Getting Conversation into the Mathematics Classroom: Essential, but Formidable—Perhaps "A Bridge Too Far"?

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The parts of this conclusion include selected comments about the importance of conversation; a glance at students' abilities to communicate mathematically in the past; observational data and selected opinions intended to illustrate possible difficulties that may be encountered while trying to get conversation into the classroom to foster ability to communicate and reason mathematically; and an attempt to look back from the future.

Why Is the Ability to Learn How to Communicate Mathematically a "Must"?

"Students are expected to communicate in order to learn and express their understanding" is identified as one of the "critical components that students must encounter in a mathematics program in order to reach the goals of mathematics education and encourage lifelong learning in mathematics" (Western and Northern Canadian Protocol 2006, 6). One of the main goals of mathematics education is to prepare students to "communicate and reason mathematically" (p 4). Learning how to talk about what has been learned and is learned in one's own words and being able to illustrate and explain one's thinking with diagrams or objects are key indicators of conceptual understanding: the understanding that facilitates or transfers to future learning and perhaps to lifelong learning of mathematics. Without opportunities to communicate, share and compare ideas about skills and procedures, students will not internalize the language that is related to these ideas or develop conceptual understanding.

The presentation of a theoretical framework and the pedagogical content knowledge that is part of such a framework is beyond the scope of this brief conclusion. *Getting into the Mathematics Conversation: Valuing Communication in Mathematics Classrooms* (Elliot and Garnett 2008), published by the National Council of Teachers of Mathematics (NCTM), includes a theoretical framework and pedagogical content knowledge matrices for listening, speaking, reading, writing and multiple communication forms, and many practical ideas for all grade levels.

Students' Ability to Communicate Mathematically: Looking Back

In *Learning Mathematics: The Cognitive Science Approach to Mathematics Education,* Davis (1986) makes reference to "disaster studies" and talks about "students who have used the human ability to imitate, and use a new language, in order to learn a form of knowledge which has allowed them to pass tests on the formal apparatus of mathematics and physics, without acquiring the 'assembled' experiential metaphors that would give meaning to this work" (p 370). It is sad that this statement applies to many of us who have completed mathematics courses in the past. Several years ago, the president of the University of Victoria was quoted in the local newspaper as stating that "even the mathematics majors know less mathematics than they think they do because they are unable to talk about the mathematics they have learned in their own words."

Anyone who has conducted diagnostic and/or assessment interviews will have collected data in support of the two previous quotes. Excerpts from interviews I have conducted show that many students will repeat verbatim the words used by their teachers in the steps of algorithmic procedures. During interviews some students will utter statements that do not make sense and they will give credit for these to their teachers.

Responses collected during interviews indicate that as part of their mathematics learning students have practised procedures that they did not understand. These students do not know the reasons for the moves they make with numerals as they record them on paper. Many explanations for algorithmic procedures begin with, "First I start with the ones." The question, "Why do you start there?" is sometimes met with a shrug of the shoulders or with "I have to." During one interview one subject answered with, "So I don't get confused." The question, "Confused with what?" was met with, "I don't know, but I don't get confused."

When one subject, who had recorded a row of zeros for the second partial product as part of her calculations of the product for two three-digit factors where the second factor had a zero in the tens place, was asked, "Why did you record the row of zeros here?" she stated, "To keep me in the rhythm." The majority of subjects will record a row of zeroes—indicators of lack of understanding and lack of number sense.

During interviews, examples of unique and unexpected "mathematical reasoning" will surface that can be quite amusing. In defence of these students, it is unlikely that the ability to communicate mathematically, the development of number sense and practising with understanding were part of these students' mathematics teaching and learning experiences.

Developing Students' Ability to Communicate Mathematically: Looking Ahead

The development of abilities to communicate and reason mathematically is dependent upon the environment created by teachers in the classroom and on how the strategies from the classroom setting are supported in the home.

