Abstract

From 1989 to the present, mathematics curriculum documents have emphasized the importance of communication in mathematics learning and teaching. In order to understand concepts and processes, learners (and teachers) need to talk about, write about, and represent their understandings. Through communication ideas are clarified, and in turn communication becomes clearer. This article presents some of the writing and teaching strategies used in elementary mathematics classrooms in three schools over the last 13 years. Via these strategies, students developed a repertoire of powerful learning strategies. They articulated connections between new learning and what they already know, and made personal sense of their learning.

The Role of Communication in Mathematics Learning

In the field of language arts education, the interconnectedness of language and thinking across all subject areas has repeatedly been demonstrated. From the work of Vygotsky (1962), Britton (1970), and Halliday (1975) to current research and writing in the area of critical literacy (Muspratt, Luke, & Freebody, 1997), the cross-curricular role of language and communication continues to be emphasized. In 1989 the U.S. National Council of Teachers of Mathematics (NCTM) broke new ground in North American mathematics education when it established a set of principles and standards for curriculum and evaluation reform that emphasized process as well as content. Published as Curriculum and Evaluation Standards for School Mathematics, the document constituted a response by mathematics educators, through their national professional organization, to a changing philosophy regarding the learning and teaching of mathematics.
Reflecting current constructivist theory (Gredler, 2000; Schwandt, 1994), Curriculum and Evaluation Standards had a wide-reaching influence on curriculum development across North America, including that within Canadian provinces (for example, the Alberta program of studies for K-9 mathematics: Western Canadian protocol for collaboration in basic education [Alberta Education, 1996]).

Continuing work in mathematics education by scholars such as Cohen and Ball (1990), Cobb, Yackel, and Wood (1992), Simon (1995), Schifter (1996) and English (1997) underscored the role of communication in the learning and teaching of mathematics. The NCTM’s later publication, Principles and Standards for School Mathematics (2000), refined the curricular focus of the previous document, and focused on five content standards (number, algebra, geometry, data analysis, and probability) and five process standards (problem solving, reasoning and proof, connections, communication, and representation). In this document, “learning to communicate mathematically” was listed as a primary learning outcome for all students.

The communication standard of Principles and Standards states:

Instructional programs from prekindergarten through grade 12 should enable all students to—

- Organize and consolidate their mathematical thinking through communication
- Communicate their mathematical thinking coherently and clearly to peers, teachers and others
- Analyze and evaluate the mathematical thinking and strategies of others
- Use the language of mathematics to express mathematical ideas precisely. (p. 402)

In addition, communication is inherent in all of the other standards, for whether students are problem solving, reasoning, making connections among ideas, or representing their knowledge, they are using language as a tool for thinking as well as communicating. Communication and the exploration of ideas both orally and in writing have thus taken on a more prominent role in mathematics education; this constitutes a significant move away from the “traditional notion of reasoning as primarily propositional, ‘abstract and disembodied,’ to the contemporary view of reasoning as ‘embodied’ and ‘imaginative’” (English, 1997, p. 4). Students are now urged to explore, problem solve, and link learning to their own lives. They are increasingly challenged to validate their own mathematical ideas and abilities and to learn to communicate their mathematical thinking clearly. They have opportunities to express and explore their mathematical thinking through the use of manipulatives, small group discussion, and writing. The NCTM Principles and Standards for School Mathematics (2000) emphasizes the importance of writing: “Writing in mathematics can help students consolidate their thinking because it requires them to reflect on their work and clarify their thoughts about the ideas developed in the lesson” (p. 61).

Schoenfeld (2002) reported that preliminary data from test results, 10 years after the NCTM Standards (1989) were introduced, indicate that “reform students do as well on skills as students who study the traditional curricula, and that they do better on an understanding of concepts and problem solving” (p. 14). We cannot make the claim that the improved performance in conceptual understanding and problem solving are a direct result of the students having more
opportunities to write and talk about their learning. We have, however, studied the kinds of writing some students have been encouraged to pursue in their elementary mathematics classes over the last 13 years, and we have talked with teachers about their experiences in using writing in mathematics. Our studies lead us to believe that these writing activities, in addition to the focus on process and the use of manipulatives and practical application, have helped students to better understand mathematical ideas and concepts. It needs to be said, however, that many teachers remain hesitant to incorporate writing and small group discussion into their mathematics classes, because they still perceive mathematics learning as an independent endeavour. Some teachers have expressed concern that valuable time might be taken up in writing that could be more productively used for drill and practice activities in preparation for large-scale testing. We have found that teachers become especially concerned as the time for standardized testing approaches. At this time they are more likely to revert to their former teaching practices and avoid writing, small group work, and the use of manipulatives.

