The Curriculum – Understanding the Mathematics Curriculum

>> It was after eleven years of teaching grades five, six, seven, eight math and in various combinations was that the connections and the curriculum book between all the grades, I started to see them a lot more, and I started to link the ideas together in my head.

>> Our curriculum is not based on discovery learning. It is a balanced approach between problem-solving and the development of skills, and I think Mary Jean gave a really good metaphor in terms of the incorporation of both playing the game and learning the skills to play the game. Perhaps for all to long all we did was learn the skills, and we never let the kids play the game. Who would want to continue with playing hockey if that's all you did was learn the skills? And if we look at the curriculum, in fact, I just pulled out a couple of expectations grade three and grade four; it's pretty obvious by looking at those expectations. Add and subtract three-digit numbers using concrete materials. Student generated algorithm, standard algorithms, and we can clearly see within the curriculum that there are expectations that address skill development and number sense of terms of students, and we also can see this is a big long one, so I'm going to filter it for you in a minute. We can also see the investigative nature of our curriculum expectations, so we determine through investigation using a variety of tools and strategies, relationships between areas of rectangle and areas of parallelograms and triangles by decomposing and composing. And so we're developing conceptual understanding about what area means and how one actually develops formulas which students will also learn about, so it's that blend of both things. All of those details there that I've blocked out; I didn't block them out because they're not important, they're actually extremely important, particularly to teachers because they give them ideas as to how to address that particular curriculum expectation.

>> So my thinking there was by being on all three grades at the school, well I could further develop that thinking, and not just by developing big tasks in each strand, but by looking at how the mathematical thinking I guess develops over time from grade six to eight; which has been an amazing experience. One of the best ones was doing patterns in algebra with all three grades at the same time. So many of the same problems fit, you know, maybe for two different grades depending, or with subtle differences; many of the problems fit because the concepts were similar. So in that specific example the grade eights would be more comfortable setting up an expression or solving an equation to get an answer, or creating a graph. The grade sixes might be more at the stage of making a table of values and trying to read it and trying to discover a pattern. The grade nines might take the--not just the table of values, not just the expression, not just the graph, but then would analyze the slope of the line and look at rates of change in things and things like that, and it's ever

so gradual, but you can see the thinking expand. But what's fascinating is that a lot of the same things work for a bunch of different grades, so you know even though it looks like the curriculum document puts each grade into its own little container with the content, if we think of mathematical thinking and math processes a lot of them actually are the same.

>> Um hum, and I think that's one reason I'm excited that Paul's here because he's secondary, so he can see the continuation. It---

>> Yeah.

>> There not--just because they're different panels the mathematical thinking just continues on.

>> Um hum.

>> So it took you some time to see those connections, and it was like eleven years of really kind of immersing yourself; obviously teaching the content, and you start to make those connections, and I think that's important because I think sometimes we feel like that transition from the way we are used to teaching has to happen quickly. And it does come after a constant kind of bumping up against these ideas and kind of--and then you start to see those connections between content pieces and the processes that support them.
>> Definitely; and how those strategies and types of thinking evolve over time.
>> Right, right. They become more sophisticated.
^M00:04:21

The Curriculum—Understanding Developmental Growth in Curriculum Expectations

>> Matthew Oldridge: When Diane and I had talked about our idea to do proportional reasoning -- first of all, it's happening a lot across a lot of the province with the Monograph, a bunch of different school boards -- we talked about how proportional reasoning does underpin a lot of the curriculum. And I've -- since it's first mentioned explicitly in grade four, right?

>> Right.

>> And I've -- since I've spoken to a grade two teacher and their project in Hamilton, I think, was looking at how it starts to develop even in primary. So even though it's not there, it's there, obviously. And their project was to look at that. So but I really felt like rates were the most real-life and often the most interesting type of thing for this age group, starting with junior and intermediate. So we looked at how the specific curriculum expectation for grade six, seven, and eight is pretty much, for all intents and purposes, the same -- setting up unit rates; you know, knowing what they are; setting them up; and actually calculating them.

^M00:01:05
[Pause]
^M00:01:17

>> Marian Small: I've been doing a lot of work lately, talking to teachers about the curriculum and "What is it telling you that we really want?" And I've made a distinction between doing stuff and knowing stuff. And when you read the curriculum, it's hard to tell which it is that you're supposed to do. My experience is most teachers are looking for kids being able to do the stuff that the curriculum says. And so when they're hearing kids talk and they are assessing what kids are saying in order to move their instruction forward, they are saying, "Yeah, he can do this," or, "She can do that," or, "He can't do this," or "She can't do that." But the real issue is: What are you listening for, and what are you hoping children can do?

^M00:02:09
[Pause]
^M00:02:22

>> Matthew Oldridge: So knowing that we could look at unit rates in all three grades, I was thinking, "Where in my life do we find them?" And so that's where I came up with -- which should still be here -- the photograph of the drink sizes when I was at the movies. The learning goal, I was looking at showing and explaining mathematical thinking with rates, and unit rates in particular because I pulled it

from each grade.

>> Paul Alves: He gives an idea of where the grade six is in terms of their own kind. Like, so they're going to be doing this problem with rates. So where are they, and where are the grade eights? So what do you think that they're going to bring to it?

>> Matthew Oldridge: What I had thought of -- okay. Well, I know these groups really well. And so I was thinking for the grade sixes, I made their numbers a little friendlier. I thought they might try and, I guess, maybe make a table or try and unitize it somehow. And the table might happen because they're more used to it.

>> Paul Alves: So they'll try to find a common number to compare all the --^*

[Multiple speakers]

>> Matthew Oldridge: Yeah, yeah. Some kind of multiple, something like that. The grade eights, probably more would attempt to calculate directly some kind of rate.

>> Diane Stang: Right.

>> Matthew Oldridge: But I think as they have more experience with numbers and obviously rates from previous grades, that "take this number and divide by this number," a what's what a lot of them will try. Now, whether they can make sense of the numbers they get is what we're going to found out. They might try and calculate the price per millilitre, which is about this much, and they get a tiny number. And so students often struggle with the decimal system. If there's more than a couple decimal places, it's hard for them to make sense of it. It's also making the questions open enough that --^*

>> Paul Alves: They'll take it where they need to.

>> Matthew Oldridge: Yeah, they'll take it to where they need to. So unit rate may not come out of it in every group's case. But in the mini-lessons to follow and the work to follow, I want to make sure that they know it's an efficient strategy -- price per one unit of something.

>> Paul Alves: Yeah.

>> Matthew Oldridge: Or that it's often how it's done in the real world.

^E00:04:39

The Strands

>> We often would think of each strand as being its own little container for content, but when you start to see how the concepts link, our job becomes that much easier, so even though there's pressure to evaluate each strand once or twice per year, when we start to see the linkage, we can develop those in our tasks and it, it just generally makes our job that much easier. And the actual truth is if, if I'm doing some math in my life, if I'm engaging with statistics that I see in the media, for example, I'm not stopping and saying this is data management and/or probability, I'm just [background comment] engaging the statistics, yeah, exactly. So in some senses, we don't do kids any, any favours with the way it's broken down. You know, and that said, we still do have to do the unit in a lot of cases, and we haven't fully navigated that problem, we're not perfect. For the data example, I try and see where statistics and graphs can support each strand otherwise, but we still do end up having to arrive at a grade for each one, and that's a huge challenge.
>> And the impact on learning is that then kids do kind of have this tunnel vision with the content, right? And kind of say, done this, now move on and they kind of, they, they don't see the connection.
>> Yeah.
^M00:01:22
>> And I think with, with students, what we have to do is make those connections explicit to them, so, for instance, if we're doing patterning in algebra, and we can bring in data management or we can refer back to, remember when we were doing this, and these, how they connect and, like, this is proportional thinking again, right? And I think that helps them, if they see the connections, then they won't compartmentalize these so much either.
>> Yeah, for sure.
^E00:01:46

Manipulatives and Multiple Representations

>> Ruth Beatty: Mathematicians have long been aware of the value of diagrams, models, and other visual tools for teaching and for developing mathematical thinking. But despite the obvious importance of visual representations in human cognitive activities, visual representations remain a second-class citizen in the teaching of learning mathematics. And this is particularly true if you go into a classroom and suggest using manipulatives. Many times using manipulatives, using drawings is seen as something that only struggling kids do. So there's a real stigma around using visual models and representations. So what we know from looking at the development of algebraic reasoning is that students who work with visual patterns and diagrams are more successful at understanding algebraic relationships, finding generalizations, and offering justifications than students who are taught to manipulate symbols and memorize algorithms. They're more successful. And that's been shown, not just through my research but the research of many people around the world. Also, we're thinking about the interactions among representations. So going beyond this idea of numbers, pictures, and words, to thinking about how representations can illustrate, deepen, and connect student understanding.

>> According to the elementary and the grade nine and ten math curriculum documents, students are to represent mathematical ideas and relationships along with model situations in a variety of ways. Students need to be able to go from one representation to another, recognize the connection between representations, and use the different representations as needed to solve problems. When students are able to represent concepts in various ways, they develop flexibility in their thinking about those concepts. They're not inclined to perceive any single representation as the math; rather, they understand it is just one of many representations that help them understand a concept.

