processes; however, I felt that little evidence of true metacognitive analysis existed.
Uncoded	Occasionally a student would write comments not related to Math so these comments were not coded.

As the coding process progressed it became apparent that there was some overlap between comments which expressed an attitude toward Math and those which were reflective in nature. Thus, comments which simply expressed a liking or disliking of an activity were coded as Attitude, while comments which were more reflective in nature or indicated some degree of self-analysis were coded as Self-Assessment.

An interesting element in the journal entries was the use of the word "easy." Some children used the term "easy" in a negative sense, to describe work that they found to be not challenging or uninteresting. For example, Student #22 states, "Sometimes I think that it [Math] can be boring or easy." Other children used the term more positively to describe a feeling of enjoyment. For example, Student #12 says, "I like math. Math is fun. Math is easy. I like math." There are only a few instances where "easy" refers to a feeling of accomplishment, such as when Student #12 writes, "But I already know them so they are kind of easy." Such variation in meaning posed some difficulty in coding the responses as they could be either indicators of attitude or self-

assessment. In such cases, it was necessary to look at the comments in the rest of the entry to determine which coding category to use.

Results

Descriptive Comments

These comments were relatively straightforward to code. They were helpful in that they helped set the stage for the rest of the journal entry. They were also useful as starting points for the children's writing; if a student was not sure how to begin writing, he or she could begin by writing descriptive comments which often lead to more reflective writing.

The descriptive comments were useful in analyzing teaching practices, particularly the importance of striking a balance between children's need for routine and their need for variety. The need for routine is reflected in comments such as, "We missed timed drill again" (Student #1). It is interesting to note that the timed drills referred to were not a daily occurrence, but clearly this student thought they should be! The importance of consistent teaching and assessment practices is reflected in comments such as: "I also got to hand out the Math duo-tangs" (Student #19), and "I got most of my sheets are kliped off"(Student #22). [Explanatory note: as the children completed and corrected the papers in their Math duo tangs, I cut the corners off, indicating that no further work needed to be done on the pages]. Similarly, the teacher must significantly vary activities in the lessons, as indicated by comments such as, "in math we mostly do the same old stuff" (Student #2).

Attitude

The children were very forthright about expressing their likes and dislikes. One of the most frequently mentioned Math activities was the one-minute drills which were sometimes used as multiplication practice. The children were encouraged to beat their own goal each day. The journal entries indicated that those students who did well on these drills enjoyed them while those who struggled with them did not. For example, Student #7, who is very capable in Math, stated, "I like doing tests and drills," whereas Student #11, whose performance is inconsistent, commented, "I don't like doing the timed drill very much."

Understanding

The effect of visual aids in enhancing understanding is apparent in the journal entries. For example, Student #6 commented that during the lesson on factor trees, "[w]e also use the overhead projecter and we also used the board and wrote it down." Similarly, Student #25 remarks, "we all learned how to make factor trees, they were over the board growing and growing into lots of different shapes!"

The Math journals were helpful in assessing the children's understanding of the material covered. For example, after the lesson introducing the concept of division, Student #13 comments that, "It's just like times tables but backwords." Similarly, Student #17 writes, "It's sort of like backwards times tables." During this lesson, the children observed that when related

multiplication and division questions were printed together on the chalkboard, the second equation appeared to be "backwards." Although I showed the children how multiplication and division facts could be grouped together in "families," I did not explicitly say that multiplication was "like backwards division." These comments indicate that the students were developing an understanding of the relationship between multiplication and division.

Indications of a lack of understanding were also apparent in some of the journal entries. For example, when describing the lesson on factor trees, Student #15 writes:

...all you do is think of a number and you put a circle around the number you picked and then you think of a answer that goes with the number you picked then you do another answer that goes with the first answer.

After participating in a lesson introducing the long division notation, the same student states, "you make a house you put the dividend number in the inside of the house then you put the other number out of the house then you put the question on top of the ones." It is clear that this student is learning math in a mechanical, rote fashion, carrying out the operations without an understanding of why she is doing so.

The math journals suggested that the students need more experience using math language. Frequently when describing a math calculation, the students used vague, nonmathematical terms. For example, Student #3 explained how to create a factor tree: "you have to print a number and circle it then you write the factor that equals the number then you just keep going on." Similarly, Student #18 wrote about multiplication: "Then you do the ones. Then you do the tens." It must be noted, however, that there were some examples of children demonstrating a good understanding of mathematical concepts through their use of mathematical language. For example, Student #5 wrote: "We also learned what the big number is called it is called the dividend and the answer is called the quotient and the number in the middle is called the divisor."

It is interesting to note that when I used novelty terms to describe a new concept or operation, these terms were quickly learned and used by the students. For example, when I introduced the long division notation, I referred to the symbol as a "house." Subsequently, many students wrote in their journals using this term. For example, Student #16 wrote "you make a house with a curved wall or with a strate wall. You put the dividend in the house and put the divsor on the left side of the house and the quotient on the roof." Using such terms appeared to be a useful teaching strategy, as many students remembered and reiterated them in their journals. Concerns could be raised about using novelty terms in lieu of true mathematical language, however, so it is important that the correct terminology is also introduced.

