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Writing in a second grade math class

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Abstract

Writing in math has given me a much better benchmark-driven curriculum. I know more clearly how to help students accomplish math benchmarks. I used to have a separate time for the students in my classroom to write and a separate time for my students to do math. Nearly two years ago, I had the idea of writing in math. I read what other teachers had tried and I tried to include more writing in math. The results have confirmed my belief that writing in math is a worthwhile practice. Writing in math gave my students a greater understanding of math. It showed me what the students understood and it exposed their misconceptions. Reading the students' math writing helped me make instructional decisions and assess student progress. Writing in math offers an interactive way for students to communicate what they have learned, so that teaching is not a one-way street (Stix 1994). Now we still have a time in our classroom to write and a time to do math, but our math time also regularly includes writing about math.

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"Write your name and number your paper from one to ten. I'll show you a time on the clock and you write the correct time on your paper." These were the directions for the school district benchmark assessment that I needed to give my second grade students to show their proficiency in understanding the basic concepts of time. I had a benchmark-driven curriculum for math and I was able to determine which of the students were accomplishing the benchmark assessments, but I didn't have insight into my students' thinking about math. I couldn't really tell why they succeeded or failed on an assessment. I only knew who got the right answers and who didn't. To help my students more effectively, I needed to know why they wrote their math answers and what they were learning.

I had an idea. "Write what you have learned in math about telling time." I gave my students a prompt without really knowing what to expect from their written answers. When I read the writing, I gained information about the students and their learning that I hadn't known. When Clark[1] wrote, "My mom helped me learn to tell time," I learned that he had been practicing telling time outside of the classroom. Sarah wrote, "I got up at 8:00 and I went to school at 8:30," and I learned that she was making connections between telling time and her own life events. Dean wrote, "Some kids get confused about whether it is 9:30 or 10:30, but I have learned that if the short hand of the clock is between the 9 and the 10, then it's 9:30." I learned that Dean was developing a higher level of understanding with reading the time shown on a clock. It seemed to me that

[1] Names have been changed to protect identity.

there was value in having students write about math. I had a window into what they were learning and what they understood (Burns 1995). The writing had brought to light thoughts and understandings that were not available in typical classroom interactions (Norwood and Carter 1994). The writing allowed me to know the students' thinking that was not immediately evident from more traditional methods of assessment (Mayer and Hillman 1996).

Writing in Other Math Classrooms

The student responses to the writing prompt caused me to consider the potential of using this instructional practice more often and I gathered information on how other teachers were using writing in mathematics. I found that teachers from a range of grade levels, early primary through post secondary, asked their students to write in math class and reported their findings. In a study that examined the usefulness of expressive journal writing in a first grade mathematics program over an 18-week period, it was suggested that writing in math makes learning active and personal, and does not limit students to learning only by memorizing, transcribing, and recalling (Wason-Ellam 1987). By using math journals, the students reflected on their learning, discovered gaps in their knowledge, and explored relationships between what they were learning and their prior knowledge. The journal writing did not test students on what they had learned. Students wrote in journals to discover what they had learned.

Meaningful learning was also seen when second grade students were involved in a project that examined the levels of achievement and metacognition in expressing math understanding and problem solving processes. The students

used writing in daily math learning. To study the effects of the writing, Card (1998) noted scores on a math problem solving assessment and conducted individual interviews. She also kept anecdotal records during a seven-week study. Card concluded that through daily writing activities that involved expressing math thinking, problem solving, and the creation of word problems, students' math achievement and metacognition increased. The author recommended writing in math, especially math-writing experiences that foster reflection and analyses of knowledge to promote and extend thinking and learning.

Improving higher-order thinking skills in math was the goal for students in grades three, five and six during a five-month action research study. Butkowski, Corrigan, Nemeth, and Spencer (1994) found their students' math scores showed weaknesses in problem solving. They researched effective interventions and studied the effects of a curriculum revision that included supplementary activities such as math journaling. The study found that student cognition and achievement on higher-order thinking skills improved as evidenced by test results, surveys, questionnaires and observation checklists.

