# Webinar: Making math Accessible, one step at a time

Webinar from the DAISY Consortium held on April 22, 2020

Full details and other resources are available at:

<https://daisy.org/news-events/articles/making-math-accessible-w/>

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>> Richard: Hello everyone. And a very warm welcome to today’s webinar, Making math accessible, one step at a time. My name is Richard Orme from the DAISY Consortium and I am your host today. Before I hand over to our speakers, lets quickly cover some housekeeping information.

Today’s webinar is being recorded. We will post a link to the video on the webinar webpage in the next few days. Please revisit the content and share it with your colleagues. We will also post the slide deck and any resources that are provided to us by the webinar presenters.

Whilst the webinar is underway we invite your comments and questions. If you think of a question for the speakers at any point, please use the Q&A feature for this. We will cover as many as we can in the discussion section after the presentations.Live captioning is provided for today’s session. If you are using a computer then the recommended way to view these is with your web browser and using the link daisy.org/webinarCC. Alternatively you can click on the CC button in the Zoom controls.

And so let’s get this webinar started. I’m delighted to hand over to our panelists who will introduce themselves and share with us how to make math accessible, one step at a time.

>> Alex Cabral: All right. Hello, nice to meet everyone. My name is Alex Cabral. I'm a researcher with benetech on the diagram center. I would like to introduce my colleague Matt Nupen.

>> Matt Nupen: I'm the project manager for Mathshare. I'm a former math teacher and I have a child with special needs.

>> Abi James: I'm Abi James. I'm an accessibility consultant and researcher based in the UK. I work with the British Dyslexia Association. I have worked on a number of projects over the years to look at how Assistive Technology can help students with learning disabilities in math and science fields. So I'm going to start. We are going to hand over to Alex.

>> Alex Cabral: For a quick overview we are going to set the scene and learn how to support students with learning disabilities with showing work and developing number sense and teaching concepts in a multi modal format. This is directed to teachers and AT specialist. At the end we will have time for a Q&A.

>> Abi James: Thank you. So just to set the scene a bit. As somebody who has worked within the Assistive Technology field for nearly 20 years, math is often an overlooked area, but actually 1 in 5 children have specific disabilities around learning and processing and attention. That's the same in the U.S. and UK. These students are significantly more likely than their peers to repeat grade or drop out of school or not achieve that school leaving qualifications in mathematics. This impacts them into college. I've been involved with projects with engineering students with dyslexia who have problems with mathematics and reading content as well.

The reason they struggle with learning math is math requires lots of executive functioning skills. In particular it relies heavily on working memory, organizational skills, reading skills. There is a lot of reading in maths. It requires a lot of attention and focus and also particularly reliant on spatial and sequential processing skills. Often if people are anxious then that really affects their executive functioning and working memory and all these skills and there's a cycle with mathematics that people get anxious about doing math and that can lead to more problems as well. One of the difficulties with developing math concepts is relies on coexistence on number sense and understanding abstract parts. You have to have a good foundation in order to apply mathematic problems. Some of the research I've done in the UK when looking at Assistive Technology and how it can help learners is that accessible math if we can provide it in an accessible format it could support with decoding, problem solving and accuracy. One of the things we have been limited in is access to Assistive Technology and accessible formats as well. There's a cartoon on the screen of someone scratching their head and looking at an equation on the board. If I had an inaccessible document and I put that through Assistive Technology likelihood it would be read out HX equals X25 equals X minus 1. If we get good Assistive Technology and accessible content we can offer supports and it will read H of X equals X squared plus 5 over X minus 1. We are representing the math into something that makes sense. We can have a full description where it is H of X equals start fraction X power of 2 plus 5 all over X minus 1 end of fraction. We can provide a lot of support. I have been working in the Assistive Technology field for 20 years. I'm dyslexic. I started as a meteorologist and I was shocked about how little support there was about helping math. That has improved over the last 10 years but I'm excited to be talking with Matt Nupen and Alex with book share to hear about exciting things in this field. It feels we are starting to get the technology we need. I'm going to pass over to Matt.