We collected data in three separate studies between 1989 and 2002. Edwards (1992) investigated the use of dialogue journal writing in mathematics in grades 2, 4, and 6 in one school over a one-year period. The journal writing ranged in frequency from once a week throughout the school year to once every few weeks, depending on the teachers’ wishes. Interviews with the teachers were held approximately every two months and were audiotaped. During monthly classroom visits, field notes were recorded. All data were analyzed qualitatively according to themes and clusters (Patton, 1990).

Ellis (2002) explored the implementation of the communication standard of the NCTM Curriculum and Evaluation Standards for School Mathematics (1989) in a grade 6 mathematics classroom. In this instrumental case study, Ellis visited the classroom twice each week for six months. Data collection procedures included 10 open-ended interviews with the classroom teacher, classroom observations, field notes, and documents such as teacher resource material and samples of student writing. Data were analyzed using a qualitative approach (Bogdan & Biklen, 1992).

Wolodko visited a grade 3 classroom daily for eight months as a participant-observer. This was the beginning of a two-year ethnographic study of children’s perceptions of learning mathematics. At the request of the classroom teacher, she taught a unit on multiplication and division, following the NCTM guidelines and using a constructivist approach. Data included classroom observations, field notes, and samples of children’s mathematical work. Once again, data were analyzed using a qualitative approach.

In this article we explore the use of think-books and dialogue journals, as used by the teachers in the above studies, to promote understanding, communicating, and using mathematical ideas among elementary school students. In particular, we highlight some of the strategies teachers used in their mathematics classrooms and the purposes for which the writing was carried out.

A Rationale for Writing in Mathematics

The NCTM’s Principles and Standards states, “Because mathematics is so often conveyed in symbols, oral and written communication about mathematical ideas is not always recognized as
an important part of mathematics education. Students do not necessarily talk about mathematics naturally; teachers need to help them learn how to do so” (2000, p. 60). In their attempts to promote the communication standard, teachers have encouraged their students to work with mathematical tasks that are meaningful and that provide worthwhile topics of discussion. Students are encouraged to be creative in their problem solving, share their ideas with others, and write about their mathematical thinking. Now, students frequently engage in small group discussions and write about their mathematics learning in various formats, including think-books and dialogue journals.

Whitin and Whitin (2000) maintain that “writing and talking are ways that learners can make their mathematical thinking visible. Both writing and talking are tools for collaboration, discovery and reflection” (p. 2). Principles and Standards states that “reflection and communication are intertwined processes in mathematics learning” (p. 61). Think-books and dialogue journals can help students to consolidate their thinking, requiring them to reflect on their work and clarify their thoughts. Through them, students can explore their worlds, find their own voices, and make their thinking visible, increasing their confidence in their own thoughts and ideas. Think-books and dialogue journals are among the vehicles that allow children to share their thinking with their teachers and/or peers in a supportive environment. They encourage further expansion and exploration of ideas and allow children to demonstrate the meanings they have constructed. Children learn how well they have conveyed their ideas, and they learn to attend to the special meanings and use of mathematical language.

The writing students do in think-books and journals acts as a platform on which other ideas can be built. Students can go back to their writing and re-examine the ideas captured, reflect upon them, and refine them, as they integrate new knowledge with old. In the past, educators frequently thought of writing as something that was done when ideas were fully formed. Today, writing for understanding is seen as an intrinsic part of the total learning process. It makes learning personally meaningful and creates what might be called “action knowledge” rather than “book knowledge” (Barnes, 1976). After Wason-Ellam (1987) studied journal writing in mathematics with a group of grade 1 children, she concluded that “writing to learn demands a view of learning which is active and personal. The students created their own language through interaction with mathematical experiences ... Knowledge was a personal possession based on the knower’s experience. This was different from memorizing, transcribing and reciting” (p. 22).