Determining if writing would help students learn more about math was the intent of a study with two fifth grade classrooms (Evans 1984). The teachers of both classrooms used supplementary skill practice. The only difference in their approach was that the author's class incorporated writing during math time. In the study, students wrote explanations which described "how to do" something, they wrote their own definitions which gave them the chance to describe

something new in their own familiar terms, and the students did "troubleshooting" writing when they had to specifically explain errors on homework or quizzes. Evans could see who understood the math concepts she was teaching and who didn't. The results of the study showed that on both math units, the author's test group scored poorer on the pretest and better on the posttest than the control group in the other classroom.

Algebra II students were involved in a study that investigated the effects of implementing an integrated, experimenter-designed writing program within an existing basic text. Kasparek (1996) designed a program that consisted of lessons in writing designed to enhance the students' understanding of topics studied. Writing activities, both transactional and expressive were integrated within the experimental groups' lessons. The author found the use of writing in the mathematics class had advantages both for the students and the teacher. A primary advantage was communication. When students explained their understandings, Kasparek gained insights into the ways students were learning or not learning and teaching strategies could be developed or altered. It was beneficial for students to construct their own knowledge and make it personal, and therapeutically they expressed their feelings, attitudes and concerns. The benefits to the teacher included gaining insights to students' understandings and misunderstandings, being better able to evaluate progress, and being better able to address the needs of the students.

Stewart and Chance (1995) addressed the question of whether the National Council of Teachers of Mathematics (NCTM) standards could be

combined with the focus on writing to learn to strengthen mathematics instruction. These authors investigated the use of journals by students and their teacher in four secondary first-year algebra classes over the course of a school year. Two classes wrote in journals three times a week during the last five minutes of class, two classes did not write. The journals were analyzed by the level of mathematics understanding displayed, precision and detail, and nature of content. The authors also analyzed recurring themes and common patterns of thought within the students' entries. The journal-writing students (the experimental group) showed significantly greater achievement scores and a decrease in anxiety scores that approached significance.

Linn (1987) conducted a project to determine the effect writing would have on the thinking skills of high school geometry students in three levels of high school geometry classes. The results of this study showed that journals were effective in: 1) each student becoming actively involved in his or her own learning process, 2) students synthesizing information and becoming aware of what they did and did not know, and 3) students recognizing their individual learning style and strengths and taking advantage of those strengths. The journals served as a diagnostic tool for the teacher, opened the lines of communication between the teacher and student and personalized the learning environment. The author says the results suggest journal keeping would be effective in all disciplines, but it is especially recommended that it be implemented throughout a mathematics department. The emphasis was on "How did you get the answer?" rather than

"What answer did you get?" The author honestly stated the one negative aspect of the study was keeping up with the reading of the journals.

College students were involved in a study where journals were introduced in the math classes of Nahrgang and Petersen (1986) at Michigan Tech. Over a ten-week period, journal-writing sessions replaced unannounced quizzes and it was found that the journal entries demonstrated individual learning activities. The authors concluded that their students grew both in the understanding of mathematical concepts and in their ability to express that understanding. When the authors examined the journals, they noted that students used their journals to think about solving problems associated with mathematical concepts. The student responses to questionnaires indicated that they viewed journals as a worthwhile inclusion in math class.

Two studies investigated how often teachers are asking students to write in math. Quinn and Wilson (1997) studied current teacher beliefs and practices regarding the use of writing in the teaching of math with sixty-three teachers from five elementary schools, five middle schools, and four high schools who participated in a questionnaire. The results showed strong evidence that even though the second, seventh and eleventh grade teachers in the study had favorable attitudes toward the use of writing in mathematics teaching, they were not putting those beliefs into practice. Teachers cited poor student writing ability, teacher time and class time as reasons for not using writing activities in the mathematics classroom. The authors wondered if the diagnostic benefits of writing might be a desirable luxury in which time would not permit teachers to

indulge. Silver (1999) examined the use of expressive writing, known as writing-to-learn (WTL), in mathematics classes. Participants were 117 math teachers and members of the National Council of Teachers of Mathematics (NCTM) in New York State. The survey results revealed that 43 percent of participants had never heard of WTL or had never used it in their classes, 20 percent had used WTL rarely, and 37 percent had used WTL frequently. The survey results also suggested that younger women teaching at the elementary level make the greatest use of discovery and expressive writing assignments in their mathematics classes.

