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First-Time Teacher-Researchers Use Writing in Middle School Mathematics Instruction

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This paper is a study of 4 middle school teacher-researchers who engage in action research projects for the first time, in which they incorporate writing activities as part of their instructional practices. Embedded in a professional development program with an emphasis on reform mathematics efforts, the teacher-researchers report to their research support group on their experiences with using writing. They used writing in order to improve classroom communication and state-mandated test scores. Recordings of conversations, written reflections, and other documents showed that they used various writing activities including journal writing, essays, problem solving, and the writing of stories. The teacher-researchers identify the major benefits of using writing to be the support of student thinking and the increase in student discourse. The teachers' projects encouraged future ideas for instructional change.

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This qualitative study investigates the experiences of four middle school mathematics teacher-researchers engaged in action research as part of a professional development program. The focus of this paper is to examine the experiences, practices, and issues that emerged from the teacher-researchers' projects as they employed non-traditional writing activities in their mathematics classes.

Action research is a practice by which teacher-researchers have the opportunity to learn from and about their teaching. Through this methodology teacher-researchers can reflect, evaluate, and learn not only about their teaching, but also from their students. Conducting action research projects allows teacher-researchers to reflect on their teaching and to explore issues of teaching and learning that are relevant to their lives. Engaging in action research can benefit all those involved in that it can bring self-renewal and increase efficacy, morale, and student performance (Sagor, 2000). Additionally, researchers reported that action research increases a sense of professionalism for the teacher-researcher (Elliot, 1991; Smith, Layng & Jones, 1996).

The teacher-researchers around whose experiences this discussion revolves were involved in a professional development program at a major urban midwestern research university. This program served as a master's degree program for some teachers and as a professional development program offering graduate credit for those either not pursuing a master's degree, or those who had previously obtained a master's degree. The premise of the program was for the teachers to implement innovative practices in their teaching that coincided with current educational reform and conduct an action research project with the support of doctoral students and faculty from the university. This culminated in a final paper centered on their research. Collaborative efforts between teacher-researchers and universities as well as professional development programs such as this one serve to aid in teachers' pursuits of conducting research projects of their own, and thus create a life-long process of inquiry for the teachers (Raymond & Hamersley, 1995).

Given what research says about using writing in mathematics, I set out to see what the use of writing looked like in the field from these teacher-researchers' experiences. It was important to me that I get their perspectives on using writing in mathematics instruction. In keeping with a grounded theory research methodology, the data was approached without a priori research questions that would subsequently drive the data analysis. Instead, personal questions or inquiry issues provided the motivation to investigate the experiences of the teacher-researchers in this project:

1. What do the teacher-researchers hope to gain by using writing?
2. How do the teacher-researchers use writing in their teaching?
3. What benefits do the teacher-researchers see in using writing?

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Why Writing?

The use of writing assignments in school mathematics gained recognition with the "writing to learn" movement in the '80s and continues today as evidenced by the National Council of Teachers of Mathematics' (NCTM) standards document, Principles and Standards for School Mathematics (2000). The call from NCTM to make communication an important facet in the mathematics classroom has led to an increase in instructional activities that encourage communication not only between teacher and student, but also among students. The Communication Standard (NCTM, 2000) includes being able to organize, communicate, analyze, and evaluate thoughts using the language of mathematics. An essential facet of communication is writing, which is used in just about every academic subject though rarely in mathematics classes. When used, communication through writing in mathematics classes generally takes two forms: (a) journal writing, or (b) expository writing assignments and activities. In journal writing, students reflect on some activity or respond to a prompt given by the teacher in order to solidify their thinking on some topic or concept. In expository writing, students use writing as an active part of the learning process with in-class writing activities or prompts aimed towards explanatory or expressive purposes. For instance, a writing prompt may require students to solve a mathematical problem and then explain their thinking or problem-solving processes. Expository writing activities allow students to use another avenue or representation in their mathematical learning, along with a period of reflection when deciding what to write. Expository writing assignments can be thought of similarly to what some (Birken, 1989; Powell & Lopez, 1989; Rose, 1989) call transactional writing, in which the assignment is meant to be read by someone other than the writer, usually a teacher. It is important to consider both uses of writing in mathematics because each activity has its own benefits depending on what the teacher wants to accomplish (Birken, 1989; Borasi & Rose, 1989; Cai, Jakabcsin & Lane, 1996; Drake & Amspaugh, 1994).

