THE POWER OF MANIPULATIVES

>> We had an opinion question within the clinical interviews, and the question was based on the lessons that we taught, your teacher tried some new strategies and some new ways of teaching patterning. What for you was most helpful as a learner when you were learning about patterning in algebra or linear relations for Grade 9? So this is a student in Grade 5. And the student says I think with the tiles because you can actually do something hands-on. When you do something hands-on, it teaches you. It helps you think. I know this because, like, when you do something hands-on, you can remember it. It's much easier because you know you're actually doing it. So the student strengths when we looked at the student's IP perceptual reasoning and processing speed but her needs were in memory. You can clearly hear through that student voice of how the tiles were actually leveraging her strengths and responding to supporting her needs. What was fascinating is we had just over 70 percent of the students who indicated that it was the tiles that was supporting them. We went to look at their IP. Not all of them had perceptual reasoning listed as a strength. Some of them had it listed as a need. That it was supporting a diverse group of students who had learning disabilities. What's important for us to be thinking about is the power of the tools, not just concrete tools, visual representation, double number lines. Things that will allow students to kind of hang on and preserve those relationships and can serve as a transition for algebraic reasoning as well. So it's that visible structure that is the power within those representations. So we want for students to kind of transition between kind of just random piles that are not very organized, which is loading on working memory, which is loading on processing speed, which is making it more challenging from a perceptual reasoning perspective, but then to help them in transitioning to something that provides, that can reveal the mathematics and can free up the load in some of those areas of challenge. We are really paying attention to representations that make it explicit structure of the mathematics. How that's allowing us to kind of leverage student strengths and then respond to their needs at the same time. We're paying attention to how electronic learning tools, digital learning tools. This is a great time to plug the mathies tools. How we can pay attention to nonverbal forms of communication, but how that can tell us a lot about what students know and understand and how, it not only is allowing them to showcase their spatial reasoning but opportunities to further develop that if that is not as developed.

MATH CONTENT KNOWLEDGE - THE MATCHSTICK TASK

>> When we engage in that collaborative inquiry in mathematics, we have to really engage in the math. That's what actually gives us sharper lenses to be able to interpret student thinking and then respond to that thinking. And identify, you know, what strengths the student has and how we can leverage that within the mathematics. So I'd like for you to take a bit of time now to solve the first task which is the matchstick task. Matchsticks are arranged as seen in the image. And there are 3 figures shown. So if the pattern continues, how many matchsticks would be used to make figure 10? So let's highlight a few possible strategies, a few possible solutions that you may have used to solve your problem. So some of you and some students, in fact, will actually build up
to figure 10 or will build figure 10. And they will arrange some toothpicks or as we saw the pipe cleaner segments and they'll count one by one in order to determine that there are 33 matchsticks. So we'd call that a one by one count in terms of the mathematical thinking. And the problem-solving strategy, we might name that as, you know, creating a model or some sort of a diagram or some sort of a concrete representation for that one by one count. Some of you may have also decided to extend the pattern using repeated addition. And so you might have seen immediately figure 1 represented in the blue. And then seen this or observed kind of a C pattern, this 3 ness that exists within the model for figure 10. Some of you might have actually taken that and created a table of values. And looked at how the number of matchsticks, the growth of those matchsticks, for each figure. Noticing that it's an increase of 3 each time. With that kind of additive thinking approach. We can also represent this relationship through a table of values where we're graphing the number of matchsticks and against the figure number. So for every figure number, there's an increase of 3 matchsticks. And so we can really see the additive thinking or that pattern that's extended graphically. And we can use the graph then to be able to extrapolate or predict how many matchsticks at figure 10 that, in fact, there were 10 sets of 3 plus another 3 represented through the green triangle. And if you were working at the secondary level, you might say, wow, that looks like a Y equals MX plus B, that linear relationship that could be expressed in that way. What's interesting about this is the connections, the similarities and differences across the solutions. Where do we see the 3 ness within each representation? Where do we see the part that doesn't change which was that triangular, that triangle represented within figure 10? So the power of our thinking is about different ways of solving the problem. But then how those connect and what we notice. Because this is what's going to support us in thinking about how to move student thinking forward mathematically. Of course, we can make lots of connections to one of our ministry documents. Paying attention to proportional reasoning. So this task is really about understanding quantities and change. And we saw that through the change of an increase of 3 each time. But foundationally, we can also see that unitizing was really important. Being able to see that set of 3 within the matchstick pattern, the representation. Well that was also the segue to being able to then create a pattern rule and thinking multiplicatively. And depending if you were creating a model such as we see here in the front on the floor, you might have also been doing or engaging in some spatial reasoning. So regardless if you built the model or you were trying to interpret from the visual representation, a lot of that was at work.