The Mathematics Classroom

If students are to develop the ability to communicate and reason mathematically, opportunities are needed for students to engage in conversations in the mathematics classroom. The inclusion of these opportunities requires the preparation of plans that include high-order thinking and/or open-ended questions and creating an environment that provides students with "opportunities to develop and present new procedures; listen to the shared procedures of others, including their teachers and peers; discuss why different procedures work; and practice procedures they understand" (Hiebert 2000, 437). During conversations, all different types of comments and responses have to be accommodated and integrated into ongoing discussions. It is more than likely that the classroom environment that is required differs from the settings the majority of teachers experienced when they learned mathematics. It may also be that the training teachers received did not prepare them to create and manage these types of opportunities for their students.

In many elementary classrooms settings mathematics learning is a solitary activity. The focus for students is on completing activity sheets. One possible reason for this could be that their teachers learned about mathematics in this fashion. The other main reason could be related to the texts provided by publishers for the students. Many publishers have based the designs of references for students on the assumption of "two practice pages of tasks for every school day." According to publishers, that is what some teachers ask for. How many of these teachers end up talking about *curriculum pressure*, the pressure to cover the material?

Many years ago, while teaching in the largest elementary school in a city (there were four classes of each grade, 1 to 6), the intermediate grade teachers exchanged subjects. These exchanges included music, art, science and physical education. Not one of the teachers was willing to give up and exchange mathematics, and the reason for this was obvious. Assigning pages from a prescribed text requires very little or no planning beyond explaining examples, assigning tasks and marking, a setting that is void of conversations that include high-order thinking and/or open-ended questions. The emphasis was on speed. "Being good in mathematics" was defined by many teachers as being able to arrive at or to recite answers quickly. Many people and some teachers of mathematics still believe this to be true.

Data from research indicate that teachers who during their training were prepared to implement approaches other than those they experienced as they learned mathematics eventually tend to end up employing strategies that they experienced as part of their learning of mathematics. This could be a result of some sort of peer pressure in the school or it could be due to the fact that "teachers, especially elementary school teachers with limited knowledge of and experience with mathematics generally, tend to feel more comfortable with and capable of teaching lower level knowledge and skills rather than more complex knowledge and processes" (Romberg 1995, 76).

For the majority of teachers, the implementation of a mathematics program that gets mathematics conversation into the classroom and is conducive to reaching the goals of developing the abilities to communicate and reason mathematically requires professional development. In times of restraint, monies for this necessity are not available and without this in-service it seems fair to assume that any data based on observations from looking back in the future will not be any different from any previous looking-back observations.

Beyond the Mathematics Classroom

As a member of the University of Victoria Speakers Bureau, I have contact with many different groups of parents of children in preschool and the primary grades throughout the year. These parents pose questions during presentations and some will exchange ideas after the session. The comments that follow are selected from conversations with these parents. Some statements are based on reactions by parents and relatives as they observe me interact with my grandchildren. A few generalizations come from observing parents interact with their children at sports venues and in settings that involve waiting for an appointment of some sort.

The Irish poet Yeats told us that "education is not about filling a bucket but lighting a fire." I believe that statement to be true for mathematics education. As a fire is lit, or as attempts are made to do so, the "bucket" will be filled! I encounter parents who disagree with Yeats—they believe that the "bucket" needs to be filled with rote facts and procedures. I have been put in the position to respond to, "Why spend time on understanding the number 5 (developing number sense)? Why not teach them how to add and subtract?" One parent of a preschool child asked me what I thought about her child enrolling in Kumon Math. Another parent was attracted to Montessori because young children get to work with big numbers. Teachers of preschool children have told me that there are parents who urge them to teach their children about addition and subtraction, rather than spend time on readiness activities.

Open-ended questions and problems can put children into a state somewhere between what they know and understand and potential knowledge and understanding. Tasks of this type provide for valuable teachable moments. However, these moments are negated every time an adult interjects a child's developing thought process with not only an answer, but also the thinking strategy the adult thinks appropriate for arriving at the answer. I find it frustrating to see children deprived of talking about ideas in their own words and, as a result, missing the opportunity to internalize the meanings of the words they say. Providing a child with the words that parents want to hear when they notice indicators of cognitive conflict brings to a sudden halt the emergence of possible informative and interesting ideas. This action is not a developmental shortcut.

