Communications

math is hard

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"math is hard" are the words the mathematics student union at Simon Fraser University put on their 2006 t-shirt.

In 1992, *Teen Talk Barbie* said, "Math class is tough!" This created an outcry amongst women mathematicians and educators across North America. Criticism from the American Association of University Women led to Mattel removing this sentence from Barbie's repertoire. I was protesting then, too; I was even interviewed by a reporter from a local newspaper.

Why the protests? To many, what Barbie was saying was, "Math class is tough – let's do something else!"

For years, girls had been discouraged from taking mathematics and sciences classes in high school. They were told that mathematics was too hard; that it was not "feminine"; that girls who are good in mathematics and science would not be popular with boys. I once saw a girl wearing a t-shirt saying "I'm too pretty to do math".

I remember talking to one of my neighbours one day, years ago, about her daughter, who was then a grade eight (thirteen years old) student. The mother told me how once, when the daughter was in grade six (eleven years old), her teacher told the girl, in front of her mother, "You know that you can't do math. Just try to finish school, marry a nice man – we need women who are just mothers." "But I want to be a veterinarian", said the daughter. "You know you can't do that", said the teacher. The mother was telling me how the daughter, now an eighth grader, would ask, when struggling with her mathematics homework, "Why should I work so hard, if I can't do it anyway?"

One of our graduate students told me how, when she was in grade 11 (16 years old) and was choosing courses for grade 12 (17 years old), a school counsellor told her not to take mathematics. When she asked why, she was told, "It is too difficult". She answered, "But I got an A from math in grade 11. If I can't take math 12, who can?"

Barbie's message threatened to warn girls against mathematics during their elementary school years – much earlier than the counsellors did – when many of them excelled in all subjects.

Is math hard?
At the 1993 Canadian Mathematical Society winter meeting in Victoria, BC, John Conway gave the plenary lecture, which was devoted to educational issues. He talked about his group theory course and how he was trying to get his students actively involved in learning mathematics. He painted a fascinating picture. He acted more like a sports coach than a mathematics professor, expecting his students to be more

than listeners in his class – he expected them to participate, to get physically involved, move around, shout loudly. At some point, to show what he did in his class, he lay down on his back on the floor, and moved an upright flashlight along his belly, to show the line the light was tracing on the ceiling. I loved the talk.

Afterwards, at the reception, I overheard two men talking about Conway's talk. One of them said, "It is wrong to teach mathematics this way. It's sending the wrong message to students. Mathematics is hard work, not just fun and games." I wanted to tell them that everybody knows mathematics is hard work. What people need is something to ignite their enthusiasm.

But – do people *really* know that mathematics is hard?

There is a perception, particularly strong in North America, that mathematics is something you either can or cannot do. Many students who believe they can't do math assume that, for those who can, mathematics is easy. The fact that *they* have to struggle is, to them, the proof that *they* can't do it.

Over the years, I have worked with many students who had poor mathematics backgrounds, and either lacked confidence or were made to believe that they "don't have a head for math". One of the most memorable was a woman – a successful businesswoman – who came to me asking for help with preparing for an examination she needed to take. She wanted to get an MBA, but was not sure whether she could do it, since her mathematics background was very weak. She told me that she had never been good at mathematics; she was so bad that she could not even understand fractions.

I asked the woman to tell me what she remembered about learning mathematics. She told me that both her father and her elder brother were very good at mathematics, and that her parents made her brother help her with her mathematics homework. He hated it – he hated teaching. Or, maybe, like many elder siblings who were made to help younger ones, he resented the chore. (My two younger siblings can attest to this; they still tell stories about the times I helped them with their homework ...) And of course, he was not a patient teacher. She clearly remembered how one day, when he was explaining fractions to her and she could not understand, he threw a knife at her.

I worked with this student for several weeks. During one meeting, when we were working on division of fractions, she suddenly stopped, looked at me, and said, "It *is* difficult!"