SOME OBSERVATIONS FROM COLLAB

>> So I'm going to highlight just a few pieces of the clinical interviews because I believe that they shed probably the greatest light. And for us as educators and how that then allowed us to move that forward within our work last year. One of the tasks within the clinical interviews was here are some tiles, so they had some square tiles, concrete tiles and they were also given some position cards. And they were asked to build a pattern for the following pattern rule. Total tiles equals, position number times 3 plus 4. Look at these solutions, look at these similarities and differences between the two
representations. And then how do you think each student described the number of tiles in position 10. So I think we've hit on some important things and I'll just give you a bit of a highlight then. So we did see students that didn't always look like this, but we saw students who built patterns where the structure was very visible. And we, I would actually see students grabbing 3 tiles at a time. That unitizing, that gesture, that motion with the tool told us that they were seeing the threeness within the pattern. They said things like oh well that's easy, it's 10 sets of 3 green and 4 red. Or 10 times 3 plus 4. So that was just an immediate thing that they talked about based on how they built their pattern. Different though than this sample, it's kind of linear format. In order to determine the number of tiles in position 10, they had to do it through doing 4, then position 5, then position 6, they had to extend all the way, each and every one to get to 10. So they had more difficulties making those predictions at position 10 without having to build all the way up to that. They tended to use additive thinking to make those far predictions and contrary those who arranged it where units were visible they used multiplicative reasoning, they tended to use it. We did have some students who interchanged multiplying constant, but yet if they arranged the pattern their tiles in each position with visible units they still used multiplicative thinking. So they would have said oh it's 10 times 4 plus 3. So it told us the structure mattered. How they built their pattern mattered. We still had to deal with the interchange of constant and multiplier, but we saw a lot of promise and potential to that arrangement of the pattern with visible units. So about half of the students with learning disabilities correctly associated the growth to the multiplier and then the part that stays the same to the constant. These students whom we analyzed their IEP'S they tended to have a strength in perceptual reasoning, so making sense of visual spacial relationships, part whole relationships. On the flip side for those students who did the interchange who probably had just under 1/3 of those students where again they did show a part that was growing, and a part that stayed the same, but had interchange multiplying constant. While the majority of these students had perceptual reasoning listed as a need in their IEP'S. So what that told us is just because we use manipulatives, doesn't necessarily mean that that's going to be the only thing that's going to work. What in conjunction with that would be helpful for us to be able to better support them. So one of the other tasks that was included, was the matchstick task. And what was fascinating is we had probably about 4 or 5 students who had actually chosen to draw the matchsticks for figure 10, but this is what they drew. Total number of matchsticks is equal to, figure number times 4 plus 3. That's what they were seeing, that's what the image they were generating in their mind. So that also told us that how the children and the students were perceiving some of them might be perceiving that visual information was really important for us to pay attention to as well.

MATH CONTENT KNOWLEDGE - THE CATERPILLAR

>>> For those now who have been embarking on collaborative inquiry and mathematics, what's been really fundamental to that is the work in building and developing our own content knowledge for teaching mathematics. And for us in the case of students with learning disabilities, it's not just about understanding the profile of the learner. Although that is very important. It's about the mathematics. So that's where I think some of the
work that we've done and that other boards now are taking on I think is having them really dig into those two layers in conjunction with one another. So some of you may recognize this task, it's the caterpillar and leaves task. So this is about Krista who loves caterpillars. And she needs 5 leaves each day to feed her 2 caterpillars. How many leaves would she need each day for 12 caterpillars? Let's talk about some of the key concepts within this task that are really, really fundamental. You might have drawn an image or a picture of 5 leaves with 2 caterpillars. And then kind of continued that pattern to be able to see then for every 5 there are 2 and so maybe through a skip counting approach, you would have determined that there were 30 leaves for 12 caterpillars. And that would be kind of an additive approach. What's significant here is the way in which the representation has been created. There's a structure to it, there's a visible structure to that model. Perhaps some of you might have, again, created a table of values and extended that pattern. Kept on holding on to that relationship of 5 leaves for 2 caterpillars. And then extended it to be able to determine the number of leaves for 12. That kind of extending the pattern or that rate using repeated addition. Again, an additive type of approach. Some of you might have gone to the graphical approach and really neat to be able to see the rate and how the rate can be used in order to make predictions. Some of you I heard in the audience were talking about ratio tables. Which is really a neat way of being able to, again, hanging on to two quantities that are changing simultaneously. So you might have gone to perhaps a unit rate to determine how many leaves per caterpillar. The idea is that we are scaling down to then scale up. And the scale factor now changes from factor 6 to factor 12.