Most parents define a *teachable moment in mathematics* to mean correcting an answer that is wrong, as well as telling or showing how to arrive at the answer. At times this procedure begins with the comment, "No, that is not it," uttered while a child is in the process of attempting to explain his or her thinking. Parents fail to see any possible advantages of having children try to explain the thinking used to arrive at an incorrect answer. Consider the following incident. It was reported to me by a teacher enrolled in a course I taught. His son, who was in Grade 2, arrived at home, looked at his digital watch and stated, "Dad, it is 5:41—21 minutes to *Scooby Doo*." The dad, a teacher, took charge of this "teachable moment" with the questions "How many minutes is it from 41 to 50?" "How many minutes is it from 50 to 60?" and "What is the answer for 9 plus 10?" The son followed the answer, "19," with "But dad, there are 2 minutes of commercials first."

Over the years I have had opportunities to conduct diagnostic interviews at all elementary school grade levels. At one time many of these were videorecorded to be used for instructional purposes on campus and as part of distance education courses. Several things became obvious to students who viewed excerpts from these recordings. Children who used their own words to describe calculation procedures were in the minority. Most children were not confident enough to look away from the objects or diagrams they were facing as they talked to the interviewer. I was amazed at the fact that children trusted a complete stranger and were willing to talk mathematics. However, challenges existed. I did make the point to a group of students in my course before they ventured to conduct their own interviews that, based on my experience, a special effort may be required when interviews are conducted with children whose parents' backgrounds are Asian or First Nation.

One of the students in the course, a Chinese-Canadian, interviewed a boy with a Chinese background. The following conclusion about the interview and an addendum that were submitted as part of the assignment are presented verbatim:

> While the boy needs remediation in some basic concepts, the major problem is not with the boy but with the instructional strategy he has experienced. Incidentally, the boy is Chinese. This point

is peripherally relevant in that I know of no Chinese families, except ones where the parents are completely enculturated or are university-educated teachers, that would not emphasize speed and correctness of basic facts and getting a page full of computations correct, regardless of understanding. The emphasis for school, and life, is on learning the rules quickly, accepting and tolerating them, and applying them with deadly accuracy. For those who are allowed few or no mistakes while learning, admitting to a mistake at home, and at school, would be a humiliating experience. There is a lot of pressure in terms of adapting and excelling and maintaining the stereotype of the hardworking immigrant and being socioeconomically "better" than the parents were. It would be pretty hard to explain to parents why their child, being schooled here in the land of opportunity, is using blocks in Grade 4 when students in Hong Kong, in an extremely competitive society of high "academic" standards, stopped using them in kindergarten. I hope there's some cultural validity in what I just said and I hope it helps clarify your comment at the beginning about students with a Chinese background being afraid to provide anything but the right answer. (And then there's me, who was my father's greatest disappointment when I decided to go to university for, of all the low-status, low-paying jobs, teaching ... once I became a principal, I found I had a father again).

Over the years this explanation has served me well as I tried to talk to more students and to parents of these students in schools and in the neighbourhood.

Attempting a Look Back from the Future

I believe that the results of looking back from the future with respect to ability to communicate and reason mathematically will depend on the answers to four main questions.