>> Matt Nupen: So I want to reiterate that I worked as a science teacher for 12 years and I did a lot of math and always working with at risk teens who had unrecognized disabilities and were seen as being lazy or uninterested. One of the big issues is that educators are often unprepared to help students with learning disabilities succeed. So we are grouping them into parents and teachers and tutors who may not be aware of the different strategies to facilitate math learning. This is compounded by the fact that these disabilities are hard to diagnose early on. So people will view this as laziness or misbehavior. Going back to my experience as an educator, my room was filled with those students that were kicked out of school for misbehaving or were uninterested in education. By working with them and utilizing different tools, then we are able to really address what were the reasons why students were falling behind and what were those behaviors. So target those needs that the students have.

Showing your work is an incredibly part of learning skill. It's not just about assessment. It's about the learning process. The national council of teachers of mathematics advocates the promotion of thinking and reasoning. One way to improve student learning is through day to day formative assessments. So the issue is that most online math editors only allow students to submit the answers. Either it is simply a very simple fill in the blank or multiple choice and there's no opportunities for students to actually work through the problem or show their process. So this makes it difficult for students to track actual understanding of the problems and concepts that can lead to the frustration and decreased confidence that goes back to the issues of where it seems students are simply uninterested or unengaged or misbehaving.

So now I would like to share Mathshare is one of the tools we have been working on. It's freely available to all teachers and parents and students. Our big focus is about that step by step process of working through the problems. Mathshare isn't designed or meant to be a tool to teach you math. There's a wealth of amazing tools like that but they are missing the critical piece of allowing students to work step by step through it. It is an open source program. I'm going to go ahead and show you how students can work through this.

[Additional note: Matt “Showing Work” Mathshare demo: The intent is to demonstrate working through multiple steps in a math problem. Matt reads through the prompt (solve for x) and the first step of the math problem (2x plus 4 equals 10), adding steps on the left side of the screen, and explaining reasoning on the right. On the new step he clicks “start dictation” and it transcribes his speech for explaining his reasoning in plain text. ]

This is the Mathshare editor here. I've begun the problem here. We have it step up that the prompt is clear. Students have the instructions of solve for X and the problem of 2X is 4 equals 10. That's step 1.

Step 2 this one I have worked through as the student. This is one of my favorite things as a science teacher that's been crossed out. The explanation here. This is really what sets Mathshare apart from the other learning tools. The students have the dedicated step by step process. I'm going to simply finish this math problem here. Solving for X. I have to divide by 2. I'm going to subtract 2 from both sides. Over here I'm going to explain what I'm going to do. The last part I need is get X by itself. So I'm going to divide both sides by two. It's put in the speech text there. You can see all of the math tool pallet down here. Key board combinations for each. I can use the calculate tool which will cross that and do the math for us. I know this will end up being X. Now it cleaned it up. Mathshare looks at what you crossed out and gives you it cleaned up. They can then select finish. They can go back and edit through it.

This step by step process of 123. Having the cleanup steps, having a place to explain your work is something that is necessary part for students to develop their own mathematical thinking and problem-solving skills.

I'm going to now hand it off to Alex.

>> Alex Cabral: All right. Thanks Matt. So the second point of what can really help a lot of students is helping them develop number sense. This can be bolstered by working interactively on concepts. Using real world examples. I have a ruler here. One of the first things that a lot of teachers use is comparing things that students can either see or feel or touch that they are familiar with of seeing like this is about half the size of this object.

It can also be added by focusing on the process rather than the solution.

So one of our tools that I want to share with you is the PhET simulations which is done by the University of Colorado bolder. They have a number of simulations that are [inaudible] screen readers. I have V equals Ir. The I is larger, and the R is smallest. Let me update my share screen.

[Additional note: Alex PhET Demo: What is shown on the screen is V equals IR. Two bars on the right allow you to raise voltage (V) or resistance (R). As you raise the bar for voltage, the V and I in the equation become larger. It also shares a sound rising in pitch as the voltage increases. As it is decreased, the V and the R become smaller, along with a decreasing pitch. As the slider for R is increased, the R becomes bigger and the V and I become smaller.]

So in this demo what this is showing on the screen is D equals IR. It also shares a sound as the voltage increases. [Inaudible] you can also see the I decreasing as well. So this would be particularly helpful for older students who are still trying to grasp how algebraic equations affect each other. How they interact to create [inaudible].

So for the third point multi modal learning. This can also help students consolidate what they have learned. Not only adapting to students learning styles but showing concepts in multiple formats can help students understand and consolidate that information more effectively. This is for really important for students with learn disabilities. This can help support visual, auditory and tactile kinesthetic learning.