The writing that students do in mathematics classes is quite different from other classes or disciplines since mathematics is presented as a heavily symbolic discipline. The bulk of student work in mathematics classes consists of symbol manipulation. The symbols are the language of mathematics and ordinary language is used to explain the mathematics. The use of writing to learn mathematics, however, tries to use writing in different capacities of the learning process. Keith (1989) offers several types of writing assignments such as: assessment of material, anticipation of new material, discussion, peer collaboration, revision, and evaluation. Birken (1989) suggests that writing can be used for informal in-class writing, homework problems that interpret or analyze, essay questions, and formal technical writing. Multiple-entry logs, another type of writing technique, combine journal writing with expository writing; students are asked to respond to a prompt or problem, then revisit their writing and thinking periodically to see how it changes over time, if at all (Powell, 1997). In trying to articulate their thoughts into words, students engaged in these types of assignments reflect and internalize. This process promotes further learning.

Two studies (Pearce & Davison, 1988; Shield & Galbraith, 1998) approached student writing in a discourse analytic manner where they classified students' writing in order to determine the elements present in student writing. They offer a more in-depth look into student writing in mathematics classes. In these studies, researchers recognized that the type of writing that occurs in mathematics classes is different than that of other disciplines, and thus needed to be examined further in order to assess the elements of student mathematical writing. In effect, they examined the writing that resulted from various types of writing assignments and discovered how students communicated their knowledge to the teacher. Shield and Galbraith (1998) analyzed 8th-grade students' writing and developed a coding scheme for content of the writing in order to generate a model of student writing. In addition to developing the coding scheme, they compared the writing samples with the type of writing that occurred in the students' textbook. They identified six features of the students' writing: exemplar, goal statement, kernel, justification, link to prior knowledge, and practice exercises. The most common of these was *exemplar* in which students gave written descriptions of specific examples, diagrams, conventions, and graphs (p. 39). In comparison with the textbook, they found that studentwriting samples heavily reflected the same type of writing style: (a) a focus on procedures and algorithms with little elaboration, and (b) an authoritative tone (p. 45).

Previously, in 1988 Pearce and Davison determined the amount, kinds, and uses of writing that teachers employ in junior high school mathematics classes. By looking at student samples and teacher interviews, they classified five types of writing activities: direct use of language (copying and transcribing information), linguistic translation

(translation of mathematical symbols into words), summarizing/interpreting (summarizing, paraphrasing, and making personal notations about material from texts or other sources), applied use of language (situations where a mathematical idea is applied to a problem context), and creative use of language (using written language to explore and convey mathematically related language) (p. 10). They found that the direct use of language activities were most frequently used.

Research on writing in mathematics offers not only various methods of incorporation into instruction, but also the benefits from using such techniques. Borasi and Rose (1989) found that journal writing had a therapeutic effect on students, as well as increased learning of the material, and improved problem-solving skills. They also found that teachers benefit from using writing in that they are better able to provide feedback and make better evaluations of student learning or misconceptions. From this, there is potential for teachers to make long-term improvements in their instruction. Miller (1992) reported similar benefits for teachers utilizing impromptu writing prompts. By reacting to student writing, instructional practices were influenced when the teachers would re-teach, delay exams, schedule review sessions, and initiate discussion over misconceptions.