Self-Assessment

The comments coded as self-assessment indicated that few children understood evaluation and assessment, or why they were doing certain work. Similarly, at this level, there seemed to be few indications of metacognition. Only occasionally did students comment on their own thinking. It is interesting to examine the children's perceptions of their own abilities. For example, Student

#5 commented, "I was speeding threw it" and "I got 25 out of 25 because I'm very smart and I can speed right threw math pages." Clearly this student equates speed with understanding. Student #21 appeared to be concerned about the appearance of her Math work, when she commented, "When I do math I try to make my best pictures and printing." Later on, the same student commented, "I need lot of pratic soon." Again, students' enjoyment of math appeared to be directly related to their understanding of math. For example, Student #21 wrote, "At first I thout it would be hard but now I know how a bit I am going "Love" math! I don't like math before now I do!"

Discussion

The information provided in the math journals served a variety of useful purposes. It provided the teacher with an indication of the students' understanding of the mathematical concepts taught as well as of their attitudes toward math and their assessment of their own learning. Based on these indications, I could then modify my teaching practices. For example it became clear that the timed drills were not a particularly useful tool as they were only effective for those students who already had a good understanding of the basic facts and could perform well on a regular basis. This highlights the importance of weighing the success of one group of students against the lack of success of the other students when determining teaching strategies and assessment practices. Discontinuing the drills altogether would likely be disappointing for those students who enjoy them, so it is important that activities that all children enjoy be included in the math program.

As the project progressed, it became apparent that the teacher comments were an integral part of the learning taking place. Such comments proved helpful in clarifying student understanding. The following written exchange between Student #18 and the teacher shows how this occurs:

Student: A factor is two numbers that you add, and a product is the answer.
Teacher: Do you add factors?
Student: No.

It also was evident that most students enjoyed the teacher's written comments. In one instance, Student #19 writes her journal entry then adds, "PS. give a coment." It was observed that as soon as the math journals were returned to the students, they immediately looked to see what the teacher had written. A particularly rewarding result involved Student #24. This student is reluctant to participate in any oral activities and rarely offers his thoughts or opinions unless directly asked. His oral answers are usually short and show little interest in the topic discussed. However, in the math journals, he carried on a fairly lengthy conversation with me:

Teacher: Are you improving?
Student: kind of. i got seventeen right and one wrong which was four times eight now were doing timed drill again tomorow.
Teacher: What is four times eight?
Student: thirty-two! I know 4 x 8 now! We might be doing division drill instead of timed drill
Teacher: That would be a challenge!
Student: are we realy going to do that

The non-threatening nature of the personalized comments was very motivating for this particular student. The comments prompted other students to interact with the teacher regarding the math program. For example, Student #14 asks, "When Im on hollidays can I have Division?" [Explanatory note: I was preparing a package of work for the student to do while on an extended vacation]. Such interaction and personalizing of the math program is not possible with traditional assignments and forms of assessment.

For some children, difficulties with writing limited the usefulness of these journals as an assessment tool. This was especially true for students with particular learning needs. Student #23, for example, produced very little written work of any kind due to a variety of learning difficulties. Similarly, Student #4, who is an extremely capable student with a highly developed vocabulary, produced brief comments such as, "I lik to have big math questions like three tousend two," or "today in math we did division."

It is also important to recognize that some children at this age have difficulty in expressing themselves through writing. For example, two capable students wrote the following comments: "It was very easy. But very hard. I learned nothing because I already had known multiplications answers. Multiplication is easy very easy but also hard a little hard" (Student #6), and "we did a math paper you did the questions then you coloured" (Student #7). If one were to rely too heavily on math journals as assessment tools, it could be assumed that these two students are struggling with math, when in actual fact they are not.

Johnson (1997) asserts that there are factors which place constraints on the adequacy of written products to reveal the quality and degree of children's conceptual understanding, including the difficulty of putting mathematical concepts into verbal form, the differences in the nature and quality of spoken and written communication, the variation in children's writing due to differences in levels of cognitive development, and the child's general writing ability. Thus we must exercise caution when using written activities as diagnostic and assessment tools.

Many of the journals described feelings about math but did not reveal much in the way of thinking processes. Fortescue (1994) describes a study in which she attempted to use math journals, with similar results. She determined that she had not set clear enough expectations and had not sufficiently modelled the use of writing in mathematics. When she provided this additional guidance, the results were much more useful. The importance of providing guidance with the journal entries was clearly evidenced in my study in the difference between the first (unguided) entries and the other (guided) entries.

The limitations of this study include the short time line and interruptions during the data collection. It is likely that many more patterns would have emerged and further conclusions could have been drawn had the children been writing in their math journals on a regular basis since the beginning of the year. It also would have been useful to have some kind of baseline assessment with which to compare the information obtained from the journals. Future studies could include comparing assessment information gained from journals to that obtained from traditional assessment techniques, such as tests and quizzes.

Despite these limitations, useful information was obtained, which allowed me to modify teaching practices in the short term and plan for future modifications in the long term. In the short term, I was able to provide enrichment activities for those children who found their assignments "too easy," and extra assistance for those students who demonstrated that they were struggling with particular concepts. In the long term, areas in which my teaching practices could be improved include providing a wider variety of learning activities which allow for diversity in learning styles. In addition, I will look for ways to help improve children's facility with mathematical language, including encouraging them to be more specific when describing mathematical operations, and modelling and discussing the use of mathematical language.

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