**Writing Samples from Elementary Mathematics Classrooms**

Most of the writing samples we collected were completed in elementary school classrooms where teachers encouraged their students to reflect on what they were doing and put their learning into their own words. The teachers provided time for the students to write about their ideas (and for many children the writing took lots of time), and sometimes they provided time for the children to talk about their ideas in small groups after the writing activity.

**Think-Books**

The children in all three studies usually wrote in hand-made think-books or on exercise paper that was inserted into folders. In a few of the classrooms, the teachers modelled think-book
writing on the overhead projector, using their own experiences of learning a new mathematical concept. Other teachers used samples of children’s writing (with the children’s permission) to illustrate what reflective writing might look like.

Jasmin’s think-book entry, shown in Figure 1 (written in grade 4 when the class was learning about multiples), provides an example of what is meant by “writing for understanding.” The writing contains Jasmin’s emerging ideas and exploratory statements, and shows how she was actively attempting to make meaning (and generalizations) from her new learning.

Figure 1

Jasmin’s Grade 4 Think Book Entry

Multiples of 2, 3, 4, 5, 9, 10

All multiples of 2 are even - 2, 4, 6, 8, 10 12
14, 16, 18 and so on. Multiples of two can be put into group. The last digit
of multiples of two are even.

Multiples of 3 are odd. For example 3 x 7 = 21 and 21 is odd.

Multiples of 4 can be formed by
the last 2 digits that are divisible by 4.

All multiples of 2 are even - 2, 4, 6, 8, 10, 12, 14, 16, 18 and so on, and multiples of 2
can be put into groups. The last digits of multiples of 2 are even.

Multiples of 3 are odd, for example, 3 x 7 = 21 is odd. Multiples of 4 can be formed by
the last 2 digits that are divisible by 4.
Think-books can provide a safe and challenging environment in which students can discover what they do not know about mathematics as well as what they do know. Jasmin, for example, when writing in her think-book, would often discover that she was not as clear about her mathematics learning as she had expected. Sometimes she expressed frustration and confusion in her writing and asked for help. On those occasions a group member would work with her, helping her to understand the inconsistencies in her reasoning or conceptualization.

**Using Teacher Prompts to Initiate Reflective Writing**

The first time a grade 6 class used think-books (during a project on data gathering), the teacher provided prompts to help the students begin. For the first few entries, the children were asked simply to write about what they had done that day. Towards the end of the project, the teacher provided a series of questions that acted as guidelines for the students as they wrote their final reflections. The questions provided a “model” for the children in writing reflective entries in their think-books. The questions included:

- What was the best part of this project?
- Would you choose the same type of question again?
- Would you use the same sample again?
- Did you find your data useful?
- What did you learn in this project?
- What did you dislike about this project?
- What didn’t you understand?
- Why did you think your question was important to others?

In response to these questions, Glenn wrote the following think-book entry after he completed his survey of students’ beliefs about life on other planets:

I think the best part of this was collecting information and marking it down. If I were to do another graph I would probably ask a different type of question. It would depend on the question as to what I would choose for my sample group.

I’m not sure who would find my data useful.

I learned that more percentage of grade six students thought there was life on other planets than grade ones. I also learned that grade one students could answer so easily and know what I was talking about. I wonder what would happen if I asked a grade three class. I completely understood the project and thought it was fun. I like doing this because it’s fun and interesting to hear different responses. I’m not sure why I chose this. Probably because it was the first thing that came to mind.

Glenn clearly articulated his confidence in his ability to complete the project, and reflected his understanding of graphing techniques and of gathering data for a survey. He demonstrated his
ability to approach the problem heuristically and understood the connection between the presentation of data and the research question, and between the question and the selection of a sample.

During the same grade 6 project, Ky surveyed grade 2 students regarding their favourite flavour of potato chips. She wrote:

Jan. 26: When I went to the class, it was hard to get the class settled down. But it was easy. Someone kept on saying “I don’t know,” because he didn’t know what chip flavour was [his favourite]. So Mrs. T. wanted me to put him under regular.

Jan. 27: My favourite part of this project was when I was done collecting all the information. The information would be useful to someone who wants to order chips for the class.

I learned that if I was going to order some chips for the class I would order more ketchup flavoured chips than the rest of the flavours. The question was important to me because I like chips.

Ky’s entry indicates the dilemmas she encountered in her data collection (e.g., the uncertainty of how to categorize certain survey responses). Her entry also demonstrates that she understood what she had done and why this type of research could be important to the decisions made in a classroom context (i.e., when ordering food for a school party).