>> Cathy Fosnot: The choice of models that we use is absolutely critical to the doing of mathematics, and that's because all models are not equal. For a model to be powerful, it needs to have the potential to become over time a powerful tool for thinking. We don't want adults carrying Unifix cubes in their pocket when they're in their twenties, trying to do a computation problem. So Unifix cubes may be helpful as counters when children are at the bottom of the landscape and they absolutely need to count all. But if we keep providing the Unifix cubes, they never skip count, they never move to repeated addition or regrouping of groups -- they just keep counting. So it's absolutely critical that we begin to introduce certain models at certain points in development as tools. The mathematics is not in the model to be seen; the mathematics is in a child's mind. Modelling appropriately to a mathematician means choosing a model and using it as a tool to model relationships, to sharpen the questions, to use the

tool as a powerful tool to think with. It's not just about solving a problem and then drawing a picture of your solution.

^E00:03:15

Estimating and Making Sense of Numbers

>> Marian Small: One of the things I've had an opportunity to talk about a lot lately is computational skills. There's been a lot of media talk about this lately. And so it comes up all the time. And one of the things I want teachers to know is that you have to think about "What kind of skills are really useful to kids in the society in which we live now and in which they are going to live?" And we live in a society where there is a lot of technology and that didn't exist, you know, 25 years ago. So even though you could argue not everybody has a calculator with them all the time, I'm betting in about three years everybody will. They will be embedded in your skin by Google somewhere, and you will have technology. And even now, any adult has a cell phone and it has technology. So I actually believe that we should be devoting way less energy to calculating with large numbers and way more energy with calculating with small numbers, doing mental math with friendly numbers, and estimating. So I want a kid not to spend a lot of time mastering 23 times 58; I want them to know that 23 times 58 is sort of like 1,200. And they can use their little tool and it didn't come out near 1,200 -- oops, I should worry; and if it did, I'm happy. I think the only way we can do that is not to ask kids to do the calculation as well as the estimation because they won't do it. They'll just do the calculation. So I'm saying don't ask them to calculate, like, stop. And the only kinds of numbers you should ask them to do are numbers like 20 and 60; and 40 and 50; and 32 and 10; or things where you're actually cultivating mental math. And I think that is the skill people really use in their life and the other skill -- get a machine out for.

>> Which one's, like, the best deal?

>> Matthew Oldridge: Yeah. You have ideas about what calculations you can do?

>> I'm thinking. So 500 millilitres equals $4.25. And we're trying to find, like, how much money for each millilitres or, like, each litre would be.

>> Matthew Oldridge: Okay.

>> But I'm thinking of a calculation.

>> So that's 8.5; does that make sense? That's 8.5; does that make sense? 4.25 divided by 0.5. Because that's -- you know how 500 millilitres is not even a litre, right? So then it's 8.5; does that make sense?

>> No.

>> Why not?

>> Because it just doesn't.

[Inaudible]

>> Because -- so that means that --^*

>> That doesn't make sense.

>> I understand what the calculation is saying. Like, the way we calculate doesn't make sense.

>> Can't you do, like, 500 millilitres divided by 4.25 doesn't make sense, either. So what calculation should it be? So basically in the beginning we were trying to find out how much money each, like, litre would be. But then we were, like, kind of stumped because all these numbers were, like, cents. And, like, there's not, like, whole numbers. So then someone in this group thought of doubling 500 millilitres, which is a small and as well as the price to see what it came out with. And it turns out that the small doubling would be less than the amount you would get in a large but the amount of money would be so much more.

>> Should we start with all the prices and the weight of the bags?

>> Yeah.

>> Okay.

>> So.

[Inaudible]

>> Each bag weighs 32 grams.

[Inaudible]

>> No, just chips. Because they weigh the chips.

>> Okay. So.

>> And each costs like.

[Inaudible]

>> Just say, like, one bag of chips.

>> So one.

[Inaudible]

>> Okay. So now we need to calculate -- so how many grams are in a kilogram? A kilogram is one thousand. So 1,000 divided by 32. So we can find out how many --^*

[Inaudible]

>> 1,000 divided by 32.

>> Yep.

>> 31.25. That means --^*

>> 31 and a quarter.

>> 31 and a quarter.

>> Which would mean [inaudible].

>> Wait, what?

^E00:04:57

Computational Fluency

>> I know in the press there's a big hub bub starting about which is more important; procedural or conceptual understanding and I just want to go on record to saying this is not the question to be asking. This makes it sound as if there's a dichotomy. This is not a dichotomy, they're both important. The question is how do we get the fluency established and you can't get the fluency established unless you're really working on the development of the mathematics and you don't want to sacrifice the development of mathematics by teaching the procedures without the underpinnings, because then after the early grades children will never take the advanced courses because they'll see no connection and those are critical too. So this is not a dichotomy, both are absolutely critical.
>> It's exciting how the definition of what it means to be computationally fluent has changed over time. At one point that kind of fluency required a slide rule and then technology changes, that's no longer necessary. This is a bit of undiscovered territory now is tools like Wolfram Alpha allow you to type into a box some very, any kind of equation you want to really at the secondary level and it'll give you an answer at any moment. That should challenge us. Like what is valuable for students to do? Is it important that they solve quadratic equations five ways to Sunday many different ways with increasingly difficult numbers and roots? I don't know if that's necessary, as necessary as it used to be. What is necessary is students know when a given tool is necessary and how to use it if they had to. So I don't want students to see tools as these methods as like black boxes to be selected off the shelf, this sense that math is some kind of strange series of magic tricks is equally bad and could be the case if we just say hey, take this and plug it into a computer. But at the same time what they can do, these computers, is so powerful it has to affect their understanding of computational fluency.
>> I just feel like that maybe it's time to end the debate over math facts. I mean the actual truth is if kids engage with math and from the very beginning they're going to know their math facts.
>> Automatization of the basic facts is absolutely critical but we want to be using the landscape to work on the development of the facts. The fact that the repeated additions can be regrouped is a critical big idea for children. The fact that you can double. So for example when you're looking at the basic facts well two times four is one children often learn early on. To do four times four you're practically done, you just double. Eight times four is done, it doubled. Right? Let's take a look at the relationships here. The fives is really easy if you know what happens when you do the tens because it's only going to be half. The relationships between the facts that's the framework, that's what's critical in terms of development, and so the facts become automatic but we want to ensure that we're building the foundation for algebra as we develop.
>> So I think in this problem is we need to acknowledge that we are practising basic math facts. Understanding's always first. Also I

wouldn't play a Jimmie Hendrix song on my guitar without first knowing a whole lot of note scales and chords.

>> In the Effective Guide to Mathematics there's a section on basic facts and strategies to use to remember your facts and I find it very useful. So for instance for addition we teach the students doubles or doubles plus one, different strategies like that so that if you refer to the guide you'll see that there are a lot of strategies you can use.

>> But we don't often have kids memorize formulas. I mean working with formulas in a lot of cases leads to memorizing them. Most of those kids like the grade eights would still remember circumference is pi times diameter, but I think most of them also know why that's true which, is the best scenario.

>> When we look at each grade, for example in grade seven, adding and subtracting two integers, my thinking is build the concept of what an integer is, look at some models like number lines or working with tiles, look at some models for how to do it, then work on the mechanics, like actually doing it, negative seven subtract negative five. Because there's a certain point after you have access to all the thinking tools that you need to just do it, so once the scaffolding's there you just need to do it independently. I just feel strongly as part of our assessment we need to recognize when to pull the thinking tools away because I go to do, in my integer example I go to do it, by the end of the first class, half the kids can just do it. So would I force them then to continue using number lines or tiles when it's redundant? Never. Do I need to check that they can all add and subtract two integers at some point? Of course, and so where we get accused of fuzziness or being discovery math teachers is maybe if people think we don't check for that and we should and we must. We're the ones that are coaching, we're the ones that understand the math and we need to check for that.

>> Somebody I like to quote from, Conrad Wolfram, is one of the CEO's of Wolfram Alpha, it's probably the biggest math company in the world, they own Mathematica, they have a huge program, and he has a campaign where he's going around the world saying we've got to stop math being calculating right now. So he would describe the importance of working mathematically and he says that working mathematically there's four components. First of all you have a problem; well first you ask a question. So the biggest growing job in the world now is a data analyst. All companies have huge amounts of data. So the first thing you have to do is ask a question of the data. So he says working mathematically you have to ask a question then you set up a model, then you run a calculation and then you have to go back to that model and interpret it, and schools spend 85 percent of the time on the calculation step and that's the one step we don't need people to do anymore. And in fact you know they never get people to do calculations, they have computers and calculators for that, but they do need people to set up models and understand and this is really an important shift if you want people capable in the 21st century.

^M00:06:22

[Silence]
^M00:06:31

Questioning in the Moment

>> Marian Small: I think it's great that teachers have what they call "talk moves." I think it's great that they do things called "gallery walks." I think all that. But you could do a gallery walk and do good stuff with it or not good stuff with it. So I don't think it's about naming anything. Essentially I think the most important thing a teacher needs to learn to do is ask the kid important questions. So "Tell me about this" and "Follow up with that." Like, when he says this, you've got to figure out what do you say now? And I mean, in the end teaching is an interactive activity. And all that matters is the relationship between those two human beings, or three, or four who are interacting. So until teachers develop skill at responding to students in meaningful ways, asking the right kind of probing questions -- not just ones that are on a popsicle stick somewhere but ones that make sense in the situation -- we're going to make relatively little progress. So I think teachers have to -- I think a good thing to do [inaudible] for teachers to play act with each other and learn to be more facile in a situation, like "What should I say, like, right now?" You don't have twenty minutes; like, right now, what are you going to do?