This account of some of the research in communication and mathematics shows how writing can be beneficial for both the teacher and the mathematical learning of the students. In many of these studies, researchers partnered with schools in an effort to study the issues concurrent with the mathematics reform efforts. In a similar manner, based upon the examination of the current NCTM standards, the teacher-researchers with whom I worked in the professional development program sought to incorporate similar research ideas into their instruction and thusly into their action research projects.

Methodology

The Project and the Teachers

I assisted in a professional development program[1] to support 4 of the 13 mathematics teacher-researchers enrolled. These four were in the data collection stages of their research when I joined the effort. I provided regular guidance in their data collection and analysis efforts for their action research projects. I had also served as a support person for one of the teachers (Iris[2]) in the previous year. As a doctoral student in mathematics education, I was asked to participate in this program as part of the support team because my research interests (communication and mathematics) and experience would be useful to some of the teacher-researchers involved in the project.

As part of their participation in the program, all of the teachers in the program were assigned a support person, who was either a graduate student or a university professor. The support person helped with planning and implementing instruction and provided support and expertise in their action research endeavors. By the time I joined the support team, the teacher-researchers had been in the professional development program for just over one year with one year left to go. Teachers joined the program in order to learn more from and about their own teaching, and (for some) to work towards a master's degree in education. Each teacher-researcher chose a topic and designed research questions they would investigate throughout the duration of the two-year program. The desire to change their teaching practices drove their research questions, which in turn provided a theme for their instruction for the two years of the program.

For their action research projects, the four teachers discussed in this paper chose to implement writing in their mathematics classes using either journals or expository writing exercises such as those mentioned earlier. Three of the teachers taught sixth-grade mathematics while one taught eighth-grade mathematics. The sixth-grade teachers, Iris, Jean, and Amber, taught in urban schools, while the eighth-grade teacher, Joanne, taught in a suburban school. Amber was the only teacher of the four who was working towards her master's degree. The other three were in the program to obtain graduate professional development credit. These four teachers individually have fewer than 10 years teaching experience.

From their research proposals and from numerous conversations, three reasons resonated between the teacher-researchers indicating why they chose writing in mathematics as a focus for their research. First, writing is encouraged in mathematics education reform efforts. To the teacher-researchers, writing in mathematics was a practice they saw as novel and outside the realm of the traditional mathematics classroom. Second, writing is incorporated in the open-response elements of the state proficiency exams. As with most school districts across the country, student performance on state exams is important, and these teacher-researchers saw the utilization of writing as a technique that would help prepare their students for the tests. Finally, the open-response questions on state exams were traditionally an area of the exams in which middle school students in their districts scored very

poorly. Thus, the teacher researchers sought to improve students' scores by focusing on writing tasks.

Research Design

In this study, I used qualitative methods to examine the experiences of the four teacher-researchers. Three types of data were collected: audio recordings of meetings and conversations, documents collected from the teacher-researchers, and my personal field notes. Each data analysis meeting for the teacher-researchers' projects was audio recorded and field notes were taken during those meetings. Other conversations regarding the projects were audio recorded as well. The documents that were analyzed included their research proposals, reflections throughout the past year, open-ended surveys, and final papers. I analyzed these tapes and documents using principles of grounded theory (Charmaz, 2000). The emergent patterns and themes in the taped conversations were investigated further and triangulated with the documents (Janesick, 2000). In qualitative research methods, these types of documents are important data sources because they catalog the participants' beliefs, values, and experiences (Marshall & Rossman, 1995), as they did throughout the two years of this program.

Although I was a support person for Iris and had personally assisted with her action research project, for this study I limited the scope of the audiotaped data collected from our interactions to those that included the other three participants in order to be fair to all of the teacher-researchers. Since I started supporting all of the participants approximately 10 weeks before the end of their school year, and subsequently the end of their data gathering and analyzing, the conversations that were audiotaped occurred within the near-weekly meetings of those 10 weeks. The documents, on the other hand, were collected throughout their program by the director and given to me once I joined the support team.