1. How much inservice did teachers receive to enable them to get mathematics conversation into the classroom? Professional development for teachers is essential and without it the results of looking back in the future may be predictable.
2. How well were parents informed about types of conversation about mathematics learning that are supportive of what is done in the classroom? Parents need information about conversing with their children about the mathematics they are learning. This information cannot be of a general nature. Educational jargon or "edu-speak" needs to be avoided. The language used needs to be clear and specific. Mathematical ideas and terms need to be illustrated with examples. A need for specificity and clarity becomes clear when some documents from the Ministry [of Education] and articles in journals are examined. For example, a ministry pamphlet for parents entitled *Math for Families: Helping Your Child with Math at Home* (Achieve BC, nd) includes many statements that are difficult and even impossible to interpret (even for someone with a mathematics education background). Consider these selected examples from the first two pages, followed by my questions:
   - "Look for toys that encourage your child to think creatively." How do parents define *thinking creatively*?
   - "Talk about ideas related to numbers, space, time and money." How will parents know what to say and ask?
   - "Use logical thinking: 'There are four kids coming to the party. How many treats do we need?'" How is *logical thinking* different from *thinking*? Is it logical thinking because the hosts need to be considered?

   An article in *Maclean's*, "Have You Finished Your Homework, Mom?" (Reynolds 2012) mentions professors and parents who are experiencing difficulties while trying to help their children with homework. Reading the article makes it clear to me that these parents are unfamiliar with the critical components and the goals for students presented in the new curriculum. Number sense, the key for numeracy, was not mentioned once; neither were confidence building and equipping students with strategies to get unstuck. As with many articles about issues in education, "edu-speak" or jargon-heavy concepts are included, which are meaningless or will result in different interpretations unless they are defined for the readers. For example, phrases used include *traditional method*, *complex problems*, *highly conceptual approach*, *if they don't know their facts they won't be able to do fractions*, *solid grounding in math* and *mastering*.

   Parents need detailed and specific information that includes examples for engaging in conversations with their children that complement and supplement classroom goals related to fostering the ability to communicate and reason mathematically. Without the required specific information, it will be difficult to reach these goals, since parents will be unable to go beyond what they experienced themselves.

3. How often did children engage in any type of meaningful conversation and conversations about mathematical ideas or notions outside the classroom? The task of involving children in conversations may be becoming more difficult.
   Children who at one time were involved in conversing with parents and peers are now focused on a gadget in their hands. I recall that last Christmas one advertisement announced that there was an electronic gadget available for every age group; some gadgets claimed to be educational. In every group setting I find myself, and that includes living rooms, there are adults as well as children who are totally occupied with a gadget in their hands. At one time, sport practices or waiting-room delays involved parents and younger siblings interacting while they watched an older brother or sister in action or while they waited to be called. Now many or most of the younger siblings that I observe are engaged in a solitary setting with an electronic gadget of some sort. I have seen many parents responding to a request from a young child without looking away from what they were holding in their hands. I believe this solitary silent existence must have some sort of detrimental effect on children's ability to communicate that could contribute to making the task of bringing conversation into the classroom more challenging.
4. What other obstacles stood in the way of making it easy or even possible to reach the goals related to fostering the development of ability to communicate and reason mathematically? Possible obstacles include the following:
   - Many or most parents, including math professors (Reynolds 2012), did not understand the new goals of the mathematics curriculum. Many people believed that what was appropriate for us is appropriate for our children.
   - Many people, including teachers, believed that having students repeat rules and practise without understanding was appropriate for students (Reynolds 2012). Some people believed that certain types of tasks that involve calculation procedures, ie, "algorithmic problems" (Norris 2012), were unsuitable for engaging students in conversations or in the types of discussions described earlier (Hiebert 2000).
   - There were people, including mathematicians, who assumed that there exists a best way of teaching and learning about mathematics or that mathematics should be learned the way they learned mathematics.
   - The curriculum used by teachers was void of specific guidelines and examples related to bringing conversations into the classroom (Chorney 2012). This meant that authors of reference texts for students and teachers lacked a framework for the inclusion of specific examples related to communicating and reasoning mathematically.

What might be a hypothetical conclusion about the abilities of future students to communicate and reason mathematically? In the past I have had the opportunity to read articles by authors who did take a look back at the outcomes related to mathematics teaching and learning and concluded that nothing had changed. Will it be possible to overcome the obstacles, bring conversation into the mathematics classroom, and develop the ability to communicate and reason mathematically? For the sake of our students, let's hope so. Are there perhaps too many obstacles to overcome? Are you willing to speculate?

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