Types of Prompts

I also learned about different prompts from Dougherty (2002) who explained three kinds of prompts for writing in mathematics: content, process, and attitudinal. Content prompts target important or meaningful concepts and skills. They can also provide situations that focus on areas where students often have misunderstandings or misconceptions. The responses to the prompts give teachers (and students) insight into how a student has interpreted a mathematical idea, and should reflect a student's progress in understanding the concept or skill.

Being aware of how one solves or approaches problems is promoted by process prompts. The responses to these prompts can give insight into students' preferences for problem-solving strategies and into how they learn or remember. When these prompts are used, teachers gain insight into how students have interpreted or altered procedures. As students become aware of how they learn

and solve problems, they grow stronger in confidence. Process prompts give students an opportunity to show how they do a mathematical process or algorithm (step-by-step procedure).

Attitudinal or affective prompts focus on students' feelings about themselves as mathematicians and students of mathematics. Students' responses allow a teacher to assess how attitudes are developing in the classroom environment. These prompts show students' beliefs. If they were used more than once, a teacher would be able to detect changes in beliefs or feelings about mathematics as a discipline as the year progresses.

The research supported my insights about the ways writing in math could help my students and me. Writing in math class seemed beneficial for students to learn math and for teachers to understand the progress of their students and make instructional decisions. But teachers were not often asking their students to write in mathematics classes. I wanted to bridge this gap between a beneficial practice not often used. My goal was to use the different kinds of prompts and provide more writing opportunities in math for the students in my second grade class.

Integrating Writing in Math with My District Benchmarks

I started the next school year with 22-second grade students in my midwestern urban elementary school of 245 students. The school had a culturally diverse population of Caucasian, African-American, Hispanic and Asian students with the majority coming from low socio-economic family backgrounds. In my class of 9 girls and 13 boys, three students qualified for special education

services, seven were served through the school's reading program and two students qualified for the expanded learning program. My school district required me to report scores of benchmark assessments in the math areas of two-digit subtracting, linear measurement, telling time, and addition with regrouping and math facts to 18. My plan was to also promote and examine student writing in these areas of math. I wanted to note what I learned from the students' writing and what instructional decisions I made based on the writing.

Math Writing in My Classroom

One opportunity for writing in math occurred when analyzing the students' understanding of subtracting two-digit numbers without regrouping. For the benchmark assessment my students had to solve story problems such as, "In the turtle pond, 12 of the 65 eggs broke. How many eggs did not break?" They were also asked to solve basic number problems like 63-20=__. Then, I gave the writing prompt, "Tell what you do when you subtract one two-digit number from another two-digit number like in the problem 74 minus 62." Even though most students were able to get the correct answers to the problems (18 of my 22 students were "proficient" or "developing" on the school district's assessment), I learned about the students' level of understanding when they explained the subtraction process in writing. Kate wrote, "I know 7 - 6 (seven minus 6) and 4 – 2 (four minus two)." Peter wrote, "I did 7 – 6 = 1 and 4 – 2 = 2, then I got 12." John wrote, "I split in ones and tens and take away."

When John was the only student to mention place value, I knew I needed to push for greater understanding with two-digit subtraction. I learned that

although the traditional assessment may have shown students were able to solve the problems and get a correct answer, they did not have the depth in their level of understanding that I wanted. The writing exposed misconceptions that may have otherwise been unnoticed (Stix 1994). My students had a partial understanding, which is a natural process of learning, but they needed experiences to broaden and deepen their understanding (Burns 1995). Reading the students' writing helped me make instructional decisions (Mayer and Hillman 1996). Without reading the students' writing, I may have moved on, assuming the students had an understanding based on correct answers to the problems on the test. Instead, I continued to emphasize place value concepts needed for subtracting two-digit numbers and I'm continuing to explore ways for students to develop their own understanding of subtracting two-digit numbers in a way that makes sense to them.