The above two entries illustrate how students can approach the same task differently and still arrive at understandings about the concepts being taught.

*Using think-books to Communicate Understandings of Mathematical Concepts*

During a project on measurement (area and perimeter), grade 6 students were invited to design their “dream school.” The teacher asked them to describe how they had used calculations of area and perimeter to create their school plan on graphing paper. Kaitlin’s work is shown in Figures 2 and 3.
Area is length x width.
I need to know how to divide and multiply. I need to know multiples and factors. If each of my squares is 10 m², then I need to divide the real floor area by 10.
Figure 3

Kaitlin’s Plan of Her “Dream School”
Kaitlin’s teacher had explained that each square on the graphing paper represented 10 square metres. Kaitlin’s think-book entry indicates that she knows the formula for calculating area and is developing an appropriate vocabulary for talking about area (length, width, metres squared). What is not clear is Kaitlin’s conceptualization of area and perimeter. The think-book entry does not demonstrate a clear understanding of the concept of area. Only conversation with Kaitlin would reveal the extent of her conceptualization.

Using Think-books as Assessment Tools

Writing in mathematics think-books can provide an invaluable source of assessment for teachers and students. Teachers can tell what students are understanding and struggling with in their mathematical conceptualizations. If shared between students, the writing can become an avenue through which students can guide each other in their learning. Figure 4 contains Alice’s response to the teacher’s prompt, “6 x 7. Tell me about it.” Completed in grade 3, this piece of writing was used as a mid-term evaluation of Alice’s conceptual understanding of multiplication. The children in the class were evaluated in their ability to describe multiplication as repeated addition and as an array. They were also assessed on their ability to describe the commutative property of multiplication (6 x 7 = 7 x 6). Alice demonstrates a clear understanding of this aspect of multiplication and easily describes multiplication as repeated addition. She also showed an ability to communicate the metacognitive process that she went through as she thought about multiplication. After viewing her explanation of multiplication as an array, the teacher used the assessment as a tool to inform her future teaching. In this classroom, the students’ writing was used as both an assessment tool for evaluating the students’ understanding and to inform teaching practice.
In a grade 6 classroom, while teaching a unit on scale and its uses, the teacher conducted an assessment of the students’ conceptual understandings of scale. He asked his students to write about what they now knew about scale. As in the case of the grade 3 teacher above, the
assessment not only helped him to provide useful feedback to students, but also allowed him to assess the effectiveness of his teaching strategies. Below is a selection of the students’ responses.

Alisha: The first thing you need to know [in order] to work on scales, you need to have the mm. and the cm. in order because then you can go from cm. to km. and then you can get all your answers right. When you have a test it’s not hard when you go one space up like 2m. = 20cm. by adding the zero in the order.

*Rami:* 1. Measure the length and width of tables in nearest metres because we want to find the actual measurement.
2. We have to decide what the scale will be because we have to shrink it.
3. We look at the graphing paper because we have to find out how many centimetre squares there are.

*Mohamed:* Scale is anything that you can measure in linear instead of drawing the real size of whatever it is! You have to do this because if you don’t it could take the rest of your life to draw it the real size!

*Taylor:* I know scale a little better now because I know some questions I didn’t know before like who does scaling? People who build houses and cartographers. Now I know that you can measure scale with anything. What do you measure money and time with?
Sarah’s writing in Figure 5 demonstrates how she understood the practical application of scale but did not understand the theoretical concept in regard to her own creation of a scale and its use in representing distance on a map. The question was, How big would a map of Alberta be if 2 cm = 1 km? (The map would be about 3000 cm, or 3 metres, from top to bottom.)
These five entries reveal the range of meanings the children created about scale as well as the ways in which they were able to apply that knowledge to the world. The writing shows how well some children grasped the concept, whereas other children were limited to trying to manipulate numbers to make the mechanics of scale work for them. The writing provided excellent feedback for the teacher and enabled the children to discover what they truly understood about scale.

Think-books take different forms within elementary classrooms but ultimately serve the same purposes: to give students a means to express their mathematical understandings and to provide teachers with an opportunity to assess children’s learning and their own teaching strategies.