Once the project concluded and all data for this study was collected, I inductively analyzed all of the documents, including my field notes, for emerging patterns and issues. These fell within two general categories, research issues, and issues related to the use of writing. For the purposes of this discussion the research issues have not been included in the findings. I then listened to the tapes of our meetings and conversations with the intent of finding more evidence to support the long list of codes that were made from the patterns and issues obtained from the documents. After several iterations of this process, the codes that boasted the most support were further examined and developed into the theory that will be discussed. It is important to note that in keeping consistency with the principles of grounded theory, disconfirming data or negative cases were sought after, but were not found.

Without discussing each teacher-researcher's individual project, the proceeding discussion is limited to their experiences with implementing the writing in their classes, including their future research directions.

Findings

What They Hoped to Gain

Each teacher-researcher began their academic year by writing a research proposal outlining their research plans for the year. These proposals were complete with research questions, methods, and proposed data collection and analysis. As mentioned before, an important reason for the four teacher-researchers to implement writing into their mathematics instruction was to improve the open-ended response questions on their students' state proficiency tests. Joanne said, "I hope to change the way students feel about math, help students do better in math, and increase their mathematical understanding." Amber echoed this sentiment by explaining that she wanted to supply her students with appropriate tools for approaching the extended response questions on the state exams. From past teaching experiences, she noticed that her students struggled on open response questions and sought to improve their scores. Similarly, Jean hoped her project would result in a change in students' attitudes and improve the open-ended response question scores. For all of the teacher-researchers, seeing their students succeed in mathematics was important. But beyond that, seeing that problem solving is an important aspect of daily life both inside and outside the classroom, Iris and Joanne wanted to furnish their students with the necessary tools to help them in the future. Iris said, "I am looking for some way of making problem solving less threatening in general, [and] to help increase students problem solving capabilities. Joanne agreed saying, "I am hoping that through writing, communicating, students' attitudes and conceptual understanding will improve."

All of the teacher-researchers not only wanted their students to do better on their tests, but also wanted to help their students learn the mathematics and make it less difficult. This concern for their students provided motivation for their projects. From their research proposals, in addition to the current literature on writing in mathematics (e.g., Borasi & Rose, 1989; Johanning, 2000; Jurdak & Zein, 1998), the teacher-

researchers' concerns and goals were both appropriate and reasonable tasks.

Their Writing Activities

Joanne. The teacher-researchers implemented writing in a variety of ways ranging from journal writing to problem solving. These types of activities were similar to those activities found in the literature. Joanne used writing activities to start class, frequently using them as a warm-up exercise to focus the students' attention on the mathematics of the day. She used writing prompts that were problem-solving in nature and insisted that students work individually ensuring that everyone attempted the problem. She often had students form small groups giving the opportunity for sharing their strategies and solutions with each other. This led to increased student participation and motivation. Since students spent time working on the problems, they were interested in sharing their work and seeing the various ways other students approached the problems. Even if students did not understand how to process the problem or get the answer, they could share how they set up their information and attempted to solve it.

To facilitate students' writing, Joanne developed a problem-solving format called ODEAR (see Zupancic & Ishii, 2002), an acronym that helped the students organize their thoughts when writing. ODEAR consists of five elements: Organize, Define, Explore, Answer, and Reflect. When given a problem to solve, the students used the acronym to start and thoroughly answer their problems.

Iris. Iris's employment of writing in her classes was done primarily as in-class activities. She used a prescribed writing process similar to Joanne's ODEAR. Iris's problem-solving format, called EPSE (Explore, Plan, Solve, Evaluate), was a process prescribed by her district's curriculum materials. She used a teacher's supplement as a source for many of the problems she assigned. Typically, Iris gave a word problem on the board and had students solve and write individually. Occasionally they would compare their work with each other, but generally they worked alone. In one of her lessons, Iris gave a problem and let students work together in groups of four to five. The groups then presented their work to the entire class allowing everyone to see the different solutions. She reported that students really liked that lesson and she found it beneficial too because she immediately saw what they knew about the material. Generally, Iris gave her classes a few EPSE problems every week. The students kept these problems along with their class notes in binders that she referred to as their portfolios. She eventually used some of the students' portfolios as data for her action research project.