This one I have a story for one of the students I've been working with. She has a severe math anxiety and an undiagnosed learning disability. When faced with a complex problem she didn't know where to start. We present her with a sketch pad. She turned the math problem into an art problem. This is really to illustrate that students with these learning needs can really freeze when faced with a lot of these numbers and complex math problems. You can help them find patterns that they wouldn't find otherwise in art.

Some tools helpful in the classroom. The tool we used was Mathshare.

[Additional note: Alex “Multimodal” Mathshare Demo: This is the problem view within Mathshare. Step one: solve for x. Prompt: A car moves at a constant speed of 50 miles per hour. How long does it take the car to go 200 miles? The sketchpad is located beneath the math work. The demo shows the drawing of a red square representing a car on a gray line representing a road. Using a line tool, the line is bisected twice to become a number line in four equal pieces.

This should look familiar or if you get a chance to try it on your own there's actually a this is the problem view within Mathshare. It has step 1 solve for X... [Reading from PowerPoint]. There's a sketch pad beneath. This is particularly helpful for students with learning disabilities particularly for dyslexia and dyscalculia.

In this case there are a number of shapes you can use and changing line colors. Actually being able to draw the problem of a car going down the road. I'm drawing a gray line going out from a red box that is the car. Then I can divide this line in half, so I know this is two pieces. If I divide it in half again and again then that's 4. As a student using these pictures and drawings and other skills to actually think through the problem, it can really help understand in a different way.

So in this case it would be 4 hours because they are going 50 miles an hour, 200 miles. That's just a simple example.

Another option is Desmos. I really support as an accessible learning tool. They have interactive graphs which can be used for both sighted students or blind or visually impaired.

This is an example of one of the tools you can show with Desmos.

[Additional note: Alex Desmos Demo: The screen shows the tool Desmos, which is essentially an interactive graphing calculator. On the left of the screen is the problem x squared plus bX plus C, which is shown as a standard parabola at the origin. There are sliders which you can interact with. As you increase b the graph reacts accordingly. Rather than having students write out the graph every time or not understanding how these numbers are interacting, they can actually play with it. E.g. as I decrease b, the minimum of the parabola moves down and to the left following a parabolic shape. As I increase C, in x squared plus bX plus C, the parabola translates up and down the graph on the y axis. ]

So in this case I have X squared... [Reading from PowerPoint]. This is a stand parabolas. As you increase the graph accordingly. So rather than students graphing out every time or not understanding how the numbers interact, they can play with it and see this actually as I’m going down it's going in this weird pattern that's like a reverse parabolas. If I increase C then the parabolas translates up and down the graph. Up for positive and down for negative. This can help them understand the patterns which are really central to understanding math and STEM concepts.

So in conclusion, it's really important to support these students by using accessible math tools to help them show work, to help them develop number sense and use different modalities to solve problems. I will share resources and links to these tools. This is contact information for Abi, me and Matt. Now we lead into the Q&A.

>> Richard: Thank you so much for our presenters for leading us through that and dealing with the time so well. It's hard to keep demos to time. If you have questions that you'd like to ask, add them in the Q&A. Let's start with a question from Sara.

>> Do any of the tools we have been looking at today allow students to complete their math work vertically versing horizontally.

>> Matt Nupen: Yes. In Mathshare being able to work vertically we will build upon that ability. I want to show you how it works within Mathshare.

[Additional note: Working vertically. In the Mathshare editor, the math editor shows 2x plus 4 equals 10. Minus four is written below the four. Then both fours are crossed out and replaced with zero. To demonstrate the calculate tool, Matt uses the drop down tool to type minus four beneath the ten. Then highlights the ten minus four, clicks the calculate tool, and it updates to the number six.]

Instead of working horizontally we did vertically. So if I select that 10 it's what we call the stack below tool. I can say minus 4 and the calculate tool will also work. So you can use the calculate tool to automatically do that. We are working on but later on to expand that out to work vertically. For now this is how you can work vertically within Mathshare.

>> Richard: Wonderful. We have a question from [inaudible] from Jeff and Blind Educator. They would like clarification on the accessibility of Mathshare and maybe some of the other things you showed for screen reader users.

