Project INSPIRE Course 6 Lesson 5 - Part 1

SPEAKER: Welcome to Nemeth Code Symbols Used in High School and Strategies for Supporting STEM Learning. We're in Lesson 5 and we're going to talk about materials and strategies for high school. The slide show has the objectives. You are going to be able to understand how best to support students in high school math classes.

Specifically, we're going to talk about algebra and geometry. You're going to understand what tools and materials can be used to support our high school students in mathematics learning. And you're going to understand concepts and tactile graphics which, of course, can be challenging for our students who are braille readers. So we really want to give you some ideas.

Slide 3 is important information if you haven't been with us for some of our previous courses because our courses build on each other. So if you're not familiar with tools such as the Tactile Algebra Tiles, Graphic Aids for Mathematics, Tactile Compass, and Geometro sets, I encourage you to go to our Course 4, Lesson 3 and our Course 5, Lesson 4 where we really describe these tools and how they're used at the middle school level. And that way, you'll get that beginning information about algebra and geometry concepts. So if you need to pause and go do that, it's OK. We'll still be here.

Slide 4. Let's talk about supporting our high school students. Now, just with all of our other students, pre-teaching is so important. The more our students are ready and know how to use materials and manipulatives before they're using them in the general education classroom, the more successful they have the potential to be. Things move fast in those general education classrooms, especially at the high school level. So part of our responsibility as vision professionals is to do that pre-teaching.

Now, we really need to think about requiring our students to show what they are thinking and not just verbalize what they are thinking. So especially when they're learning a new concept, folks, they can't do it all in their head. We really want to make sure that they're showing us what they know.

So you want to also think about the fact that you are not going to be going to college or the workforce with this person at the high school level. Our students need to be advocating for themselves. That might involve some role playing with you, some discussion of how they can approach a situation. But they need to be doing the advocating with that math teacher or that science teacher.

You want to ensure that your students have easy access to their own instructional materials. Now, I know we're moving classes a lot in high school, so they may need to have bags in their locker. They may need to have a place in their backpack where they keep some tasks and materials ready to go. They may need in that particular classroom a corner where they have a shelf on the bookcase where they can keep their materials. But they need to have material access.

And they also absolutely must have a braille copy of the same notes that their classmates are using. And so if they don't have those notes in braille, then they need to be actively involved in taking those notes, so they can refer back to them. So they are not just passively hanging out. They need to be reading those notes that have been prepared for them ahead of time or taking their own notes.

Slide 5-- we want to talk about some methods. So I know by the time we get to high school-- and in today's day and age, tech all the way. We are big proponents of tech, here at Project INSPIRE. However, the braillewriter is the pen and paper that our students use. And they're -- especially in the learning phase -- our students need to be able to manipulate and think through the math process. And therefore, the braillewriter is the tool of choice to be doing that manipulating and thinking.

When it comes to submitting answers to the general ed teacher, absolutely they can do their work on the braillewriter and they can submit electronically, especially when there aren't a lot of steps involved in solving a problem. When things are a little more complicated, we might initially have them do that work on their braillewriter.

Then we can interline their work so that the teacher knows what they have written. So it's going to be a process that's going to flow between you as the vision professional, the student, and that general ed math teacher as each new concept is introduced in the curriculum.

All right, slide 6. Algebra-- one of my favorite topics when I was in high school. So here in algebra, we're learning things like simplifying expressions, solving equations, graphing, representations, such as ordered pairs, tables, equations, graphs. Lots of fun stuff going on in algebra, but a lot of this can be very visual in nature. So let's talk about what we can do for our students.

Slide 7 reminds us of those must-haves for algebra. As I've already said, the braillewriter needs to be part of the student's repertoire. They're going to need tools for graphing and have those equations. You're going to have to graph them. So they might use a draftsman or some other drawing tool as well because they're going to be doing a lot of demonstrating that thinking and knowledge piece.

Also at this level, are students going to have a scientific or graphing calculator? It's going to be important for you as the vision professional to check in with that math teacher to see, what are the other students using? And then get your student a scientific or graphing calculator that talks, that has the same functions. And in Lesson 6 in this course, we're going to be talking about some of the different calculator options used by our students.