Based upon our research meetings and from Iris' reflective writings, she felt she had difficulties keeping up with evaluating her students' writing. She said, "I wasn't able to respond to their problems as well as I should have. I should have given them more feedback and let them give each other more feedback." Time was something with which all of the teacher-researchers struggled, but Iris felt that it was the major struggle for her. Since Iris rarely allowed group sharing of writing in the same way that her colleagues did, her students received limited benefits from reflecting on their writing after receiving feedback, whether it be from her or from fellow students.

Amber. Amber was the only teacher-researcher who used journal-writing activities. She used a journal format where she asked students to write about their feelings or attitudes, mathematical processes, and mathematical concepts. The students kept journals or notebooks as records of all of their writing. The students regularly shared their writings that focused on the mathematical procedures and content. Amber periodically collected and provided feedback addressing all the types of journal entries—affective, procedural, and conceptual. She reported that students would have benefited more from the journal-writing assignments had she been able to collect them and provide feedback more often. She said that keeping up on journals was difficult especially since the process was new to her; it was difficult to adjust to the time constraints and reorganize time usage. Even so, Amber did use the journal-writing assignments to have the students share with each other and provide peer evaluations.

Jean. Jean used a variety of writing activities, instead of focusing on one type of activity as her colleagues did. She used writing activities both during class and as final thoughts or assignments that encouraged reflection and summarization. One activity in particular was what Jean referred to as the exit ticket, a final activity of the class period that required reflection or solving a problem. This activity was to be completed either before students left the class or moved onto science, which she also taught. She also used prewriting assignments for expository essays to help create assignments her students could share and edit together. This was a way to foster thinking ahead of time. Jean felt this along with students' writing, sharing, and revising, could lead to clear cohesive pieces of expository writing. In addition to the well

thought-out prewriting and writing assignments, Jean used writing as a way of closing down or reflecting upon discovery-type activities. For instance, when she used manipulatives to model fraction arithmetic, she included a writing activity for students to express what they discovered. Jean also had a year-long project where her sixth-grade students made math story books for elementary school students from the neighboring elementary school. At the end of the year, Jean's students shared their books with their partner class, and she brought samples in for the rest of the members of the professional development program to see.

Their Observed Benefits

In our final conversations, as well as in their reflective writings, the teacher-researchers' concluded that after using the writing activities for a whole school year, there were two aspects of the experience that were of noteworthy benefit to the students and their learning. The greatest benefit was that the use of writing assignments promoted student-to-student discourse, something that usually does not occur in the traditional mathematics classrooms. The second benefit the teacher-researchers identified was an observed increase in student motivation, thinking, and understanding from previous years of teaching. This increase was a "perception" (sense of increase), not an empirical increase since teachers did not perform actual comparisons from the previous years. The teacher-researchers acknowledged that the benefits to students also served as benefits for themselves in that they saw overall improvement in the very things they sought to change.

Discussion

Improved discourse

In reform mathematics efforts (NCTM, 2000), student discourse is an important element in the activities of the mathematics classroom. Current research supports the notion that social interactions whether they be whole-class or small group discussions benefit student learning (e.g., Cobb, Wood, & Yackel, 1993; Yackel & Cobb, 1996). Although improving student-to-student discourse was not a specific goal for the four teacher-researchers, they were well aware of the importance for increasing communication in general, and had that in mind when they chose to implement writing. In addition, increasing classroom communication was an overarching theme for the entire professional development program. The improvement in student discourse was somewhat of a surprise to the teacher-researchers in that it was not planned. For the students, however, it seemed as though discussions naturally followed their writing.

Amber admitted that she never intended for the writing activities to accompany discussion of it among students. She planned to use writing as a learning tool students could use individually, and use the journals for personal reflection and learning. However, the discussion of her students' writing began by accident when a student volunteered to read her writing aloud. Amber indulged the student and after a couple of instances, the student sharing of writing became a norm and expectation of the classroom activity.