>> Alex Cabral: For Mathshare we are working with [inaudible] and his group to make it accessible for screen reader users. It's currently in process. The other two that I showed Desmos and PhET are both accessible via screen reader users. The link I shared was to PhET simulations. Those are accessible for NVDA and JAWS and voice over and safari. Desmos is not only has the sonofied graphs that are accessible via keyboards, as well as they have support for ninth braille.

>> Richard: Another still sticking with screen readers for a moment. Thinking about the use of charts that might be in a question. I don't think we saw this in the demo. What kind of possibilities might there be for a screen reader picking up charts in the question and something related to that? I didn't quite get the question but identify the use of color within a question. So what's the situation with access to charts? Is that within the scope of Mathshare?

>> Alex Cabral: Mathshare does not use charts so I can't speak to screen reader usage. Desmos does use charts and they do allow going into the charts to explore through them similar to how they allow for the exploration of the graphs themselves. PhET I believe does not use charts.

>> Richard: Thank you. Question from a couple of folks around the cost for using the different things you have shown today.

>> Alex Cabral: Yes. I should have led with that. That was part of my intent with sharing these programs is these are all free for teachers to use in classrooms. They are varying levels of open source. I believe Desmos is proprietary but still free.

>> Richard: Lots of questions on Mathshare. You shared a demo using voice input, Matt Nupen. Is there any support for handwritten math such as entered from an iPad or drawing method? This is a question from Steve.

>> Matt Nupen: Handwriting input is not supported. We have been focusing on some of the input tools we have here. It's something we have received requests for. So the more messages we receive the better. We don't have handwriting recognition input as something available right now or in the immediate future.

>> Richard: Abi, do you know from your knowledge of Assistive Technology are there ways of using a third-party tool to hand write which might enter into an area where you would normally be typing with a keyboard?

>> Abi James: There are some tools with handwriting built in. There are specific apps that have handwriting. I will try to dig out the links for them. It's built into the text equation tool as well. I have a caveat with math recognition because it's about 50/50. You have to be accurate that all the symbols are drawn accurately. We have lots of technology now to spell correct words, but equations are on a symbol basis. So it's not ideal for everybody but the technology is around.

>> Richard: So two related questions. One from Cathy and one from Caitlin. In Mathshare can you save your work or print it out after working through a problem. Caitlin asks what do the saved answers look like when you are done with your work?

>> Alex Cabral: I guess I can take that. For the saved answers you can save a link if you don't want to sign in or you have the option to sign in. It will save any of the problems that you have worked on on a dashboard to access them later.

>> Richard: Another question related to the whole once you have used Mathshare what can you do with it. A question here from Shannon which is how do you input this work into a Google doc to share online with teachers? How does that work?

>> Alex Cabral: This can be shared through LMS's very easy. That's why we went with links for sharing the answers. So you can share as Matt is demonstrating on the screen. There are options to share to Google classroom and Microsoft teams and we are building out more options as well.

>> Richard: Does that forgive me. Does that allow someone to put it into a Google doc or is that specific LMS Google classroom?

>> Alex Cabral: This is responding to the need to share with teachers. If they need to put into a Google doc they can include the link. If they needed to share with their teachers in another way in a different LMS or e mail, they can include the same link.

>> Matt Nupen: I want to add in real quick one of the big things is that the information could be copied and pasted into a Google doc but the structure to navigate through in an accessible way is lost. So that's why we focused on specifically users would have to come to Mathshare, but we tried to make the linking easy.

>> Richard: We have one from Steven. Is Mathshare able to take math ML or [inaudible]. Can this be exported to math ML and can we import math ML? So lots of interest about importing and exporting.

>> Alex Cabral: You can use math ML or Latec as an input format.

>> Richard: For outputting?

>> Alex Cabral: That's a good question. I would get back on that. There should be an easy way to export out.

>> Richard: We have a clarification question in here which is that Mathshare is up there on the banner as beater. Could you tell us about the status of Mathshare and whether it will move to production mode? How's that going?

>> Matt Nupen: It's ready to be used by teachers and students right now. We have a number of educators that have been using Mathshare during the school year. Right now our focus is on rolling out features focused on students with learning disabilities and then we will focus on rounding out the screen reader accessibility and then braille and switch access. So when we say beta, our focus is really because there's a number of features and functionality that we are adding in and we are focusing on the accessibility piece. So we do plan on being in beta for at least the next year but with that said, it is something that is ready to be used by within the school settings right now and has been.