**Dialogue Journals**

Dialogue journals are journals in which children write to and receive written responses from a partner (whether a parent, teacher, or peer). Students write about their understandings and new learning just as they do in a think-book. When teachers and students engage in writing dialogue journals, a partnership is created with the person being addressed, a partnership based on acceptance and a sincere interest in the other. The aim of a dialogue journal is to enable the learner to clarify and explore meanings in collaboration with a partner. The adage “two heads are better than one” pertains in this situation. When students work in small groups to discuss an issue or try to solve a problem, it may be more time consuming than working alone but they usually learn more from the experience. Their original responses are often modified, and they may find their understandings changing as they challenge themselves to expand the meaning they have created. The result of such dialogue is often a broader or deeper interpretation of experiences.

In most of the classrooms we observed, the student partnerships were designated by the teacher without regard for the students’ levels of writing ability or mathematical understanding. The students enjoyed the opportunity of writing to, and getting responses from, many different children, and the process was structured so that the students changed partners every few weeks. In grade 6, the students often made a number of entries back and forth with their partner on one topic before the dialogue ended. On other occasions, there was only a single entry and a single response. The teachers allowed about 10 minutes of oral dialogue among the children when their journals were returned to them. This allowed the students to talk about their ideas and receive further clarification and explanation from their partner when necessary.

**In Dialogue with the Teacher**

In a grade 2 class, the students dialogued with their teacher. They frequently drew a line on which the teacher was expected to respond. For example, Julia wrote, “I get up at 7:30. What time do you come to school? _____.” A further journal entry from this class is shown in Figure 6. Here, Nikita included an algorithm for the teacher to solve and ended his entry with a question for his teacher, “Did you know time is math?” His teacher solved the algorithm, and told him that he does indeed know that time is math!
The children in this classroom made connections with their prior learning and consolidated it into a more holistic understanding of the world. For example, children noticed that words used in one context could be used in completely different contexts. Ashif related his new knowledge of
temperature and thermometers to prior knowledge in science, and observed a rule of
capitalization:

Today we learned about temperature and Celsius and Mr. Celsius. A thermometer is something
that tells the temperature. Do you know what the grey stuff is in a thermometer? It is called
mercury. There is a planet named Mercury. The grey stuff in a thermometer is spelled with a
smaller m and the planet is spelled with a big M. Mr. Celsius is now dead. He was called Mr.
Celsius! He invented the thermometer! He named the thermometer after him.

*In Dialogue with a Peer*

The process of writing in a dialogue journal is not always smooth. Experience has shown that
teachers play a very important role in the success of dialogue journals even if they are not
directly engaged in the dialogue. Problems can arise with motivation and with the
meaningfulness of the journals. In one instance we encountered, the teacher gave very little
guidance to the students other than telling them to write. In this classroom, a child’s entry would
quite often receive an inappropriate response from the partner. For example, Marianne wrote:

The only part I don’t get is when Mrs. A. told us that when you have a question like this:

40.8 x 80.4

that the numbers in the ones place make up two decimal places. Then the decimal is two spots
from the end.

This was met with a response from Marianne’s partner about something entirely different. In the
next entry, Marianne repeated her question:

Math is pretty easy, but I still don’t understand why, when you have a question like this:
40.8 x 19.9 = 811.92

why the decimal would be two places after the decimal in the answer?

This time her partner did respond to the question:

I don’t really understand why there has to be a two decimal place in the answer either. I wish I
could do my social report on the computer ...

Marianne was remarkably persistent, and in her third entry she came back to the same question.
Once again, she did not receive an appropriate response. However, as a result of reading
Marianne’s math entries, the teacher completed three carefully planned lessons on the topic,
including guided practice for the children, helping to clarify a very important math concept that
many of the children in the classroom had not fully understood.

These samples from student dialogue journals reveal the invaluable insights that teachers can
derive about a child’s mathematical world.
Suggestions for Teachers in Facilitating Think-book and Dialogue Journal Writing

Our research experiences have led us to formulate suggestions for implementing think-book and dialogue journal writing. It is important that teachers:

· read the student think-books regularly to see how they might adapt their instruction and further facilitate their students’ learning;
· encourage students to look at any questions their partners pose and consider them thoughtfully;
· provide “talk time” for pairs of students to figure out their answers to questions as well as their problem-solving strategies. Some students may need extra time to read their partner’s responses and discuss them;
· teach children what constitutes an appropriate response in a dialogue journal; and
· model dialogue journal responses on the overhead projector to help children become comfortable with the format (not to tell children what to say, but to demonstrate a variety of ways in which they might respond to each other).