In a conversation we had about using writing and how student-to-student discourse seemed to be a natural consequence, Amber offered that the teacher would have to allow it. "I don't necessarily think that employing a writing component in your math class is very beneficial unless you utilize it and discuss [the writing]." Amber also mentioned that in interviews with her students, they indicated it was not necessarily the writing that helped, but the sharing of the writing and the discussions that came after. Even the students saw the benefit of writing along with the opportunity to discuss what they wrote with each other.

Iris commented that she agreed with what Amber discovered about writing in her classes. Iris' goal was to improve students' problem-solving skills, and she felt that writing alone would not be sufficient, but could when coupled with discussions of their problems and solutions. Though Iris did not use writing activities to promote discussions per se, she became aware that through discussion the writing might be used as a technique to encourage classroom discourse. Both Joanne and Jean reported that students enjoyed explaining their solutions to their classes and were often eager to share their findings with others. As a result, student participation became natural for students instead of requiring solicitation by the teacher. Jean responded, "The student-to-student discourse in my class has promoted conversation and debate about mathematical concepts."

Having students discuss and debate mathematical concepts is precisely the point of encouraging student discourse. Through those discussions students are given the opportunity to further reflect upon their own thinking while possibly augmenting other students' thinking to their own. With regard to writing activities, students feel they have invested their time and effort into something other than ordinary mathematics work, and thus feel the natural progression to discussing their work with each other and their teachers. These conversations then provide the students with valuable

feedback about the way they are thinking about the mathematics. The writing activities do not have to end there however, another round of revision to the writing students have already produced can solidify thinking and add another layer to their understanding much the same way multiple-entry logs enable students to revisit their work (Powell, 1997).

Supported student thinking

Another consequence of using writing activities along with discourse is that it supports student thinking. Because of the reflective nature of speech and dialogue, discussions among students can be valuable tools for learning (Vygotsky, 1978). As mentioned earlier, the discussions that accompany writing activities enhance classroom communication and have the potential to provide students with another opportunity for reflection upon their thinking. Since writing is a product-oriented classroom activity, the students have a concrete record of their participation and of their thinking, which they can refer to and revise during discussions. The written product affords students the opportunity for critical reflection, which has the potential to give students control of their learning as well as a means of monitoring progress (Powell & Lopez, 1989). All of these steps within the activity of writing support students' thinking in a way that is not usually seen in the traditional mathematics classroom. Thus the use of writing can provide students with extra tools for learning mathematics.

Joanne agreed with this position saying that without discussion to "force" students to think about their thinking, the writing activities are not meaningful. She commented, "My students have learned many things from each other this year, and from themselves. Sometimes they understand better when another student explains the mathematics." Joanne felt that if students really understand a concept they should be able to teach and explain it. Iris followed with a comment about argument and how it advances learning; "Trying to convince someone you are right through discourse is certainly a form of teaching and teaching is a great way to learn." The relationship between learning and social interaction can be seen in Joanne and Iris' experiences. The cycle of doing, thinking, and reflecting that writing promotes supports the learning process by empowering students so that they feel comfortable to take on peer teaching responsibilities.

In Jean's class, she noticed that reflection upon mathematical material did not necessarily have to take place in an elaborate/formal assignment, but could occur as the day's final activity. Recall that her exit ticket activity required students to work out a problem and/or reflect on it or that day's lesson as a concluding activity for the day. Jean said, "The exit ticket at the end of the class lesson has encouraged students to think about what has been learned in class and encouraged discussion that sometimes does not occur in the classroom due to time." Jean discovered that the students' writing gave them a topic with which they could think deeply. Their ideas and thinking were pondered even after the class was over, and could provide an opening discussion for the next time they met.