Let's go on to slide 8, one of my favorite tools, the Algebra Tiles. Now, we introduce these again in the middle school level. So I encourage you to go back if you're not familiar with them and review our previous courses to check these out. But at the high school level, our students are starting to move away from actually using these manipulatives and focusing more on those abstract concepts, such as manipulating expressions and equations. However, when we have a student who's really finding this kind of content challenging, then it's a good idea to pull out the Algebra Tiles and help them connect that abstract concept with something physical that they can manipulate.

So I want to go to the video. We're going to have a demonstration of three equations to demonstrate adding, subtracting, and factoring.

[Video] We are going to look at three problems related to Algebra Tiles. The first is adding polynomials. And Algebra Tiles come in three different sizes: large squares, rectangles, and small squares. The large squares represent x squared. The rectangles represent x's. And the small squares represent 1s. Also, there is a solid line around positives and a dotted line for negatives.

For this problem, we're going to do x squared, plus 3x, minus 2. So we have a single positive. X squared, three positive x's, and two negative 1s. We also are going to add negative 2x squared, minus 5x, plus 4. So I have two of the negative x squareds, five of the negative x's, and four of the positive 1s.

To add these, I just look for 0 pairs, tiles that are the same size and shape, and also, one positive and one negative. So I have a positive x squared and a negative x squared that I will take off. I also have a positive and a negative x, another positive and negative x. These are my rectangles. Another positive and negative x. And then I have a negative 1 and a positive 1, another negative 1 and a positive 1. And then I just look at what I have left, because that's all of my 0 pairs. I have a negative x squared, the large squares, a negative 2x, and a positive 2. So negative x squared, minus 2x, plus 2.

The next problem we're going to look at is a subtraction problem. For the subtraction problem, I'm starting out in parentheses: (5 - 4x). So I have five 1s that have a solid line around them, the small squares, minus 4x. So I have four of the negative x's that are dotted. Those are my rectangles.

And now, I need to subtract a positive 2x. But I don't have any positive 2x's to take away. So I'm going to add in some 0 pairs: a negative and a positive rectangle. One that's solid and one that's dotted for each of those pairs. And now, I can subtract off a positive 2x.

I also need to subtract off a negative 1, but I only have positive 1s. So I'm going to put in a 0 pair, a positive and a negative of the small squares. Now, I can subtract off that negative 1, and I look at what I have left. So I have 1, 2, 3, 4, 5, 6 positive 1s, so 6, and 6 of the negative x's, those rectangles, so that I have 6 - 6x.

And the last one we're going to do is a factoring one. For this factoring one, I'm going to start with the polynomial x squared, so one of the large squares with the solid line, plus 5x, five of the rectangles, the x's with a solid line, and six of the 1s. Those are the small squares with the solid line.

And what I'm going to do is arrange these somehow into a rectangle. So I'm going to start with my x squared, place those x's, some to the right and some below. And then I'm going to try to fill in with the 1s.

Now, I tried placing one tile on the right and four tiles underneath. But then I could only fill in with four of the small squares. And I have six of them.

So now, I'm going to move one of those x's to the right. So now, I have two on the right and three below and I try filling those in. And sure enough, now it fills in to make a nice, neat square. So then the answer is how far across and how far down. And the long ones are the x's. And the short are the 1s.

So we have x + 2 going across. Because I have the long tile and two of the short tiles, so x + 2. And then going down the other direction, I have x + 3. So that would be in parentheses: (x + 2) and the other parentheses: (x + 3). And those are multiplied, so they're just placed next to each other. [End of video demonstration]

So I hope you enjoyed that explanation of how to use the Algebra Tiles, especially with factoring, which I know, for me, is a great explanation.

Let's go on to slide 9 and let's talk about solving equations on the braillewriter. The reason we really want our students to use the braillewriter in solving equations is that way they can keep track of the steps. You're only seeing one line of braille on a notetaker. So it's difficult to keep track of what you're doing and we can't always keep everything in our head. And especially when our students are learning, they really need to show their thinking process. So I have 3x - 7 = 11. My student braille is the problem, then they need to add 7 to both sides. So you'll see that the plus 7 is lined up under the minus 7 on the left side of the equation. And the plus 7 is lined up under the 11 on the right side of the equation.

And then the student basically works through it. So I'm going to bring down my 3x on the left side. I'm going to bring down my 18 on the right side. I'm going to divide by 3 on the next line on both the left and the right side. And then I get my answer of x equals 6.