In order that students can accept their partners’ responses and not be hurt by a critical response, students are often encouraged to begin their responses with a positive remark followed by a comment or a recommendation. This is a response pattern many children are familiar with from their experiences in writing conferences. It makes sense for children to follow this pattern in their dialogue journals as well. In response to Jeremy’s entry on estimating, his partner wrote:

Jeremy, I like the way you explained it. It really makes sense. I also liked the way you showed an easy and a hard problem. You should talk about the remainder and tell people about estimating.

Teachers have found that think-books and dialogue journals can be used effectively at all elementary grade levels. Teachers develop their own procedures for implementing them, according to the needs of their students and by discovering what works best in their own unique classrooms.

Conclusions

Writing about their mathematics learning provides students with a mechanism through which to learn. It is an opportunity for questioning, hypothesizing, predicting, and consolidating knowledge. We have observed that writing in think-books and dialogue journals helps children to build their conceptual understandings of mathematical ideas. In addition, writing helps students to articulate their developing conceptual understandings.

Writing in dialogue journals provides, for most children and their teachers, an opportunity to discover which concepts they clearly understand and which they need to focus upon in their future learning. The writing allows the students to open up to other people’s ideas, experiences, and understandings. Writing in think-books and dialogue journals encourages children to write in their own style of language, while at the same time pushing the boundaries of that language. It challenges them with the language of mathematics, a language with which they may not feel totally comfortable until they make it their own, through using it in mathematical contexts that
are purposeful and authentic.

Language arts educators have known for many years that writing is a powerful learning tool. We know that writing in mathematics can be successful in all elementary grades and that teachers who integrate writing in their mathematics classes receive many benefits. The writing provides an additional source of data for use in assessing students’ understandings and a powerful vehicle through which teachers can examine their instructional strategies and their own knowledge base in mathematics. As teachers read student journals, they learn much about how they can improve their own practice. The teachers in the classrooms in which we worked reflected upon:

- the complex mathematical questions children ask;
- their own (teacher) knowledge and understandings of mathematics and how that could be improved;
- the need for extremely clear and explicit teaching of mathematics concepts;
- the importance of creating a context for mathematics learning versus the abstract teaching of discrete skills;
- the effectiveness of journals as assessment tools;
- the clues the students’ writing provided as to what concepts the children understood and what they did not understand; and
- how they could use the insights gained from the students’ writing to adjust and modify specific teaching practices.

The skills students develop as they write in think-books and dialogue journals provide them with a repertoire of powerful learning strategies. Through employing these strategies, students articulate connections between new learning and what they already know, making personal sense of their learning, and in the process becoming better writers. Journal writing in mathematics is still a relatively new practice. As teachers become more comfortable with writing in their mathematics classrooms, it will become a more common practice, and both teachers and students will reap the benefits. Writing provides a record of where students have journeyed in their thinking and points to which they, and their teachers, might travel next.

References


**Author Notes**

**Dr. Joyce Bainbridge**
Dept of Elementary Education  
University of Alberta  
Edmonton, Alberta  
T6G 2G5  
E-mail: joyce.bainbridge@ualberta.ca  
Homepage: [http://www.ualberta.ca/~jb5/homepage.htm](http://www.ualberta.ca/~jb5/homepage.htm)  
Work Phone: 1-780-492-4273, ext 273  
Fax: 1-780-492-762

Joyce M. Bainbridge is a professor in the Department of Elementary Education at the University of Alberta. She teaches courses in language arts and children’s literature.

**Dr Monica Ellis**
E-mail: mellis@telusplanet.net  
Work phone: 1-780-431-5489

Monica A. Ellis is a reading consultant with Edmonton Public Schools. Her Ph.D. dissertation explored the implementation of the communication process of Alberta’s Program of Studies for K-9 mathematics: *Western Canadian protocol for collaboration in basic education* (1996).

**Ms Brenda Wolodko**
E-mail: bwolodk@UTNet.UToledo.Edu

Brenda Wolodko is an assistant professor in Early Childhood Education at the University of Toledo, Ohio. She is completing a Ph.D. in Early Childhood/Mathematics Education at the University of Alberta, Edmonton.