Before the benchmark assessment on measurement where students would be required to measure ten items to the nearest inch, I asked my class to explain in writing, "How do you use a ruler to measure something?" The responses showed me their understanding. Allan wrote, "1. Get a ruler. 2. Find something to magger (measure). 3. After you find the thing you are going to magger (measure), put the thing below the inches side. 4. Put it at the 0 (zero). Find the place it ends at and write it down." Mike wrote, "1. I measure with the book and the ruler. 2. Use the inches, it goes to 12. 3. You don't use the cm. side. 4. You start with the 0 (zero)."

It seemed that writing about the task of measuring gave students a greater understanding of this mathematical procedure (Norwood and Carter 1994). I learned that if students could explain the procedure, then they could probably perform the procedure. In the past, if students could not find the correct measurement, I would only be able to diagnose what they were doing through an individual observation. I decided to keep including writing in math and look for other times when writing about a procedure might be worthwhile.

I made an instructional decision to refine my second year attempt of using writing during a math study of telling time with a clock. After instruction and practice, the class assisted me in a shared writing activity where we wrote the directions for telling time. My intent was to clarify the process in the students' minds (Davison 1988). On another day, I set an analog clock at 6:25 and asked the students to write the time and write their procedure for telling the time. Most students were able to state the time and the directions for finding the correct time. I asked the class to imagine explaining their answer to a younger student. Carrie wrote, "Just think, there is a clock that said 6:25. What wood (would) you do? I wood (would) say the short hand is half past 6. And the long hand is on the 5. You will no (know) that it says 6:25. Just count by fives with the long hand. Count like 1,2,3,4,5 for the short hand. That will tell you how to tell time." A few students stated an incorrect time, but their explanation showed me what was understood. Breann wrote, "7:25, First I read the little hand witch (which) is the hour hand. Then you read the long hand witch (which) is the minute hand. Then you read the time the clock says." There were also a few students who did

not know the time, but I encouraged them to write what they understood. Jay wrote, "I don't no (know) what time that clock is saying. But I no (know) how to tell a little bit of time, but not a lot. 12:00, 6:30, 3:20, 4:00, 7:30 and sometimes I can look at the clock and tell what it is. I thick (think) the clock on the bord (board) says hav (half) past six. I thick (think) I'm not shor (sure) what it says."

The way the students expressed themselves in writing was important to showing me how well they understood the mathematical ideas (Helton 1995) of telling time. Through writing, I found out if students had a process for figuring out the time. I also realized that when one student explains his or her method, it might be helpful for other students to listen and grow in their understanding. I decided to make writing and sharing of writing a regular part of math learning.

Before beginning a study for the benchmark assessment on money and counting coins, I asked students to write what they already knew. Brandi's writing was similar to that of other students, "I know that a penny is wouth (worth) 1¢. I know that a dime is wouth (worth) 10¢. I know that a nickel is wouth (worth) 5¢. I know that a qurter (quarter) is wouth (worth) 25¢. If you have ten dimes and have two nickels and I count them together. All together it will be one-hundred and ten cents." At the end of the study, I asked students to reread their initial writing and write any new information that they had learned. Brandi wrote, "I learned that 4 quarters is 100¢. And 100¢ is also 1 dollar. And there is a dollar coin. There is a half dollar and that equals 50¢. And if you have 2 hafe (half) dollars, that also equls (equals) 100¢. I know 1 dime, 1 nickel, 1 penny, and 1 quarter equls (equals) 41¢.

Writing in math can be used as a simple, inexpensive tool for alternatively evaluating students' progress when traditional tests are not giving a clear enough picture of students' conceptual development in mathematics to assess their progress or misunderstandings (Norwood and Carter 1994). Norwood and Carter use writing in math to assess ideas about a topic before its introduction, assess how well students understand a topic in progress, and to focus students on a review. I decided it was worthwhile to have students write before a math topic so I could assess prior knowledge. If they wrote during the study, I could see if they were progressing in their level of understanding. By writing at the end of a study, I could make a comparison of what they already knew and new learning.