^E00:01:09

Questioning the Moment - Glimpses of Grade 8 Students Solving the Movie Theatre Problem

>> If you think about it, like, you can buy like something from like the dollar store.
>> Compare the price, the regular, like how it's made first, like how much it would cost, and then like compare it with the price of...
>> Regularly, if you'd buy it.
>> Exactly. Because we know they, they want to make profit for the movie theatre, so of course they're going to charge you.
^M00:00:21
[Inaudible Comment]
^M00:00:29
>> But, like, if you to go to the manufacturing, it would be cheaper, a lot cheaper.
>> I know, sometimes it's just way off.
>> Start with the small cup and see how, like, how much more the big one costs.
>> Are you doing the difference between the sizes and prices? Great! Great idea.
>> Difference is 4.50 between the small and the medium, and then its 74 cents more for, yeah.
>> Yeah, 1 millilitre.
>> What I would say, okay, two very different things are happening. This is good and this is good. Try and develop maybe both, because this idea where it is 450 different, 74 cents is not a lot of, you know, it's not that much difference, more expensive for a whole lot of drink, and then I'd like to see the next jump between 790 and 1.3. Yeah, looks like it. Nice!
>> These drinks cost 2 cents to manufacture.
>> 2 cents?
>> Literally.
>> 1 millilitre. And that's how much 1 millilitre is worth.
>> Can you do it for the medium? To see if there's a difference?
>> Okay, so you can write that there? Write 0.0125.
>> Dollar per.
>> For 500 millilitre.
>> And 10 millilitres.
>> Okay, and then the medium one.
>> Okay, so that's 4.99.
^M00:02:01
>> Just so we understand your example, like, you have two units, dollars and millilitres, how can you fill that?
^M00:02:07
[Multiple Inaudible Comments]
^M00:02:12
You have two, two units there, dollars and millilitres. How can you show that it, it was per millilitre?
^M00:02:18
[Background Sounds]

^M00:02:23
Is this, is this number of dollars per millilitre, does it give you a meaningful reference point?
>> Yeah. It shows that, literally, the small one is the biggest rip off.
>> Well they're all a rip off in general, but, I mean.
^M00:02:37
[Inaudible Multiple Comments]
^M00:02:43
>> Yeah, well I'll just let you continue your line of thinking, because you've included that this is biggest by far, this is second biggest, and that's, okay.
^M00:02:52
[Inaudible Comments]
^M00:03:10
What else, did we decide that, like the difference in millilitres, did we decide that wasn't as effective as doing this, or? Or did we just...
^M00:03:22
[Inaudible Multiple Comments]
^M00:03:28
Yeah, I mean, if you were...if you were to do it a couple of different ways, you might have even more.
^M00:03:34
[Inaudible Multiple Comments]
^M00:03:47
>> And that's fairly close to 425.
^M00:03:51
[Inaudible Multiple Comments]
^M00:04:02
>> Is everyone, anyone else here shocked by that number?
>> Yeah!
>> Way over priced.
^M00:04:10
>> The thing is, you can buy a small pop from the movies for that price, and you can buy a 12 can of pop from the drug store.
>> But they, they do that on purpose so that you can't bring food to the movies.
>> Yeah, yeah.
>> I know, but you can always sneak it in [laughing].
>> Most people end up doing that.
^M00:04:25
[Inaudible Multiple Comments]
^M00:04:29
>> It's seven times more...
>> Here, I'll do it for the [inaudible].
>> You're going to do the other two, and you're going to be like well-equipped to decide on a fair price.
^M00:04:42
>> So in conclusions, it's 8 times more expensive. Can you do the

large?
^M00:05:15
Now, okay, but now, it's, check this, this doesn't agree with this, these are exact opposite conclusions. So what went wrong? Yeah, but that can't be though. Well, it could be, but, [inaudible background comments]. I guess what I want is I know your justification for multiplying 60 cents by 7, but I don't know your justification for multiplying by 8 or by 10 or by 13?
^M00:05:47
[Inaudible Multiple Comments]
^M00:06:00
But you said how much is in a pop can.
^M00:06:04
[Inaudible Multiple Comments]
^M00:06:19
Maybe don't use whiteout, use like arrows or whatever. So between 3 and...yeah, okay, so, your unit, your units are 10, you have to pick one is closer to it.
^M00:06:29
[Background Sounds]
^M00:06:34
>> Okay, so 120.
>> How many times did you double?
>> Could I just, I have to jump in. Remember, this, it was very precise in mathematical, you know the big one's way cheaper, you know that. You know the smaller one is way more expensive. Don't discard what you know. So as, this is going to work with the pop can as the unit of reference, but don't discard what you know. You know the big one is way cheaper, because you calculated it.
>> This divided by that.
>> Yeah!
^M00:07:05
[Inaudible Multiple Comments]
^M00:07:12
>> Now we know that this only works with this because it's the same amount. But these ones, they are bigger portions, so you can't actually.
^M00:07:22
[Inaudible Multiple Comments]
^M00:07:44
>> Okay, but he, the teacher said we have to think about reasonable price. So what's, what is it going to be now?
>> Market price then?
>> This should be 60 cents, basically.
>> But then you're not going to make profit out of it.
>> I say like...
>> I know, but...
>> If they make it, like, they raise the price up, people will buy it.
>> Just think of it as this way, you know the regular [inaudible] a dollar for a can, [inaudible], it's a dollar. So we know it's 4 times

something, more expensive. So that we know for sure.
^M00:08:25
>> 1.25 plus the, yeah, plus tax, which is 13 percent. Which is going to be 1.25 plus 13 percent, 50 dollars, that's not right, okay.
[Laughing]
>> Okay, so, well when we're done this, what else are we going to do, what, what else are we going...
>> We have to also find the price for medium and a large.
>> Oh, okay, there you go, that's the price. So, it's going to be 1.40.
>> Make it 1.50.
>> No, 1.40.
^M00:08:56
[Inaudible Multiple Comments]
^M00:09:02
>> So we also have to do the same project as you guys, so what's a fair price for each cup size? And you already know them, and we, well actually, Katelyn, saw that the difference between the small and the medium is 450 millilitres and between the medium and the large is 510 millilitres difference, and then we want to see how much a millilitre would cost, so we took the price and we divided it by the millilitre, right? And we got, for the first one, 0.0125, and it wasn't the cheapest. For a small, that's a big rip off. And if you look at the medium, the price just gets smaller and smaller, and the, the drink gets bigger and bigger. So that's, that's what we found. And it was actually kind of unfair.
>> And then we also wanted to see, like, comparing to the price of like pop cans. So we found that like if you buy a 12-pack of pop, it's like 5 dollars, so then we divided that to see how much each, each can would cost, and that was 60 cents for 354 millilitres, but we could only do that with the small, because the medium and large are different sizes. So what we did was 60 cents times 70, which is 4.2, and that's seven times more expensive if you buy, like, if you buy a 12-pack of pop or if you buy a drink from the movie theatres.
>> And then, after that, we actually decided on, like we wondered what would be a fair price for every single size, so the average price for small should be 1.25 plus tax. The average price for a medium should be 1.79, or 75, plus tax. The average price for a large should be 1.10 cents, plus tax. Oh, whoops, sorry, 2 dollars, 10 cents.
>> Okay, and even though these are like, they're like compromises in the prices, we know that, of course, the movie theatres won't bring down the prices because that's their whole revenue, that's what, the money they're making, and they're just going to see that people are continuing buying, so they're just going to keep the prices the same.
>> So that everybody wins at the movie theatre and their clients, we found a way to compromise. So a good price for the small would be 2 dollars, and the medium 3 dollars, and the large 4 dollars. So there's only a dollar difference.
^M00:11:34
[Silence]

^M00:11:41
>> You did a fantastic job. I'm going to, so, like this is the class that had this amazing discussion about, and you considered all sides of the perspective, which is critical thinking. In summary, it's better to buy one of these drinks at the movies than to buy one at the Roger's Centre. Because the Blue Jays are going to be terrible this year and you [laughter] should go to the movies instead. Spend your money on that. Maybe, well let's give them a round of applause for their great work. [Applause] I know this, based on one game. Yeah.
^E00:12:17

Proportional Reasoning in the Primary and Junior Grades

>> Proportional reasoning in the curriculum really doesn't start formally till grade four but as we know, it actually starts a lot sooner and, Kim, you would see that in your work.
>> Absolutely, so even in the primary grades when students are taking a look at, say 5 frames, 10 frames and putting the unit of 10 or a unit of 5 together or looking at money and understanding that, for instance, a nickel is, you know, one unit, taking a look at some of that unitizing is so important, even in the primary grades. In the primary grades, students may begin with some additive thinking when we are presenting them with some of these visual proportional reasoning problems or tasks; however, it's all about how to move our students into that multiplicative thinking.
>> We really want our children and our students to be relative thinkers so there's the problem in here about which dog grew more, the dog that grew from 5 to 8 kilograms or the dog that grew from 3 to 6 kilograms. The conversation's always rich about that problem but I think it -- getting kids to be able to move from absolute thinking to relative thinking.
>> We can easily tap into younger students thinking of relativity or relative thinking rather, through connecting with their feelings of what is fair or fairness. So for instance, presenting students with a problem such as when might a third be larger than a half; that whole idea of a third of a large bag of candy can actually be larger than a half of a small bag of candy and that whole fairness piece. Our younger students can really connect to relative thinking that way and we can tap into it.
>> And I think something that they talk about in here too is often when we're doing proportional thinking in the early grades and, Kim, you would know and Lori, is the fact that we're often doing it on a qualitative basis. It's a matter of we're not necessarily putting the numbers in yet, we're just trying to get them to do a lot of common sense, which I think is really important for them to do.
>> Just last week at Hobson Networks, did a proportional reasoning problem about which paint can had more blue. Thinking about those students in the class who might struggle, I decided to go with the most concrete material possible so I tried to represent the problem using cube links and I thought can I just see in this -- these proportions, can I visually see which one has more and it turned out by the process of elimination, I was actually absolutely able to tackle a fairly challenging problem just by visually representing it and then the process of elimination and estimation, which I think is a really important strategy as well.
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Proportional Reasoning in Grade 6

>> Susan Lamon who's done a lot of research about proportional thinking, she believes from her research that 90 percent of students entering high school cannot think proportionally enough to be able to do or understand math and sciences conceptually in high school. Basically all the grades count, but grades 6, 7 and 8, those transitionally are so important to prepare your kids. How you respond as far as what you've seen with your grades 6, 7 and 8 about relative thinking?

