Innovative Networks
Thinking Like Mathematicians

Suzie, let's start with you. We're all aware of the importance of student achievement in mathematics. And the research tells us that we need to engage our students in working with real, authentic math problems that allow them to develop their mathematical thinking both inside and outside of the classroom. Can you set the context for us regarding how knowledge-building and the use of the Knowledge Forum supports teachers and students in improving students' mathematical thinking, so that they can make that shift from learning math to thinking like a mathematician?

I'd be happy to. Students in a knowledge-building community really get a sense of understanding and learning math, and feel very inclusive as a collective. When I think back to preparing my students for a year of learning at the beginning of the year, and how that usually looks in the classroom when you're building student profiles and you're getting to know each and every one of your students, and suddenly starting to get excited about who you have there in front of you, and what interesting people they are, you start to think about ways in which how you can get the students to share this beauty, this intellect, with each other. And you start to imagine the possibilities for them. And so I think that when we look at students in this way and we provide and set the conditions for our learning community, students will truly thrive, and really exceed our expectations as educators.

You know, a knowledge-building community will allow students to act as resources to each other. Students will call upon each other, and eventually the teacher role shifts a bit. And really, I see that it's very powerful as an educator in the future, in the upcoming years.

It's so rewarding to watch Suzie's class, because it just epitomizes this notion that the students talk about "we;" helping each other, feeling good about finding new information, contributing to the group. The sense of community is really powerful. And I think if there is one thing, I'd love to know how you do it. But it's clear you do do it. It's in the discourse, all of the students. You can hear them talking as a community.

Oh, thanks.

Just congratulations.

Thanks. You know, it's interesting. I know you said that the student really, truly use the term "we" a lot. It wasn't the case in the beginning of the year. Students would often -- actually, I solicited information from students, and asked the students, what do you enjoy about working with others? You'll be working a lot together this year. Actually, one of the items on their list was that they like it when others give them credit for their idea. They found it very important to be recognized for that idea. It's interesting, because that dissipated. By the end of the year, people couldn't even really uncover whose idea came from where, and how the evolution of an idea continued, and how they rose above certain problems. So it is remarkable for --

Yeah. I think this notion that it has so -- it has the markings of a knowledge-creating organization. And if you study knowledge -creating organizations, there's a team spirit, but there's also this continual advancement of ideas. And I think within the learning sciences, the piece that really -- we're accustomed to defining a skill and teaching that skill. So we teach the skill of problem-solving, or the skill of inquiry. But if your knowledge- creating organization inquiries in your soul, deep understandings in your soul, you just keep -- and so to watch your students operate as a community, where they are the agents of continually raising the bar, that's exciting.

So what interests me is your -- you speak of inquiry. And you know, that's an interesting area for us, like, it is at the soul. And when students start to think about inquiry, they came to me this year and really wanted to seek an answer to their question. Or they would develop these questions, and it was almost like it was done. And they wanted to present in a certain way and share this information they had found. But it really was just -- it was ending too early.

Mm-hmm.

What are your thoughts on --?

Well, I think -- and I think I say this broadly, not just your classroom, but I'm really speaking about data that we've been collecting in many, many nations, because it's thought to be really hard to create communities where the question will be deepened. It will go off, another student will find some information in the literature, it'll be really hard to understand. But they form again as a community to deepen it. So I think that this notion of the long trajectory is that they are the sustaining force for deepening their inquiry. They literally deepen the level of questions, that it doesn't stop prematurely. I think your signal of something that says, it hasn't flipped into a knowledge-creating community yet is one of the pieces that we're really trying to study and understand how, when it happens. And we know it can happen. I think that's what surprising about our work internationally, that the data are strong. How exactly, and what you do, which is why we study you a lot. Really trying to get some sense of how you're doing this.

In the end, when you assess and evaluate where you began and where your students arrived with their knowledge-building work, what surprises you the most?

You know, and I've heard this from other knowledge-builders, and I can totally relate, that students end up achieving far more than I expected them to. Students are achieving in all different areas. They're exceeding expectations. They're learning so much, and then some. If I go back and look at some of the content areas, I can relate them to, you know, for example, my grade five students, we're touching on grade eight concepts this year. And I've heard that from many other knowledge-builders, that once we allow students to naturally ask questions at a different time, and not a specific time that the teacher has specified, they end up going places where we didn't imagine. It's pretty remarkable.

What is the difference between students doing math and thinking like a mathematician?

That's a really good question, because from the early grades on through university, most of what students do in mathematics is not thinking like a mathematician, it's solving assigned problems. And mathematicians typically don't spend their lives solving assigned problems. They discover things, and prove things, and just generally advance knowledge. Now, it's interesting, students fall naturally into that kind of knowledge advancing mode, in science. But they need some help and encouragement. At most, they're going to get just a flavour of what it's like to think like a mathematician.

I think, actually, it points to another piece of thinking like mathematicians. Mathematicians talk mathematics, so the more mathematics talk you get, the more like mathematicians you become. So the notion that, here's an idea, somebody picks it up and wonders about the mathematics in it. So not only does it display the kind of seeing artefacts as mathematics, but also in the discourse, the building on the idea. So then everybody can be a part of that community, because even, how did you figure that out becomes a valuable contribution that starts driving it forward. The more math talk you get, the more mathematical contents you're going to get.

How does this way of learning math support student well-being in mathematics?

Students see themselves as different learners, all of a sudden. Students begin to take themselves as an expert at a certain time, you know, whereas before you -- we had students that didn't contribute to a math group or a math learning circle, or sat back and just listened, and really didn't see themselves as a knowledge-builder, as someone with an idea or a question about this, or as a problem-solver in math. You know, "I'm just not good at that," students would say. But now, students really -- their self-conception is remarkable. They really seem themselves as somebody as an active learner in that subject area.

A great example of this is that I had a student that was uncomfortable, and saw themselves as kind of an outlier, and uncomfortable in the community, and oftentimes quiet. And there was a time when he was researching about the -- he's actually the one who developed the Pringles investigation; he shared an idea and a photo. And suddenly, his idea of what was a mathematical -- a food in mathematical investigation crystalized right in front of him. People started building on his ideas. And it actually spread into another classroom. And a variety, number of students were trying to build these structures and find mathematics in his idea. And this was a huge moment for him, and really it made him feel part of that community.

Looking at a box of Pringles, there's no obvious problem there. But a mathematician could look at that and say, now there's an interesting shape. What's interesting mathematically in that? And the students can do that sort of thing, too; look at it and say, what's interesting mathematically about this? And the real world is full of examples of that happening. You can't spend the entire mathematics curriculum on that, because it's not going to get them solving the kinds of problems that they have to solve in order to even a score on the mathematics test, or make it into the next grade. But they should get some flavour of it, some sense that really, there is more to mathematics than just solving word problems. That it's an enterprise of discovery, of opening up new avenues of knowledge. And I think that can

go a long way toward making mathematics something they just -- they can now connect it to things they actually respect and value.