Now, I know you're looking at this, and you're thinking, wow, everything is perfectly aligned in the braille. Folks, when you're brailling it out, yes, we want everything to be perfectly aligned. Your student needs to see an accurate example. But if your student-- everything doesn't line up -- as long as they have the concept, and they're following along with what they did, and they have the steps, it's OK if their x's and their equal signs don't line up exactly. We're really interested in making sure that they understand the concepts and the thinking-through process to solve the problem.

Let's go on to slide 10 and talk about data tables from a student's perspective. Now, the easiest way for a student to make a data table is going to be to use their Perkins braillewriter. Because unlike a refreshable braille display or a braille notetaker, the student is going to be able to see the whole data table if they produce it on their Perkins braillewriter, rather than line by line. And with data tables, students are looking for patterns in the data.

As far as your student creating their data tables, allow them the flexibility that they need to do what works best for them. Their transcriber may produce the data table differently than they do, and that's OK.

Now, data tables may have some features that your student wants to include and may not. For example, they might want to use a top box line-- dots 2-3-5-6 and a bottom dot box line-- dots 1-2-4-5. They might want to use separation lines, so that the first cell is dot 5 and then dots 2-5, and so on. We really would like to encourage them to use the English letter indicator with their x and their y because we don't want them to be thinking "it" and "you", which would be what they would be seeing if there isn't an English letter indicator.

On slide 11, we're going to look at data tables, but more from the perspective of a student and what they should be looking at when they're trying to figure out which type of function different tables represent. So our first type is linear. The table is negative 2, 5, negative 1, 3, 01, 1, negative 1, and 2, negative 3. But the student really should focus on the y's, that second column, which is 5, 3, 1, negative 1, and negative 3. Notice that those numbers keep going down by 2s. 5 to 3 is down 2. 3 to 1 is down 2, and so forth. That is linear. That's going down by the same amount or up by the same amount. That represents a linear function.

Our second is quadratic. Our points are (-2, 3), (-1, 0), (0, -1), (1, 0), and (2, 3). So looking at those y values, they are 3, 0, negative 1, 0, 3. Notice the repetition. It starts out with 3, 0. And it ends with 0, 3. So we have kind of a symmetry going on. In that case, it represents a quadratic function.

And our last example is exponential. Our points are (-2, 1), (-1, 3), (0, 9), (1, 27) and (2, 81). If we look down the y values this time in the table, the values are 1, 3, 9, 27, and 81. In this case, those numbers are getting really big, really fast. And that represents an exponential function, those y values increasing or decreasing at a large rate.

Let's go on to slide 12, and let's talk about graphing. Because this, honestly, is a big part of what we do in algebra at the high school level. When we first start having students do graphing, they're going to be doing it by hand. And then later, they're going to move on to electronic tools.

But just like everything else, they've got to be able to do the basics before they move on to the more complex. So we can get back to the basics: pushpins on a corkboard. You can have the student use the APH Graph Benders. They're wonderful. Brass fasteners, sticky foam sheets, things from Exceptional Teaching aides. They have all different kinds of supplies. So check out our resource list for what we have from them and from Maxi-Aids. We also have materials you can get from the craft store.

So I have two photos as an example. One is the APH Graphic Aid where our student is using pushpins and rubber bands to do some graphing. I want to point out that we have the pushpins up at the top right so that the student can locate them. Our second example photo is a picture of using graph paper and foam dots with the APH Graph Benders for our x and our y-axis. Pretty is not what we're after here, folks. Functionality is what we are after here when our students are doing graphing.

On slide 13, we're really trying to focus on helping students to make sense of information displayed in different ways. In our first example in the upper left, we have points. The x's are different, so it is a function. Our points are (1,1), (2,3), (3,2), and (4,0). But in this, we really want the students to just focus on those x values-- the 1, 2, 3, and 4. Notice they're all different. If any of those x's repeated, then it would not be a function.

In the lower left, we have a table. The table includes the points (1, -2), (1, 3), (2, 5), and (3, 5). In this case, those first two points are (1, -2), and (1, 3). Notice those have the same x values. We want those students to focus on that first column, that 1, 1, 2, 3 and the fact that one repeats, which makes it not a function. If all four of those x's were different, then it would be a function.