>> I guess from my perspective, the proportional reasoning that happened exceeded all expectations, because we went from the familiar strategies that I thought I would see to way, way, way more than that. And then hybrids of different strategies, for example different types of things you would see here, a definite blurring of strategies blending multiple types of thinking. Like underpinning strategies. Just many, many, many types of thinking.

>> That was interesting because you were always looking at the students from a developmental point of view. So in grade sixes, you had them working in a more concrete manner. So do you want to just explain that?

>> What I was looking for the cup sizes was nicer dollar values, and dollar values that could lend themselves to maybe they might want to make a t-chart and/or proceed with pattern like they do. Or like they've been, like they're learnt to do. So, for example, 425, 475, I use those sorts of numbers. And then I kept the number of millilitres slightly more friendly as well. So they wouldn't be maybe encumbered by calculation. And some did try and look for a pattern beneath it. But from there, like the whole idea of the drink cups were that they were not in proportion. So, from there, it would have pushed their thinking further because they would realize, hey I can't do that. It's not as simple as looking for example an additive pattern. They had to look for it in different ways.

>> So the more you pay I found, the more you get. So when you paid less, you only get a certain amount. But because it increased by 75 cents each time, when you got the medium one, you increased by 250 litres and 75 cents. But if you got the large, you increased it by 500 litres, and 500 millilitres and got, and it was the same 75 cents. The more you paid, it would continue to make the more you get.

>> Several of the solutions showed one cup size relative to the other, or two combined to make as near as possible to one. So, I think it showed that they were looking at them relatively.

>> Because it's not much of a difference between the large and the small. Because the large one litre and 25 millilitres. The small has

500 millilitres. If you just have two smalls, it will be the same amount as the, pretty much the same amount as the large just will, without the same price.

>> So basically in the beginning we were trying to find out how much money you, like a litre would be. But then we were like kind of stumped because all these numbers were cents and like, there's not, they're not like whole numbers. So then someone in this group thought of doubling the 500 millilitres which is a small. And as well as the price to see what it came out with. And it turns out that the small doubling would be less than the amount you would get in a large, but the amount of money would be so much more.

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>> The whole concrete of being way to solve it, to be able to build towers in order to see it. Do you want to just explain how the students went about using mind craft?

>> So in this example specifically, they had, the drink size represented as millilitres by block, 100 millilitres per block. And then the price represented beside it. So they felt that the relative size of the tallest drink size relative to the price had the largest separation or difference. And therefore more was given for the price. And I considered going full Sesame Street on them and saying, letting the problem be one of these things is not like the other and why, because that's how I proceeded with this inquiry, the drink size inquiry if you want to call it that. I knew that the small one was not anywhere near being a proportion. But I knew that because my eyes told me so.

>> Right.

>> I didn't even need to see the prices.

>> So just raised the price really high and made it look like they're all closer to each other. Like when just the 500 millilitre [inaudible].

>> We made the cups a lot wider. That makes them look bigger.

^M00:04:52

>> I think we saw a lot of examples of relative thinking for sure.

>> I think we did. And I think a lot of it was really a conceptual understanding.

>> Well I think the grade 6 clearly had less experience working with different types of rates. Whereas the grades 7s and 8s were jumped

right to calculating them in a lot of cases. And in some cases multiple rates. So the grade 6s, the problem also what's a fair price, didn't have to lend itself to that. But in future lessons and future activities, we need to look at setting up more rates with them. The grades 7s and 8s were more alike in that they were comfortable calculating price per litre, price per kilogram, seemed more natural but was actually setting up and doing the calculations. So they had a lot more experience with it. And as proportional thinkers, we definitely thought that and saw that as well, that they had access to more different types of strategies to support their thinking proportionally. Whereas the grade 6 didn't. But we also noticed that the grade sixes were able to decide the, you know, the fair cup was out of proportion, which was the big point anyway. But they have less experience justifying it with math.

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Proportional Reasoning in Grade 7

>> So should we look at some of the work from the grade sevens today?
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>> Yeah.
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^B00:00:07
Well I guess in this one they had an idea that there was 15 to 20 chips per bag so they had an estimation tool and they had an idea about cents per chip, so this is the one where they researched a manufacturing cost.

>> Right. And I was really impressed with the use of the devices and I was mentioning to Diane that, you know, in our day we just didn't have that information. I would never have been able to Google what is the average manufacturing cost of Lays chips where they can just, they have easy access to that now.

>> Yeah, and so in this one they knew that a factory made 156 whereas we can only buy 31.25.

>> Again you've got the proportional thinking. I said well how many times more would that be and they were able to come up with oh, that would be about five times more and I thought that was really good because they were taking it--I wanted to see if they were thinking of the two proportional, if they were able to do that, so.
^M00:01:02

>> Yeah.
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^B00:01:08

>> They had decided that 1,000 grams equals 1 kilograms, so they wanted to know how many bags of 32 grams were in a 1,000 grams, so they, when they converted 1 kilogram to 1,000 grams they also converted the 32 grams to a kilogram, so they converted it to 0.032. So at this point they were dividing grams by kilograms. And they were getting an outlandish number like 31,250.

>> That's right.

>> So then when asked if it was reasonable they, you know, some of them were aware that it was unreasonable but they really weren't sure how to proceed from there.

>> But they at least were questioning whether the numbers the calculator had given them was reasonable, were reasonable or not, and so they were able to find the answer, but it just took, so like going to the calculator first rather than starting from a hypothesis I think

caused them to take way more time than they needed, which is kind of a lesson; calculator can't do any kind of thinking, that's for sure. It could be a good occasion for a mini-lesson about not just making sense of decimals but deciding what calculations to do if using a calculator, because if you don't know why you're doing the calculation you probably won't be able to make sense of what it gives to you.

>> Right.

>> So judging reasonableness of the answer that could be a good mini-lesson as well.

>> It certainly could, and I think it really helped them when you asked them to check by multiplying.

>> Yeah.

>> Because then they realized they didn't have, it didn't go back to close to 1,000 so. Yeah that's good.

>> Probably a good example of proceeding--so they proceeded from a piece of information they looked up, family size bag 410, 300 grams. Wherever that came from, probably a grocery store flyer somewhere, gave them enough to work with but it gave them enough to work with so that they're able to say that it should cost exactly 44 cents. And the calculations flowed through that so in this family size bag would be 9.37 of these smaller ones, and then all their calculations flowed from there. For example, that almost $10 more than the family sized bag, trial and error to find out how much the price would be, like scaled out of that 300 gram bag.

>> Yeah I liked that because they were using a lot of common sense as they were estimating right, so I thought that was really good.

>> Yeah and they just got closer and closer and 44 cents.
^M00:03:56
This has got to be upside down.
^E00:03:58
^B00:04:01
They started from listing things that they knew and making a goal for it. From there I guess because they were so clear with what they knew in their goal, the first calculation was number of small bags per kilogram and the second calculation took them right to the desired number, 4688 per kilogram. But again, they had some idea of a 500 gram family size bag and so they used that.

>> One guy he said, he said I eat these chips all the time so I know it's a 580 gram bag.

>> Oh yeah, yeah.

>> Then they looked it up to double check and they found it was 482 grams so that's where they did it.

>> So this is a lot like the last one, now they had concluded that 6 times less 25 cents is a fair price and they were actually very surprised by that number.

>> And again there's that proportional thinking when they're being able to articulate six times.

>> Absolutely.

^M00:05:06
>> Once again I like how even though he gave this he wanted to make sure, like the group wanted to make sure, they Googled to make sure that it was accurate.