After students had completed the benchmark assessment on two-digit addition with regrouping, I handed out the corrected tests and prompted the students to write about the test. Jeff wrote, "I did good, but I got some wrnog (wrong). I fixed them up to make them write (right)." Jeff then made two columns on his paper and listed "Before" and "After." For example, on the test he had solved the problem 28+61=99 ("Before"), but he corrected it and wrote 28+61=89 ("After"). Ellen wrote, "I think that the reson (reason) I got them right is because I lisent (listened) to the teacher and pade atinchon (paid attention) to what I was suppose to do."

We had been reviewing and practicing basic addition facts for the benchmark timed test and I asked students to write about the strategies they use. I gave the prompt, "I can add because..." Ali described her method of "counting

on" when she wrote, "I start with the bigest (biggest) number and conut (count) front weards (frontwards) the smallest number."

Ali's answer helped me realize I wanted more students to be able to express the strategies they use. I plan to keep prompting students to write about how they solved math problems and then share their strategies with the other students.

I also gave the students an attitudinal prompt after they had taken the timed test. I asked them to turn their papers over and write about taking the test. Jake expressed his thoughts as he wrote, "This test is heping (helping) me get better and better because sometimes I try to race the clock to see how fast I am. I'm good at it." Blaine wrote, "This time, I got don (done). I thot (thought) I was not going to git (get) don (done). Brenda wrote about subtraction, "It's OK but harder than adding. I'm not that good, but I'm getting beder (better) then (than) last yare (year). It's getting harder eyech (each) yare (year). But I still get it and the ones that were hard are not hard any more."

Improved mastery of mathematics concepts is shown when students are asked to write their understanding (Miller 1991). In addition to doing math, it had become natural for the students in my class to write about math.

Future Planning

I had used content, process and attitudinal prompts, but I decided that if I used all three types of prompts with each area of math that would give me an even greater window into my students understanding and learning. Next year,

I plan to expand writing in math. As an example of this, I have constructed writing prompts for the concept of counting coins. A content prompt would be, "If you had one quarter, one nickel and one penny, what would be the value of the coins? Write about how you know." A process prompt would be "I find the total value of coins by ..." An attitudinal prompt would be, "Being able to count coins is important because..."

I am also planning to prompt parents to write about math as a way to communicate between home and school. This year I periodically sent updates of how students were doing on addition and subtraction timed tests. Parents were asked to write back and tell me how their child was doing with practicing at home. I received written comments such as, "We hadn't practiced at home until last night. Brody seems to do okay on addition, so we are practicing subtraction. He did pretty well with accuracy, he just needs to be quicker."

Parents and students in my class were aware of my emphasis on writing in math and near the end of the school year I asked them to write about it. One student shared her thinking about math when she wrote, "If you are adding hundreds, you have to do the ones first. Next, you have to do the tens. Then you have to do the hundreds. To me, it looks like I'm going backwards." Kamii (1989) would encourage Bridget to do her own thinking about math problems and construct more efficient procedures for solving them out of her own ways of thinking. Bridget's parents had written, "Sometimes Bridget practices at home. She really likes to work with two-digit numbers. When papers come home, we go over them, discuss what she did wrong, and try to explain how to do it correctly."

Next year, I plan to ask students to write about math using all three kinds of prompts and prompt parents to write about their child's learning in math with each area of math we study.

Reflection

Writing in math has given me a much better benchmark-driven curriculum. I know more clearly how to help students accomplish math benchmarks. I used to have a separate time for the students in my classroom to write and a separate time for my students to do math. Nearly two years ago, I had the idea of writing in math. I read what other teachers had tried and I tried to include more writing in math. The results have confirmed my belief that writing in math is a worthwhile practice. Writing in math gave my students a greater understanding of math. It showed me what the students understood and it exposed their misconceptions. Reading the students' math writing helped me make instructional decisions and assess student progress. Writing in math offers an interactive way for students to communicate what they have learned, so that teaching is not a one-way street (Stix 1994). Now we still have a time in our classroom to write and a time to do math, but our math time also regularly includes writing about math.

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