This is called actually a ratio box. And so it's a bit of a condensed version of the ratio table. And it's being able to kind of plot in some of the information or include the information that's given. And then think about the relationships. You know, how many sets of 2 caterpillars are there in 12? This ratio box actually allows for a lovely transition into a proportion equation. Which is what we might start to see in the intermediate grades and into secondary. What's lovely about the ratio box and we can certainly see this even within the proportion equation is that it can reveal all the relationships within and across the two quantities. How important it is to preserve that relationship? The relationship between the number of leaves and the number of caterpillars. Another one that I think is also an important one is that idea of the scaling up and down. And, again, that's proportional reasoning.

INTRODUCTION QUESTIONS GUIDING

>> One of the things we know about students with learning disabilities is that they have average to above average cognitive ability. So what's common about students with learning disabilities is that they will have strengths and they will have needs. And there will be a discrepancy between those strengths and needs. How they differ, though, might be what needs they have and what strengths they have. Students with learning disabilities actually represent, it's the largest group represented within the population of students with special education needs. It's almost 50 percent of those students. We also know that many of these children, these students, are within reach. So they're often working in and around level two and can't quite seem to get to that, you know,
working at level three or beyond. And, yet, we know that the potential is there. One of
the things we were also interested in is this understanding of the mathematics and the
content. The classroom teacher typically is responsible for that, but how would it also
benefit the special education teacher to develop that understanding around content
knowledge? And how would it support us in being able to respond and support students
with learning disabilities? Differentiation needs to happen in that setting within the
classroom. So what knowledge and what understanding does the classroom teacher
need in order to be able to do that to feel equipped to do that? I'm so happy to be here
with you to share, you know, what we've learnt so far. And I want to emphasize the fact
that it's what we've learnt so far. There's still lots to learn. And but I feel like, you know,
we've kind of come across or uncovered a few golden nuggets. Which I think are not
only helpful for the work around supporting students with learning disabilities, but also
about supporting all students and mathematics.

FURTHER REFLECTION ON THE COLLAB

>> You've seen great transitions in terms of the IEPs, what now is being included within
them, the precision, and that alignment between strengths, needs, and the
accommodations. And we're constantly trying to ask students what's working for them,
what's helpful, and what's helping you to kind of move your thinking forward. I think the
work that we've been doing around students with learning disabilities that precision, that
narrow focus in terms of understanding the profile but also the content precision, the
focus, the depth, is actually allowing for it to move beyond that narrow piece. So now
teachers are really thinking differently, not just about students with learning disabilities,
but even all their students. What strengths do they have, what are they noticing that
they never noticed before. So we're seeing that ripple effect, kind of moving itself out.
Still lots to learn and, and we will have more to share following the end of this year's
inquiries. But I want to thank you so much for your engagement and your interest. And
hope there's a few things that you take away, back to your local contacts that will
support you in your work. [applause] Thank you.