^M00:05:14
>> That was good, yeah.
^M00:05:15

>> It was very good.
^M00:05:17

>> And then so this group they started from ideas. What else was in the vending machine? Small candy, large candy. And another type. A lot of their reasoning was based on that. And they had a good calculation. $1.50, 150 cents per gram but what they wanted to do was, their initial hypothesis was that a $1.00 or a $1.25 should be the price they stuck to that and came to 125. But based on that they had an idea it was too cheap, might seemed cheap and too expensive is too expensive and so they picked the number in the middle. Which was interesting the only thing they could have done is test their original hypothesis a little more. But they were confident in that.
^M00:06:10
>> They were. I like how they went to the other vending machine as a comparison.
^M00:06:13
>> That was a good idea.
^M00:06:14
>> It was.
^M00:06:17
I remember these girls, it's so interesting because we're always talking about units. Making sure that we're identifying what they are so they knew what they wanted to do. They wanted to find out how many of the small bags were in the big bag. But what they did was they went 300 grams divided by 32 grams would be 9.4 grams. So I just said, "What are you trying to solve here. Why did you set this up?" Because once they get to the calculations they often think, "Okay grams, grams

grams." Right, so then finally they realize, "Oh we're not talking about grams here we're talking about the bags, the small bags and the bigger bags." So that was really great then they were just off to the races again.
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>> So again they used the family pack.
^M00:06:57
And they proceeded from cents per grams as well as the rates that they picked.
^M00:07:03
I think perhaps maybe they would need to finish.
^M00:07:05
>> Yeah, I don't think they were quite finished.
^M00:07:06
>> This group I had in mind that I'd want to work with. They're only the grades sevens I'd would want to work with a bunch of different rates and then maybe some procedural mini lessons making sense of units. Making sense of decimals. Deciding what's an appropriate rate to use. So, I think in the next stage could be some practice. Brainstorming of different rates maybe see what's in the tips unit a couple more problems on maybe very, very different types of rates. Because I wouldn't want them to think that it's just food or just weight. Yeah, that's where we'll go with it.
^M00:07:50

Proportional Reasoning in Grade 8 – Analyzing the Thinking

>> I believe all, all teaching of math has to do with what math you care about and who are you talking to? And so feedback is the same thing. The feedback is about what math you care about, and it's also about what child are you talking to? And I think teachers are getting more sensitive to, to whom they're talking, and they actually often have been, not all, but many teachers. I think the part that they need the most work on is what math you care about, because their own learning experience in math gave them very wrong ideas about what math is and what math they should care about. So, much of the work I do and much of the work I'm sure other professional learn, learning leaders do with teachers is to help them better understand, what is the math that you should be focusing on? Is math that you can do these things, or is math that you think in a different way about certain kinds of situations?
^M00:00:59
>> Matthew, what did you notice from your two groups of grade 8 students?
>> Well, the biggest thing I noticed, that was surprising, is how astonishingly diverse all the strategies were. I think, for myself, I might jump right to the unit rate, because I know, even if I was standing there, I could calculate those right there and know. But they had such a wide range of ways to do it, such as referring to different grocery store prices for different containers and figuring out the price per unit, such as the price per can. This one had millilitres per dollar, which is a rate I probably wouldn't have used, but worked so well because we had, it was such a stark difference, 80 millilitres per, over 217. Furthermore, this one also used the price per litre, so it was like double justification.
>> When they were figuring it out, what you would pay for 1.3 litres, around there, and right away they're going, oh my goodness, they're paying three times, there's the proportional thinking, three times for the small, like 17 dollars, and they know you don't pay that in a grocery store.
>> What else did we have? We had a diagram of the cups, a couple of them, including these two, had looked at the jump in millilitres, and Matt tried to match it to the jump per, per price. Here, they actually represented that jump as a cup on its own, except I'm not sure what this number is.
>> They have this third cup because they were doing, one cup compared to another cup, so they were taking two at a time, two at a time, and saying, okay, they're narrowing their focus, so I'm only going to focus on two cups at a time, and I want to see how do these two compare and then once they have those three comparisons, then they can kind of draw a larger conclusion, which was really neat, [background comments] really neat approach. 960, exactly, yeah.
>> And then some millilitres per dollar, which is, again, the opposite to the rate which I would have used, but they were right there, they knew what it meant.

>> They did the division of the price, the, no, the quantity by the price, and they got an 80. I remember them getting an 80 and they really were a little disturbed by that, and, that can't be right, that can't be right. They all, they were all saying, oh, you're reversing it. You're doing the division in the wrong order, you're doing the division in the wrong order.
>> Do you want to talk about the global average price [laughing]?
^M00:03:22
>> The interesting thing was the idea of fairness, and so some of them approached it as fairness, like so I'm standing there in the, in the movie theatre, what's fair right now? Like, within this microcosm of the movie theatre, what's the fair price? But then they, like as you said, a few of them went to the cans and said, okay, just what's a fair price for pop? And so that's when, that one group said, they, they did a search for the global average price for Coke, and so they came up with, with a price, and then they kind of used that as their baseline to use, to make their comparisons against.
>> Matching the global fair price, these guys also did some Googling, but they knew about the dollar cup at McDonald's, which, which led into a whole other thing, but they did other research as well, and it was all to come to a very, [paper crunching sounds] where is it? A very precise conclusion, that the small should cost exactly 86 cents. One of them that stood out the most was the ones that just wanted to take the pure. We know, well the, from the business point of view, as they said, they only, they don't want you to buy a small cup, even though families might want it for little kids. They might be trying to confuse you. So they took more of a, this is propaganda-type perspective, but they were questioning right, right away, so we call it taking a critical stance.
>> That group there, I remember them, and they were discussing, the one interesting thing they were saying, as a, from the business perspective of it, what do you want people to do, and why are they kind of, why were the prices the way they were? And as a, from a business perspective, you want them to spend more money.
>> I found this really interesting. These two girls, right away, they said, well we really can't relate to this problem because we don't drink pop, but, they said, but, what we're going to do is go to the, the second question, which is the cheapest? So they said that would be a good way, so they decided that they thought it would be best to do the average.
>> It's based on five different grocery store containers. Price per dollar than averaged out to 678 millilitres per dollar. There is a lot of analysis here.
>> For me, the big thing is that regardless of what they're doing, whether they're coming up with the price per dollar, the price per millilitre, or the price per litre, that they all understood that they have to get a, they have to have a common unit that they're comparing against, and that's really the big thing. Like whenever you're talking about using rates is, is, as long as I can kind of always talk in the same language when I'm comparing the products, and really the

rate doesn't matter, it's just as long as I'm consistent when I'm talking about the different products, so, but you're right, eventually, yeah, we talk about some standards that we have and those, and they make it efficient, but the, the great thing was that they understood that, as long as the rates were consistent.
^E00:06:04

Proportional Reasoning in Grade 8 – Overall Assessment and Next Steps for the Unit and for High School

>> How do you feel your kids have a handle on rates?

>> I feel they have a great handle on it. So everyone was able to do something, and it, clearly the correct conclusion was that the small one is unfairly priced, and I think in every single instance, they knew that, they were just exploring it in a, a slightly different way. So, I feel great about them knowing that, when they go to the movie theatre.

>> In your mind, you have a clear idea of where you want, or what you're looking for, right? It's just now, as you said though, now, it's you can't be fixed or kind of restricted into this, into these lanes, you've got to kind of now make some adjustments in your instruction, right?

>> Yeah, and so, I had a specific expectation targeted for each grade, and it's basically being able to apply, understand, apply, and calculate rates. The learning goal is to show mathematical thinking in context of that. I can show my mathematical thinking about rates...period. But there may be other things attached to it, as I said, like a few little procedural things, but exposure to a bunch of different rates is, is key, and the variety of thinking that we do, proportionally as well.

>> That's a good point.

>> I don't often know the exact endpoint of the, the, of the working with the mathematical concept. I'm, in some cases, will have a final task in mind. For this one, I used to always do grocery rates from flyers. So, like seeing the advanced knowledge of the class, I don't know if I'll go there this year, but I feel like math is a creative process for me, for one thing, that I need to be open to where it takes us. And that might mean completely rethinking my second problem, which was to be about pop sizes again. Now I'm worried about redundancy of concepts, and of the task. I think at some point we'll have to practice some of these skills, and I might want to give them a bit of a procedural anchor with maybe setting up rates, solving different proportions, so just the more procedural, skill-base side of things. So, but that would be a whole other set of observations, because I would really be able to see who doesn't grasp the concept and is, therefore, not able to work with the procedures, or, when it comes time to be independent problem solving and assessment, I will know who to focus a little more on.

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>> Maybe you come up with, okay, I, I went to another store and I say they charged me this much, this much per whatever, now how do I adjust? What do I do? How do I take that, that 80 cents per millilitre, and be able to compare it, so?

>> Well, I guess, and I don't want to miss the obvious, I could do a mini-lesson on what is a unit rate? Why does it matter? So if this is one case, why it matters, or where we, there's a least three different unit rates here, so, we can then brainstorm some more, like,

rates of speed. I do think in this case, I have to think of, I have to come up with the right problem, that's just going to hit the sweet spot with all these concepts and all the work we've done.
>> You're from the secondary panel, so how do you feel this kind of work is preparing them for when they enter high school?
>> The process. The, the process, like that's the, the thing that struck me is the number of ways that they were representing their solution, the tools that they were selecting, the communication they were using, the way they were solving a problem, and, you know, that gets at the heart of the math. Allowing kids to see that, it's, and not being confined and restricted to say, you got to solve it this way or that way, but there are a variety of strategies and that some of them are more efficient than others, but that there are a variety of strategies that get at solving problems. But in terms of this content piece, you know, proportional reasoning and, and, and these, these rate problems, like this is huge, when you think of grade 9, linear relations, when we get into, you know, those, those kind, a slope and, and that this is a significant piece of, of the content in the grade 9 applied and academic. And as I said, I do it in grade 10 applied as well, and, because it forms the foundation for trigonometry in those kind of, that similarity that we see, so, yeah. But I think the bigger thing for me is, is just outside of the content piece, is just doing the math, doing the math, and seeing that there's a variety of ways to solve a problem.
^E00:04:38

The Value of Technology – Twitter as a Vehicle for Professional Learning

>> Dan Meyer: For about four years I had this kind of double life. I was teaching in this school in rural California and also, I was online on Twitter where I had this other kind of faculty lounge. And they were both useful for different things. Obviously, my online faculty lounge on Twitter and in my blog community, they couldn't cover a period or offer me some advice right then in the moment in person. But what I found was is the issues that I was trying to uncover and solve for myself as a new teacher weren't shared by my community there in that school. They were older, more veteran; they had solved these problems already. And so I found a community online, on Twitter, through my blog. And so there's an enormous spirit of kinship there that I'm sure kept me in this profession longer than I would have otherwise without it. The other great part about social media is that once you have people that are tuning into your thoughts and interested, you can put them to work for you in some very powerful ways. So for instance, I would oftentimes post every day's lessons; the handouts; the lesson plan; the slides; whatever we did, I'd post it. Student work. And I'd be very explicit in inviting criticism. I felt like I grew two years as a teacher for every year I was in the classroom because I had all these people behind me, pushing me forward faster.