>> Richard: And you have talked about students with specific learning disabilities. We have had quite a few questions about screen reader access. You have talked about the coming period of screen reader experience and polishing that. We have a question about what is the timeline for screen reader accessibility?

>> Matt Nupen: Our focus for that is going to be on the summer. So we are looking at early next school year when that fully reviewed rounded out screen reader accessibility will be launched. Early next school year.

>> Richard: Thank you for that. So sticking with accessibility before we switch a little bit. We have talked about screen reader technology, maybe JAWS and NVDA but with Mathshare or Desmos be compatible with read aloud like read and write for chrome or speak in Mac.

>> Matt Nupen: Yeah. We are aware of the different browser extensions for the text to speech read aloud. Because they work in different ways and not all students have them, we are going to be adding in text to speech within Mathshare. That's going to be launching this spring early summer where we will have text to speech buttons with individual steps as they are going along so a student can select a button that's in the my work section and it will read out the equation and the explanation as they are going along.

So we are going to be building that out so that it's integrated within Mathshare. Some of the read aloud browser extensions could be compatible with Mathshare. Not all of them are. Again, the way they interact with the page is different. Mathshare is different from your traditional basic text on a page. So I can't give promises on which ones Mathshare with will work with, but we will release built in text to speech.

>> Richard: Abi, you talked about the frustration with the lack of Assistive Technology that works well in math. I wondered what your thoughts of are having seen some of the things that our colleagues have shown here and hearing that read aloud is coming to Mathshare and what do you think still needs to be done?

>> Abi James: I think it's great innovations. I've seen early versions. It's great to see how far it's come along. It's interesting to see the questions this is a piece in the jigsaw. One of the things like browser extensions within chrome have limited impacts on math is the lack of support from math ML and that whole workflow through in creating math in a nice format to be read aloud and coming out in an accessible format as well.

I really liked the graphing tool as well to see that type of conceptual tool as well. We have to link that into classroom and Microsoft teams and one note to be able to share that with teachers. In the UK we find it's the children with special needs may have a laptop, but they have to go back to a non-tech solution to share with the teacher. So we don't have laptops in classrooms.

>> Richard: You talked about different countries there. We have a question from Yan which is are any of the resources that we have been showing today available in languages other than English? What do we know about that?

>> Alex Cabral: Currently Desmos is available in a number of different languages. I think at least 10. Mathshare is built so that we can expand to other languages. I believe we are looking at that in the next year. Currently it's primarily in English.

>> Abi James: Can I ask a follow up question of Alex, will your text to speech be in English or language options on that as well?

>> Alex Cabral: Currently in English but the way it's built out it will be scaled to other languages later. It's not being precluded.

>> Richard: We have a bunch of questions around what kind of levels of math education these tools relate to. We have questions around can it be used for college level physics or other college math. Could this resource be useful for a math major who is using higher level maths and other questions around the complexity. So maybe if we have a complex nested equation with nested equations and division lines and the ideas of tagging that and making that accessible. The question is around screen readers, but it talks to the level of math problems that these tools relate to and the level of education that you feel are most applicable. Could you speak to that please?

>> Matt Nupen: I will start with that one. Right now our focus is on the middle school upper elementary to high school focusing on algebra. The tools that we have built Mathshare off of have a lot more mathematical functions and abilities built off of it for calculus and statistics. That's something we are working on. We are working on a new tabbed interface for the math tools that will allow us to build in more math functions without increasing the cognitive load for users. For right now our focus is very much on basically middle school algebra, but that is on our road map of launching out math functions that is needed in higher grade levels. Some of them like long division, which is more elementary, but we do have that something we will be releasing for calculus and statistics and Greek alphabet. If there's functions that are more specific that people need, please let us know, but that is something we are going to be expanding out this spring and into next school year. So the input of how people will be using it is fantastic. But that is our plan to build out so it can be used beyond high school. We want the students using Mathshare now we want them to be able to continue using that platform in college.

>> Richard: Wonderful. One question starts with "sorry to be a dummy." Nobody is a dummy here. Asking about how the educator actually enters the problem into Mathshare. The related question from Alice is how would a student in a college course be able to use Mathshare to solve problems or demonstrate how they solved problems from a published textbook?

>> Alex Cabral: These are both excellent questions. That is not a dumb question at all. How a teacher enters the problems is demonstrating on the screen now. Hoover over problem set. It allows you to select the buttons for the problem set which relates to which grade levels this is applicable for. If you don't want students to be distracted you can leave certain tools off.