FRAMEWORK OF THE COLLABORATIVE INQUIRY

>> I'll give you a little bit of just a frame around the Middle Years Project. And I mention
that it was supported by the student success learning to a team group at the Ministry of
Education. Our work was, yes, about learning disabilities. But it was also about a study
of mathematics, a specific study. We began with proportional reasoning, as I
mentioned, and then kind of transitioned naturally into patterning and algebra as we saw
this morning that task that we looked at was a patterning task. But, in fact, had so many
kind of concepts connected to it that were about proportional reasoning. Together
working as a team, the not only classroom teachers, but we had special education
teachers with us from grades 4 to grade 9 applied. So we had elementary and
secondary represented within our group, our study group. And we also had school and
system administrators was with us at the table learning. And as well as math and
special education consultants. So we needed everybody's minds and learning
experiences and ideas at the table to try to work through this. And we were working within three families of schools within our board. And we allocated six days per teacher in order to do that learning. Our inquiry questions really focussed in on how math content knowledge as well as understanding of the profile would work hand in hand together to support educators in planning for instruction, in assessment. Specifically, for students with learning disabilities. But we were also very interested in how that would help beyond just that demographic or that group of students. And, of course, we were interested also in how this would specifically impact student achievement. To give you a bit of a sense of kind of what we did within our collaborative inquiry, we were, we always studied the mathematics when we were together. We spend a lot of time thinking about the student profile and learning about the student profile. But, specifically, through a mathematics lens. So we were spending time engaging in simulations to better understand how students with learning disabilities think about mathematics and how some of the struggles they might face. And we also spent time unpacking the IEPs through a mathematics lens. We engaged in lots of job-embedded professional learning. So we were out in the classrooms testing out lessons, observing, coming back together to debrief that. And a fair bit of our time was allocated to analyzing student work. So we used a process called collaborative analysis of student learning to be able to not only look at the work around what students knew and understand mathematically. And maybe some of their partial or transitional understandings or some of the struggles that they had. But then how did that link to their profile? So what were we noticing within the work and how could we link that to the profile? What could we then be thinking about and embedding within our instruction that would continue to kind of leverage the students' strengths but then respond to their needs at the same time? We did do some pre and post assessments. Those were paper assessments. We did also look at kind of our castle analysis, our collaborative analysis of student learning tasks that we did early on and then later on in terms of how students' thinking or approaches were changing. And then, finally, we conducted clinical interviews with our students. And that's what teaching and learning is all about. You know, at the end of the day, we're all trying to kind of learn more and develop our own capacity more so that we can serve students to reach their full potential. So, really, the only way we're going to do that is if we can really dig in deep and then think about what that means then as we move beyond that kind of very narrow and deep focus.

DIGGING DEEPER INTO STUDENT PROFILES

>> I'll give you a little bit of just a frame around the Middle Years Project. And I mention that it was supported by the student success learning to a team group at the Ministry of Education. Our work was, yes, about learning disabilities. But it was also about a study of mathematics, a specific study. We began with proportional reasoning, as I mentioned, and then kind of transitioned naturally into patterning and algebra as we saw this morning that task that we looked at was a patterning task. But, in fact, had so many kind of concepts connected to it that were about proportional reasoning. Together working as a team, the not only classroom teachers, but we had special education teachers with us from grades 4 to grade 9 applied. So we had elementary and secondary represented within our group, our study group. And we also had school and
system administrators was with us at the table learning. And as well as math and special education consultants. So we needed everybody's minds and learning experiences and ideas at the table to try to work through this. And we were working within three families of schools within our board. And we allocated six days per teacher in order to do that learning. Our inquiry questions really focussed in on how math content knowledge as well as understanding of the profile would work hand in hand together to support educators in planning for instruction, in assessment. Specifically, for students with learning disabilities. But we were also very interested in how that would help beyond just that demographic or that group of students. And, of course, we were interested also in how this would specifically impact student achievement. To give you a bit of a sense of kind of what we did within our collaborative inquiry, we were, we always studied the mathematics when we were together. We spend a lot of time thinking about the student profile and learning about the student profile. But, specifically, through a mathematics lens. So we were spending time engaging in simulations to better understand how students with learning disabilities think about mathematics and how some of the struggles they might face. And we also spent time unpacking the IEPs through a mathematics lens. We engaged in lots of job-embedded professional learning. So we were out in the classrooms testing out lessons, observing, coming back together to debrief that. And a fair bit of our time was allocated to analyzing student work. So we used a process called collaborative analysis of student learning to be able to not only look at the work around what students knew and understand mathematically. And maybe some of their partial or transitional understandings or some of the struggles that they had. But then how did that link to their profile? So what were we noticing within the work and how could we link that to the profile? What could we then be thinking about and embedding within our instruction that would continue to kind of leverage the students' strengths but then respond to their needs at the same time? We did do some pre and post assessments. Those were paper assessments. We did also look at kind of our castle analysis, our collaborative analysis of student learning tasks that we did early on and then later on in terms of how students' thinking or approaches were changing. And then, finally, we conducted clinical interviews with our students. And that's what teaching and learning is all about. You know, at the end of the day, we're all trying to kind of learn more and develop our own capacity more so that we can serve students to reach their full potential. So, really, the only way we're going to do that is if we can really dig in deep and then think about what that means then as we move beyond that kind of very narrow and deep focus.