>> Matthew Oldridge: We follow each other on Twitter as there's many Peel teachers and math educators in general on there. There's such a large community of teachers now that, on any given night, there might be people chatting with a hashtag or asking for resource advice. It's really wonderful. In Peel we have Peel Math Chat, which you need to be in next time. And there's just a lot of great stuff happening. More of a collaborative culture happening these days with Twitter and social media. So we don't have to feel as isolated in our classrooms. The collaboration can happen in real time, anytime. And so that's the big thing I find about Twitter for me. If I have a math teaching idea, I can put it out there and get feedback right away, for example. And --^*

>> Paul Alves: Or if you're looking for an idea, a creative way to kind of try to approach a topic and you're kind of stuck -- you know, as Matthew was saying -- in the past we were kind of confined to the community that was within our school. But now you've got a much wider community to kind of access. So again, it's that collaborative piece and that access to a lot of creative individuals.

>> Matthew Oldridge: And it's all at our fingertips.

>> Anna Presta: Well, a colleague recommended that I follow you on Twitter, Matthew, and I was very pleasantly surprised because you have such practical ideas, such authentic ideas. And I've got some here

that I've saved to my camera roll so I can show teachers as I go around Peel. I think it's been a great thing for me because I've got some extra resources now. I can go to Twitter and look at things; whereas normally I would just have gone to the Internet or I would have gone to some books. And now I've got this. And I find it very, very authentic. Very practical for me.

>> Matthew Oldridge: Thank you. For myself, I think I'm fond of saying now that my career is in the Twitter era, and I wouldn't want to go back to before the Twitter era, "BTE." I prefer this much better because there's a lot of sharing of math that happens in real time or at anytime of the day. And I've managed to build a good network of people around the school board, and around the province, and around the world who want to talk math at any given time. So I do feel like the networked educator gets access to more and more ideas. And in your specific examples, I had just tweeted some of the material that I wanted to use or was thinking of using for this webcast. So I wanted to see if anyone had any feedback or ideas.

>> Anna Presta: Well, I really like them. I thought they were very authentic. And it's interesting because it got me thinking, especially the one about the theatre.

>> Matthew Oldridge: Yeah?

>> Anna Presta: And the drink sizes? It got me thinking -- I was actually at the movie theatres over the weekend and I did think about that. I was trying to figure it out for myself. So it was a very good connection for me.

>> Matthew Oldridge: Yeah. That's the sort of idea I like to share on Twitter because it's being aware of the math that's around us because it's everywhere. But then the extra layer can be talking about math on places like Twitter. And I just feel like it's for the people. It's not a textbook publisher telling us what the math is, it's not somebody's fancy website. It's us, the math educators, that are finding it and sculpting it.

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The Value of Technology - Twitter for Activating Student Thinking

>> Dan Meyer: So let's look at way for how we can make a single situation accessible and differentiated for all these different students. So you got a student that doesn't really enjoy, say, a water tank filling up, to quote one example. And, really, like, that's every student -- every student is just somewhat like a water tank. If you pose it that way to them, they're not going to care about it. But you show them the visual, it immerses them a little bit, and then you ask this question: "Just guess how long do you think it will take?" And there's no silver bullet here. Don't let me tell you that there is. But one thing that's very reliable for me with students of all kinds of ages and interests is guessing -- guessing how long it will take. And if the student has enough of the context via the video, they can, then, like, pose a reasonable guess. And once the guess is down, you have some matter of buy-in for the rest of the task.

>> Matthew Oldridge: One of the things I'm trying to do, like, with this one is see how much information I can embed into a photograph. So photograph-sized math tasks that we don't always need to be wordy about how we present things. So I'm experimenting with either a short video, like a Vine or in this case a photograph with annotations, plus a tweet. So we have 140 characters, plus whatever text is on the photograph. And I kind of had that idea from following Dan Meyer on Twitter. At one point he did a blog post and he called out for "tweet-sized tasks" he called it. So math problems in a tweet. And I just think we can activate the mathematical thinking really, really precisely with technology. So pull a photograph; pull it into an app; annotate it; put it out on Twitter, or a blog, or somewhere.

>> Diane Stang: I think it makes it very real. I mean, this is what kids see, right? In their math world they're not reading a problem; they have to be able to take in the information that they're seeing and be able to solve it from that aspect. So I think it's great.

>> Anna Presta: Quite frankly, it really influenced me because I have actually -- seeing the pictures you take, and how authentic it is, and how easy it is just to snap a photo of something -- I've actually been thinking more along those lines as I go out now. So it's been very useful.

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Grade 6 - Problem Solving with Technology

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>> Matthew Oldridge: What makes us so different is that the -- as opposed to just working with markers and chart paper -- the work could look very differently, depending on who's doing it. So I suggested Explain Everything, which is a powerful app for capturing your thinking. Some may make a different choice. And I think in the BYOD age we have to become comfortable with that. And the other flipside to this technology, sometimes -- and in this class happens -- some may prefer to work on paper. It doesn't look like that's going to happen today, but for me that's also part of it. So there's an extra layer added: Are they using technology effectively to capture mathematical thinking? So that's what we have to look for in this period.

[Inaudible chatter]

>> Matthew Oldridge: Just call one cube or one block 500 millilitres.

>> Yeah, that's what we did.

>> Matthew Oldridge: Nice. That's how we do it.

>> Yeah.

>> But we're going to have, like, not all of them. We're not going to have, like, one block [inaudible].

>> Yeah. So.

[Inaudible]

>> Yeah.

>> One hundred millilitres.

>> Okay.

[Inaudible]

>> Matthew Oldridge: Nice. So you're scaling it down to the Minecraft world. This is great. In this app which is called Educreations, you can draw your thinking on the screen, but also, if you just hit record, it's recording your voice. So they're called "screen capture apps." If she wanted to, she could go on the Internet and take that actual picture and pull that in as well.

>> Medium we got 750 and also five dollars.

>> We're doing the math together.

>> Matthew Oldridge: Okay. In this case they're each in a different world in Minecraft. So they're collaborating in a way. Is it because you couldn't both get on the Wi-Fi? Okay. So usually they would be able to be in the same world as, you know, virtual representations of themselves and they could run around and do the work together.

[Inaudible]

>> Yeah, if there's more that you can't show, that's perfect. In this case you've got copying down the information in Educreations

>> Well, I'm using Minecraft to build, like, a model of the Coke so I can find out the exact amount. And I'm also doing the multiplication and, like, normal math to find out how it worked.

>> Matthew Oldridge: Just leave it for next class.

[Inaudible chatter]

>> Matthew Oldridge: What we saw in the grade sixes working on the problem was a wide differentiation of how they use the technology -- quite a wide range of technology was used. And -- but also the same learning goal. So whereas it looked like that they might not have been working together, there was actually some good collaboration happening.

>> Diane Stang: If you're not real tech-savvy, you may think that they're just in their own little worlds. But they're not. They are really collaborating, and I think that's really important to realize when they're using the technology.

>> Matthew Oldridge: As Diane said, some of the kids side by side, not seeming to be collaborating but actually collaborating, which can happen these days -- each person's looking at a screen but they're together. I mean, they're on the same learning goal for sure.

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Technology for Discovering New Frontiers

>> Infusing technology in the math classroom really can support enhanced learning. We need to think about the how factor versus the wow factor. When I talk about how, I'm talking about things beyond engagement, so we can wow students with new technologies, and, oh, look at our new clickers or new whiteboard or new iPads, whatever it may be, but that, that's going to wear off. And it's really, it's a little bit superficial. What we want to think about is how deeply, how students are actually enhancing their learning through the use of the technology supports.

>> And I think that's one thing about the technology, that some new and novel ways were happening.

>> I'm a firm believer in, you know, like, in something you said about technology and its integration in the classroom. Sometimes it can get in the way, but, but if, if it gives you something you couldn't have before, then it's an effective use of that technology, and it's obvious that there was something happening here that I couldn't have had prior to, prior to that.

>> So the, this one, it's 500 millilitres, and each block represents 100 millilitres, so I have 5 blocks, which equals to 500 millilitres, and that's what represents this cup. This one, it's the 750 millilitre one, and so I have 7, 7 blocks, which represents 700 millilitres. And then I have like a slab, which is half of a block, to represent the 15th, because it's less than 100. And then for the third one, this one is a 1 litre, 1.25 litres, and so all I did was I did, because there are 1,000 millilitres in a litre, I did 10 blocks, and then, because I, times 100 by 10, and then I just added like a small piece to show that it's 25.