Writing also provided support for student thinking indirectly by supplying their teachers with feedback they would not normally have from their students. In a sense, student thinking was made more clear to their teachers, which in turn allowed the teacher-researchers to make adjustments in their teaching and acknowledge misconceptions. To this effect, Jean explained, "I sometimes realize that I may have not taught a concept clearly when many of the students have come to the same misdirected conclusion." Amber concurred saying that she felt that she knew her students' mathematical ability much better than in past years. "I know more about my kids than I ever have any other year," demonstrating the ability of writing activities to transform learning experiences for students. Joanne remarked that she was able to find out what her students really knew, and cited an example of discovering that a poorly achieving student - knows more mathematics than his/her grades indicate.

Future directions

The benefits of using writing in their classes show that the teacher-researchers learned a great deal from their students by reading and participating in discussion. They learned from themselves by using different teaching techniques and deciding on better ways to foster student learning. They also learned a great deal from each other by participating in our conversations and meetings about the data analysis and debriefing of their action research projects. Another, among the many things the teacher-researchers learned not only about their students but also about themselves, is what they want and/or need to do in the next school year when they use writing. It is important to realize that when trying out new teaching techniques, everything might not result ideally the first time. Good teaching techniques take years to perfect, and these teacher-researchers have a sense of how they would proceed in the future.

Amber expressed that she wants to collaborate with her language arts teacher to use writing more than what she did this year. She also wants students to keep a journal book in the room instead of using loose paper as they did this year. Timely responses were a concern for Amber and she intends to make a better effort at responding in an appropriate amount of time. Joanne wants to try writing activities with her learning disability (LD) students. Seeing the benefit to her past year's students, using writing with her LD students might show similar promise. She wants to have students grade their own and each other's writing using the ODEAR rubric that she devised. Hearing about improved student discourse from the other teacher-researchers, Iris plans to incorporate the use of discourse with writing into her classroom. Next time she wants to incorporate more discourse and re-writing (post-writing) after they have discussed their solutions. Jean wants to make changes to the rubric she used to grade expository essays. This past year, she used the district's rubric and ended up not liking it towards the end of the project.

Concluding Thoughts

After completing these projects with the teacher-researchers, I think they learned wonderful lessons from their own teaching. They enjoyed the process enough to want to continue the use of writing in their classes, and continue to make improvements in their teaching—one of the main goals of conducting action research in the first place. This research surveyed the experiences and issues that arose from first-time teacher-researchers incorporating writing strategies into their mathematics classrooms. Teacher-researchers utilized several types of writing strategies including expository writing, warm-up writing, problem solving, journal writing, and reflective writings. They discovered several benefits of using writing in their practice. They found that writing was not only advantageous to the students, but also to the teachers themselves. These results are consistent with research that addresses not only student benefits, but also those for teachers (Borasi & Rose, 1989; Miller, 1992). Students benefited from writing by increasing their thinking and reflection, and having an opportunity to share their writing that, in turn, led to dialogue and discussion with each other as well as the teachers. The teacher-researchers developed a better understanding of their students' knowledge and conceptions because of the additional opportunities to discuss students' thinking and provide feedback on their writing samples. The ultimate benefit from writing is that it enables more dialogue between all members of the classroom, something that is often missing from the traditional mathematics classrooms.

This project served as a great learning tool for everyone involved. The teacher-researchers learned about their teaching, as well as potential future directions for their research. Action research provided another learning arena for teachers because they stepped back from their practice and evaluated it systematically. Furthermore, writing can serve as a learning tool that has the potential to be extremely beneficial as well as enjoyable when discussions are an integral part of the process.

My involvement in this project gave me the opportunity to evaluate the use of writing in mathematics in action. Engaging in this project allowed me to see the applications of research to classroom situations and vice versa. Working with the four teacher-researchers highlighted the reality of conducting action-research in a middle school setting and all of the challenges and enjoyment that can result from it. This experience illustrated for me, firsthand, the issues and concerns teacher-researchers encounter when trying new teaching and instruction techniques for the first time.

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