In this upper right, we have a mapping. Now, this is really going to be a tactile graphic. So we need the students to be able to track those arrows from left to right. So that first arrow moves. We've got two circles. The left circle is for the x's. The right circle is for the y's. So we're going from an x of negative 1 in the left circle to the number 2 in the right circle. That's point (-1, 2). The next arrow goes from 0 on the left to 6 on the right. And the next arrow goes from 1 on the left to 4 on the right.

And the last arrow goes from 2 in the left circle to 6 in the right circle. Now, in this case, we want to really focus again on those x values. So in this case, each of those x values -- negative 1, 0, 1, and 2 -- only have one arrow going from them. We don't care that there's two arrows going to the 6.

We want to focus on those x values. So there's only one arrow coming from each of those, which makes it a function. If there were two arrows, let's say, coming from the one on the left circle, over to two different y's on the right circle, then it would not be a function.

And the last one is probably the most complex, and that is from a graph perspective. There's something called the Vertical Line Test. In this case, I have a graph that curves starting low, going up, and then coming back down. This is a function because any vertical line I draw through that graph is only going to hit the graph one time.

The right graph, though, starts in the upper right. And then it curves down into the left and then back down into the right. So you've got kind of a sideways U-shape. But this one-- if I try to do any vertical line through that graph, it's going to touch the graph two times. That makes it not a function. We don't want those vertical lines to cross it twice, so they have to imagine those vertical lines. Or they could take out a ruler, or a pencil, or anything straight and see if it's going to cross that curve or line more than once.

On slide 14, we're going to be looking at graphing inequalities and curves. Now, as these become more complex and we have two graphs on one, we want to be sure to use two distinct types of pins or dots. So I'm using the Graphic Aid for Math. I have my pushpins in the upper left just stored there and some tacks in the upper right. So the student can easily, for one graph, grab the pushpins and for the other graph, grab the tacks.

Now, in this case, we're going to graph two inequalities. The first one is y is greater than or equal to x squared minus 3. So we're going to use the pushpins for this one. And the students are going to just plug in the numbers to get the points. So I'll start over at negative 3. Negative 3 squared is 9, minus 3 is 6. So that's going to be up 6. 1, 2, 3, 4, 5, 6.

Then I'm going to plug in negative 2. Negative 2 squared is 4, minus 3 is 1. So I'm going to place that just up at 1. Then at negative 1, negative 1 squared is 1, minus 3 is negative 2. 0. 0 squared is 0, minus 3 is negative 3. Then at 1, 1 squared is 1 minus 3, is negative 2. At 2, 2 squared is 4 minus 3, is 1. And then I'll plug in 3. 3 squared is-- 9 minus 3 is 6. 2, 3, 4, 5, 6.

So I just use the pushpins to make the points. Now, I'm going to use a rubber band and I find it easiest to just go ahead and place that around the points and then bring it back. And that makes a nice little curve for my graph. Now, in this case, it's greater than or equal to. Since it has an equals, that's a solid line. So the student can just put an S next to that particular graph to say this is solid.

All right. So now, the next one is y is less than 2x, plus 4. So I'm going to use the tacks for this one. First, I'm going to plug in negative 3. 2 x -3 = -6, plus 4 is negative 2. So we'll place that tack at negative 3, negative 2. All right. We'll grab another tack.

Now, I'm going to plug in negative 2. -2 x 2 = -4, plus 4 is going to be 0. Grab another tack. Plug in negative 1. 2 x -1 = -2, plus 4 is going to be 2. Grab another tack. 0. 2 x 0 = 0, plus 4 is going to be 4. And then we'll plug in 1. 2 x 1 = 2, plus 4 is 6.

And again, 2. 2 x 2 = 4, plus 4 is 8. Right 2 and up 8. And then 3. 2 x 3 = 6, plus 4 is 10. So remember, right 3, up 10. And then, similarly, I want to place a rubber band around those particular points to show that particular graph. So we have a nice connected line. I like to place them underneath those tacks. Now, this one is just less than, so it is dotted. There's no equals. So I'm going to place a "d" next to that. And now, I have to figure out where the shading is on this. And it's greater than the first graph, but less than the second graph. So it's going to be above the first one and below the second. So we can just place some a figure in there, saying this is the shaded area of my graph.

Now, we like the students to become independent here. So a para isn't just set copying this down onto a piece of paper. Instead, I just have a little set of index cards with problem numbers. So let's say this was problem 12. I could place problem 12 next to that, take a picture, and send it to the teacher.