>> Now how are you going to decide which is a good price or not?

>> Um...well, I'm, I'm still working on that.

>> Yep, no, for sure. So now that you got a physical representation.

^M00:02:07

[Background Sounds]

^M00:02:16

No, you go ahead. Because you're one of the, in the class, tell me what you're thinking about it.

>> Well, I'm, I'm thinking that this one, the tallest one, it's, it's the best choice because, not because it's the tallest one, but because if you compare like how much it costs and how much, like, it is, it, it'd be the better choice. Because this is really close to the other two prices, but the other two [inaudible] less.

>> I have to show, somebody else has to see this. This is entirely new. It's unlike, it's an example of where, you know, like being in the Minecraft environment gave you an entirely new way to do the answer.

>> Basically what I did was after I found out that each cup contained what, I put the golden blocks, they're representing how, how many millilitres each cup has, then I decided to use white blocks to represent how much each costs and each block is 1 dollar. So, I, I, I

built all of them, and then I, I think the tallest one would be the best choice because the, the price is almost the same as the other two, but the millilitres, like there's much more than any other two cups.

>> Yeah, you can see that yellow stack beside it is like twice as big as the dollar price, so, it's so visual. Nobody would have done that on chart paper. It was new and novel and it clearly showed which one is cheapest. That type of thinking was represented, in a lot of different ways, but not exactly like this, I'm really, really excited by it.

>> It would be really neat to actually kind of show that to the class and maybe ask them, what would it mean if they were the same height? Would that mean that it's a good deal? Which, which wouldn't be true necessarily. So it, I, I think there's so much that you can kind of draw on that, that there.

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Enhancing Problem Solving with Technology

>> Cathy Bruce: We seem to be moving now toward an experience era where the emphasis is on experience. And that means we're moving to production with the use of technology tools, so moving a little bit away from consumption and toward production. And in that case, now we're looking at something that's much more dynamic, not so static; we're actually manipulating. And I think this is particularly true with the touch technologies, so iPads; and interactive white boards; that kind of thing; any tablet use where we're touching and using our hands to help us with our thinking and demonstrate our thinking in dynamic ways is quite a bit different. And so the experience -- the actual physical experience of working with the technologies -- is leading us to more dynamic, experienced way of understanding the capacities of the technology. And it helps us -- again, is an enhancing feature, rather than just analysis. Now it's analysis, synthesis, and production.

>> Anna Presta: I was really impressed with the use of the devices. And I was mentioning to Diane that, you know, in our day we just didn't that have that information. I would never have been able to Google "What is the average manufacturing costs of Lay's Chips?" where they can just -- they have easy access to that now.

>> Okay. So I'm looking online, a sharing bag of Doritos is 200 grams.

>> It is?

>> Yeah.

>> Family size?

>> No. A family-size bag of Doritos is 17 ounces, which I don't know how much that is.

>> Is that ounces? Is that ounces? Okay. I don't know how much ounces is. I think there's an app here for converting.

>> But you're buying the 32 grams. That's --^*

>> You're right, 17 ounces is about 481 -- or 482 grams.

>> Okay.

>> Left out a little more money, like, besides buying the cups and the drinks because then, like, they won't make any profit.

>> But, like, still it's kind of high. Like, how much do you normally pay for, like, a soda?

[Inaudible]

>> Maybe two dollars, right? Like, $5, $6?

>> Okay. Well, this website says that if they're making 85 percent profit at the concession stand. Yeah, it's not so much seeing the movie; it's the food.

>> Matthew Oldridge: The group that researched McDonald's, and then they were using the grocery store prices, and then they arrived at a calculation was -- I was actually even stunned that they did that.

>> So basically, you can get four larges.

>> At McDonald's.

>> So for the same price.

>> Price difference is pretty big between the two. So why not just [inaudible].

[Multiple speakers]

>> Yeah, Burger King's way more expensive.

[Inaudible]

>> No, this is all the same I'm saying.

>> Matthew Oldridge: But the idea of the one-dollar drink from McDonald's was something that is part of their world. And so that became the point of the reference for what's fair. And for another group -- actually a couple of them -- it was the standard can became their point of reference.

>> Doing the research itself, like, looking at for what I did, we went to McDonald's website and the Burger King website. And, you know, just using the resources we were given -- like, all our tablets and everything -- really made it more interesting and it, like, made me want to jump right into it. I think it's a way of the school getting you more engaged. It's more interesting because, you know, you have the technology at your hands. Like, you have a question, you can Google it or whatever.

>> I think Mr. Oldridge was thinking outside the box when he's using Kid Blog and letting us use our devices to find answers and scroll through Internet so we can justify uniquely how we got our answers.

>> When he incorporates this technology we feel, like, more involved.

So we do things that are not just so, like, boring, like, out of the textbook; we actually get projects where our minds are put to work.

>> Diane Stang: It was neat because they weren't just asking questions; they were actually asking the question and finding the answer so they could make good decisions.

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Grade 8—Glimpses of Incorporating Technology when Solving the Movie Theatre Problem

>> Oh, you put the problem up on your iPad already?

>> You can use my iPad for a calculation.

>> Oh, I've got one here.

>> Use black. Only black.

>> Okay. So what is a fair price? Okay. So we have to write the prices down.

>> First you have to write down the ratios.

>> Okay. So what is a fair price for each cup? So a large cup is how much?

>> A large cup's five.

>> 1.3 litres.

[Multiple speakers]

>> So here it says a two-litre bottle at the store -- bottle.

>> No, it's not two.

>> Yeah, it's a two-litre bottle. It would be $5.

>> It says six. [Inaudible] You knew that already. So we have to find out "What is the fair price?"

[Inaudible]

>> So basically they're putting a price that would be for 4.2 litres.

>> Where is it?

>> So we just have to figure out, like, a fair price for all of them? Okay. So for the large size, I'd say -- okay, let's try to think of a price for the large size. So a litre currently it's around $6 bucks. So as you can see, you could get a little bit more at grocery stores for $3 less.

>> This should be less than $3 since this is 1.4.

>> So somewhere around $2?

>> Two-something.

>> Two-something? $2.75.

>> A little higher I would say.

>> $2.75. Okay. So for the large, we think it should be that. For the medium, what do you think it should be for the medium? So how many millilitres you get? You get?

[Multiple speakers]

>> But it's still super overpriced; like, they're making too much money and on top that you're paying taxes.

[Inaudible]

>> So at this rate, it would be one litre equals $1.

>> The one litre would be $1.

>> Yeah, at that rate.

>> So $1 per litre. So.

>> So are you done [inaudible]?

>> So yeah, so we think realistically the price for a one-litre drink should be $3.50 to $4. But mathematically, a normal price would be around $2.75. But again, at the grocery store you can see that it's way, way cheaper. Like, it's about $1 per litre. Yeah, there's a big difference there. Okay. All right. So we have -- we've talked about the large size; how about the medium size? The medium size would be 790 millilitres, right?

>> Yeah.

>> So at the grocery store, how much would you get for about 790? Eighty-eight cents per -- okay. So large should be somewhere between like you said --^*

>> $2.50 to $3.

>> Yeah. Yeah. So how much is one of those small cans over there? Does it say?

>> One of the small cans [inaudible].

>> Okay. Times that by around three will be $1.20 or something.

[Inaudible]

>> So for the medium size it would be about $1.50? Since one -- how much?

>> $1.49.

>> $1.49. Okay. So you could see the difference between the large. At the movie theatre you're paying [inaudible].

>> Yeah, but I doubt the large is a 1.3 litres.

>> Large is pretty big.

>> Yeah, but now we buy two larges and we probably have more than 1.3 litres.

>> Yeah, you probably have more. You're going to be paying around not more than $3 bucks, plus tax.

>> So basically, you can get four larges at McDonalds at the same price. And that -- yeah.

>> Price difference is pretty big between the two. So why not just, like, sneak in McDonald's?

>> I think that's more realistic.

>> Yeah, Burger King is way more expensive.

[Inaudible]

>> No, this is all the same. That's what I'm saying.

>> Yeah. So you can still see from both these restaurants or fast food areas, they're way, way cheaper than whatever theatre would be, even if they're not exactly 1.3 litres. Even if you buy two of them, you're probably going to get more than what they're offering. Those would show how many litres they would be offering.

>> Yeah. A large cup has one litre at McDonald's.

>> A large cup has one litre?

>> You're getting four litres about if you buy four for the same price.

[Inaudible]

>> Okay, how much is for one large at McDonald's?

>> One large at McDonald's would be $1. Oh no, I'm sorry, $1.49.

[Multiple speakers]

>> Four litres from McDonald's would be equivalent to 1.3 litres.

>> Yeah, you're getting more than a litre for less. Okay. Let's like --^*

[Inaudible]

>> So one litre for $1.49. So what?

>> $5.96 you would pay.

>> Yeah, so it's about 1.9.

>> So you basically get four litres of soda.

>> For the same price -- for the same price. So if you were to buy four of those, the price would be somewhere in 20s, 22.

>> Yeah, it would be over 20, guaranteed. And.

>> And you're only getting 1.3 litres here. For the same price you're getting pretty much the same.

>> Matthew Oldridge: So was your main tool to calculate this, was it this, the grocery stores, the McDonald's, or a bit of everything?