Years ago, this woman was being repeatedly told, "It is so easy – why can't you see it? You are so stupid!" The realization that mathematics was difficult was a revelation to her. It gave her a reason to work hard and win through.

math is hard – but
Many of my colleagues, upon seeing the "math is hard" t-shirt, immediately tried to find out what was written on the back. Nothing is, and this has been a big disappointment for some. They say that something should be, for instance,

- but it is fun
- but it is important
- but it makes you smart
- but it is beautiful,

One of my colleagues, Jean Taylor, in conversation using e-mail, said about the t-shirt,

> Contrast it to, say, "Puzzles are fun". Puzzles can also be hard, of course, and the 'fun' part is in finding ones that are hard enough to be challenging but easy enough to be do-able. To say "Puzzles are hard" somehow implies a more negative attitude toward them than to say "Puzzles are fun". On the other hand, to say "Puzzles are challenging" captures both the difficulty and the enjoyment in overcoming it. Sticking with "Puzzles are hard" somehow only captures the difficulty.
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> Now, if a t-shirt said "math is hard – but I can do it" or even "math is challenging", then the message would be more positive (though not as pithy as just "math is hard")

Is replacing "math is hard" with "math is challenging" the answer? It does send a message of being do-able, but would it speak to those who struggle but don't see the fun?

What I like to tell my students is that yes, "math is hard", but so are music, chess, in-line skating, snowboarding and [choose your own favourite activity]. Everything worth doing is hard. Activities that are too easy bore us quickly. But, to work hard we need a reason and a hope that we can succeed. "math is hard – but you can do it"– yes, maybe this would be a good message for the next t-shirt.

A process of becoming

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When talking to a friend recently about my upcoming oral defense (called the candidacy examination in Canada) of my doctoral research proposal at the University of Alberta, and trying to understand why this examination felt so different from all of the examinations I have taken in mathematics and statistics, I remarked "It's interesting becoming something that you've never been before." The statement to my friend was a realization that this examination signifies a part of a process of becoming – when it is done, the process will still go on.

In contrast, the examinations I have taken in mathematics and statistics tested fixed pieces of knowledge. When the examinations were done, they were done, the process completed by my knowledge written into a test booklet with seemingly few implications for who I was as a mathematician or statistician. Just to share an anecdote, during an orientation for a graduate program in mathematics, my cohort was told that we were now mathematicians because we were being paid for our work. So, all of a sudden, I became a mathematician. I had arrived.

This new experience of the candidacy feels quite different. It feels like a part in the process of becoming something – a researcher, an academic, an educator – part of a community. However, I won't move (hopefully successfully) through *this* rite of passage and all of a sudden become that thing. It will continue to be an evolution – a process of and

attentiveness to being. There is a sense of empowerment that the proposal for my research will continue to have a life beyond this examination; that it, too, is in a process of becoming.

This sense I have of my own process of becoming seems to parallel the process of mathematics graduate students 'becoming' mathematicians and mathematics teachers. This is what I wish to study. They are in their own process as well. However, I am not sure that it has been conceptualized as such. Many dichotomies exist in mathematics and, in that community, you either are or you are not a mathematician. There is little focus on the process. As a friend of mine in a PhD program in mathematics said during a discussion about a joint effort of mathematics and mathematics education students to work with school children, "I know the mathematics and you know how to teach it." I was the mathematics teacher and he was the mathematician – we had to be one or the other.

So, in thinking about this process or the idea of becoming future academics, professors, researchers, teacher educators, or mathematicians, where do we look for what we are supposed to become? For indications of how we should be? Of how we attend to our work, students, our discipline, ourselves? What has meaning for us in how we present ourselves within our disciplines?

For graduate students in mathematics, what are their experiences, what is it that they interpret or understand their lives to be like in mathematics? What has meaning for them in their process of becoming? What do graduate students in mathematics interpret as having meaning for who they should be and how they should be as mathematicians and as teachers of mathematics? In my own experience in mathematics, what had meaning for me? Who did I feel I needed to be and how did I feel I needed to be in mathematics?

For me, this looking at the process of becoming, of being a mathematician, resonates with my sense of mathematics – more a way of being than a body of knowledge to know. For me, who I am (thoughtful, reflective, hard working, passionate, interested, curious) allows me to move into mathematics, explore it, work with it, have patience with it. Who I am allows me to dwell with it, live with it, to work with it in a process, and it helps me think about the world in this wonderful way, to be what I think is a mathematician.

The questions that I am asking have pointed me to hermeneutics as a theoretical framework for my study. Davis (2004) offers a description of hermeneutics as

> a mode of inquiry that is oriented by two intertwining questions: What is it that we believe? How did we come to think that way? (p. 206)

Smith [1] states that hermeneutics asks the questions:

> How is it, how has it come about, that I use the words or act in these ways? (p. 28)

Through my own line of questioning, how is it that graduate students come to their lives in mathematics, their ways of being in mathematics and being teachers? How did they come to be that way? What texts or messages did they interpret as having meaning for their way of being? Thus, the attention hermeneutics pays to different texts and their