>> A bit of everything.

>> We used the grocery stores in the starting which you gave us but then we wanted to compare the prices of [inaudible].

>> Matthew Oldridge: That is simply amazing that you've gathered so much data, that so much research went into the solution. And that it should be precisely 86 cents for the small. It's so precise. And it's, like, the calculations --^*

>> So realistically, we'd say about $1.50. But what we think is super fair would be around 86 cents.

>> Matthew Oldridge: What's interesting about your fair price is, as we talked about, McDonald's will give you -- if it's, like, the last couple years -- any size cup all summer for one dollar.

>> Yeah.

>> Matthew Oldridge: That's pretty close to 86 cents.

>> And four large drinks at McDonald's is the equivalent to one large drink at the theatre.

[Inaudible]

>> Matthew Oldridge: These numbers are astonishing. And it was such great work.

>> We set the price of $5.99, you get four litres of Coke or a soft drink at McDonald's but only 1.3 at the theatres.

>> Matthew Oldridge: All of you are recognizing that you have all the data you would ever need at your fingertips.

>> Yeah.

[Inaudible]

>> Explain how the realistic prices are different from the mathematically correct prices. [Inaudible]

>> Okay.

>> So yeah, that's what we talk about.

>> And then we have this ratio up here.

>> Yeah. Four litres.

>> Four litres to 1.3, and that is still -- that's about [inaudible] 13, 26 -- that's about $4.52 for four litres and you're still paying $5.99 for 1.3. So just put that down.

^M00:08:06

>> All right. So to figure out fair prices for our project, we actually used multiple sources. So as Matthew will mention, we did use McDonald's and Burger King to, like, find out a fair price for the movie theatre food prices. Mathematically correct, we'd say a fair price for the large drink would be about $2.75; medium would be about $1.26; and for the small, we'd say about 86 cents. But of course, the movie theatres do need to make some revenue at least. So realistically, the lowest they would bring their prices down for the large would be $3.50 to about $4 bucks; for a medium it would be $2.50 to about $3 bucks; and then for a small, it would be $1.50 to $2 bucks. So at stores three, $6 two-litre bottles of pop would be about $6 bucks. But like, technically, it would be a litre for $1. So we took that, looked at that, and we thought of a fair price. The movie

theatre currently is $5.99, so we, like, thought of a fair price and still be making revenue but attracting more people.

>> Okay. So we used McDonald's and Burger King as a point. And McDonald's small is $1; their medium is $1.29; and their large is $1.49. So their large is about one litre, which is .3 less of the movie theatre. And then we have to take into account also the Dollar Drink Days. So if I were to compare Dollar Drink Days to movie theatre prices, I could buy five larges for $5.65, which is way less than the theatres where I'm only getting 1.3 litres for $5.99. Now, with Burger King, the prices are a bit more. The small is $1.69, which is more than the McDonald's normal large; medium is $1.99; and their large is $2.19. One thing I was thinking about taking into account was on Tuesdays the movie theatres are have a deal where the movies are half off. So one thing that I was thinking of is back in the day -- like, a long time ago -- Tuesdays were really big for movies because you're saving money there. But now me and my dad recently went and absolutely no one's there. There's little to no people in the theatres. So one thing they could do is lower the snack prices to half price, too. Because now that we think about it, we spend $6 for the movie, we're saving $6. But now when we go to buy our snacks and all that, it goes back up to $16 -- $26, around there because we're spending money on food. But now there was also another offer that I thought of, which was a $10 cup. You spend $10 on a cup at any time and the refill's only $1. And I feel like this works out for everyone better because it's basically a Dollar Drink Day at the movie theatres now.

>> And not just McDonald's is cheaper, but also we did six cans of any type of pop for 237 millilitres, which equals $3. And so we did 237 times 6, which equals to about 1.4 litres, which is about $2.99. And you see for the theatres 1.3 litres is for $5.99. So you save about $3.

>> And that's also why we decided to make the large at the movie theatres about $3.75.

[Applause]

>> I like that you compared both places to get, like, a look at the average [inaudible].

>> Matthew Oldridge: The extra research really, really adds to the mathematical thinking. They had multiple points of research, things that they looked up with their iPads and devices. But that's great.

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Technology and Collaboration

>> Technology also can build collaboration, both amongst teachers and amongst students, and so if we're sharing the technology, we're sharing a learning space, and that tends to engender collaboration.
>> But it's part of the culture of this class is they all just gravitated towards the technology, so it's them, and the Minecraft thing is what they were interested in, and then more people became interested so it's just knowing each class. It's just where, it's just what they like and it's just what they do.
>> You know, it was so neat because, you know, the group over there who was elbow-to-elbow, but there interacting, virtually, in this environment, but also they're talking, they're talking back and forth, they're agreeing on what does one block represent, what is this? And they're, then they're making adjustments in there, but it was so neat to kind of see that happen.
>> Here, usually, if the Wi-Fi is working properly, they log on, they're in the same world in Minecraft, as in, I'm running around and I can see this person running around. They couldn't get on in the same spot, so they each had a different world, but they were still beside each other collaborating.
>> And I think that is, is defining a new way of collaboration, as well. When they were over there, I noticed the same thing, I'm thinking, they're all just on their own devices, and the next thing, oh no, they're really not, they're interacting through that, and, like I said, they're talking. So I thought that is something that you have to be able to see, this new definition.
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The Benefits of Technology-Infused Learning

>> I've done a lot of work getting the iPads into this school, and as this, as BYOD's come here, I've done a lot of work on it, as a committee member and as someone who's learnt a lot about it. So I knew the potential, both for math and for any other subject. For me, it's recognizing whether technology helps, helps the learning, doesn't get in the way and is somewhat efficient, this group of grade 6's has, they showed their love of Minecraft early in the year, and, which is the way that some of them, a bunch of them chose to do this math, because I was initially worried that they weren't going to find a way to do it and it would be a waste of time. But they did again. They proved me wrong. And I think that's one thing about the technology.
>> Some of the key benefits to technology-infused learning include a change in the teacher and student role. So, teacher can very smoothly become a learner along with the students. And we've seen this time and again as new technologies are brought into the room, that the teacher might say, um, I need some help thinking about how to use this, does anybody want to give me [laughing] some help or did somebody else want to try and show me something, and it just kind of recalibrates things in the classroom a little bit differently, so it's a genuine, sort of authentic way that the teacher is a learner alongside their students.
>> All of them were really doing a good job of coming up with, they were coming up with the, you know, unitizing, which is so important in proportional reasoning, and they, they kind of had these, these, the blocks, and they knew, okay, this one represents this and this, and so they all got to a point where they could represent the different cup sizes, in, in the environment. But then, okay, now how do the prices fit in?
^M00:01:44
[Silence]
^M00:01:49
>> Technology-infused learning can increase the complexity of tasks, even if we think back to calculator use, for example. That might be true of graph and calculators. Maybe I'm spending more time analyzing the graph rather than making the graph, which is a key sort of higher learning or higher-order thinking way of working.
>> Math became a lot more interesting, and it's a lot, it's a lot better way than to do it than just pencil and paper. Because, like, you get to use a better physical representation of it. Like on paper, you would just make a drawing, but you wouldn't really know accurate it is. But on Minecraft, you can make, you can make it more exact, because [inaudible] like the exact same. So it's a lot easier that way.
>> Minecraft can help with perimeter in a bunch of ways. Because say you've got to build with this giant perimeter, and you can, and it would take a while to make on paper. You can go and use Minecraft, and you can make a box, say worth times 10, and make the structure, and you can make it so that you could measure it from, and you could

give it a bird's eye view. And you could put, put signs down just to explain everything, kind of give it a visual, a better visual, to make it look neater and better done.
>> It's easier, like in Minecraft for geometry, for showing your work and it's a lot easier. So, if you're making a tank that's, say, 100 centimetres tall and 10 centimetres wide, like, each block could be 1 centimetre long. So you can show your work and it, the tank would be this many blocks high in Minecraft and then same amount wide.
>> It gives you a better visual of, of the whole.
>> If you have, if you just have it on the paper, you can't really see it from different angles, so it's hard to judge how many squares are inside. In Minecraft, you can go around it and see.
^M00:03:37
>> The other type of app that we saw was screen-capture type apps, and, in that case, they were simply drawing their thinking on the screen, whether it was pictures or words for their calculations. None of them got to recording, it would have been too loud for that anyway, but if they wanted to, they could record their voices in those same apps.
^E00:03:56

The Challenges of Technology

>> There are some equity issues with technology. Lack of access is a key issue here around the cost of, the affordability or cost of technologies, and availability in schools seems to be somewhat uneven at this point. What are we going to do with that, to level the playing field and engage our students who do not have as much access, as much as possible. The thing about bring your own device to school, is even there, there are pedagogical decisions to be making around shared technology. If some students are bringing handhelds, how can we have pairs work? Small group work? Where the technology is there to support the learning, but there's some collaboration occurring simultaneously, and that tends to be one way to really think about levelling out access.

>> I guess it's new and novel as compared to the chart paper. But new and novel can be its challenge, so students themselves need, you know, more practice and time with their devices to think about how to, to show their thinking. So, a drawback is it can take a lot more time. But I think building the technology into the culture of the classroom definitely helps. Just where it hinders is if, if technology is just a one-time thing here and there, then not only will the tasks take more time, they might see it as just a shiny toy. So our ultimate goal is its just one thing that supports math.

^E00:01:39