Then you go to an add new problem set. So you add the problem itself and the prompt.

So solve for X plus 3X plus 2... [Reading from PowerPoint].

So you can share this with the students.

>> Richard: What about the question about a student themselves using this to demonstrate their work from a published textbook or an assignment sent to them in a different way?

>> Alex Cabral: That's there's another program going on at benetech around accessible math called math detective. That's something we hope to link up to in the near future. So if there's a particularly on book share because we are very close with bookshare having links within the actual textbooks themselves. So if there's math in the textbook you can click that link and bring it to Mathshare to solve those problems. Barring that also it's possible to create extensions to actually get put in the math equations into Mathshare so you don't have to rewrite them. If you have a paper textbook a student can create their own problem sets and work through them and choose to share their answers or not.

>> Richard: Thank you. I love the way we are doing live demos in response to the questions coming in. You showed how a problem set can be created. A question from Kelly which is are students able to input problems and show their work of solving their problem using verbal input technology?

>> Alex Cabral: We have done work with voice input technology. For the prompts and working through the steps and the explanations for the steps those can be given verbally. However, giving the math itself, that's something that's much more of a significant problem. Abi, I wonder if you know of math dictation tools that are particularly well crafted that can interpret spoken math effectively.

>> Abi James: It's a complex problem because we don't consistently speak math in the same way.

>> Richard: Or even the word.

>> Abi James: I keep saying maths and not math. Even between British and American. How we say symbols is different. I'm sure with other English-speaking countries they are spoken differently. So there is a plug in for dragon naturally speaking. You have to do a lot of training with the individual to train them to speak the math correctly. So what we tend to see is things like individual symbol recognition. You can say square root of and that will be recognized but dictating advanced equation structures is proving a technological challenge at the moment.

>> Richard: Thank you for that. Another accessibility related question. We haven't touched on this before. Is there any work

>> Matt Nupen: There's another project called otter math. The goal is machine working to build up a large library of people speaking out the equations. People say the same equation many different ways. I will find the link and make sure to get that to you Richard to put in the resources. That's a project where that's the main focus to improve the speech recognition specifically for the math equations which our goal is to take that and put that into Mathshare where we have a robust model to understand what people are saying when they say the same equation in many different ways.

>> Richard: I know that organizations that create audio versions of math textbooks also have to work very hard to guide their narrators in how they read out the equations and expressions and so on. As Abi says, it's a complex area.

So the question is there any work being done or considered specifically for low vision users? Here we are thinking about magnifying the expressions and not having issues with the pixilation and you may speak to color contrast and personalization.

>> Alex Cabral: Yes, all of the work we are doing to make it more accessible for screen readers we are also looking at how to make it more accessible for low vision. So all of the color contrast would be WCAG AA AAA compliant. So keeping everything that works well with screen magnifiers. We are also adding in personalization settings because there's a lot of students who weren't necessarily diagnosed as low vision because they had other learning challenges. So teachers assume they didn't understand the concepts, but they really couldn't see the board. So personalization settings are beneficial in the program itself. So increase font size and contrast, use colors that are more effective. I notice a comment around CVI. That's one of the folks we are working with as well for things like having I believe red on black can be very effective. Or the others red and yellow can be helpful for students with low vision.

>> Richard: Thank you for that. We have a couple questions around some of the technology underneath Mathshare. So one is about the platform which is based on is it something that runs from a remote server or a local server? Does it require if you are using it on a tablet it is access through an app or browser? The last question in this space is checking is equation behind this?

>> Alex Cabral: I will take this one at a time. This is a web application. So access through the browser. Not a local version but through online. For the Equatio is not the engine behind it. We have worked with Equatio in the past doing similar work.

>> Richard: I think it was the clarification if someone is using the tablet they would use the browser like safari or chrome to complete their work.

>> Alex Cabral: Yes.

>> Richard: Great. So now a little bit around the scope of where Mathshare can be most appropriately used. One question from Amed is can Mathshare work on differential calculus. Sarah said she would love to see lower levels for early elementary to use a tool to show their work. Tackle both ends of that question.

>> Alex Cabral: Mat, would you like to speak to this one?

>> Matt Nupen: For the elementary one I was talking with a teacher in Minnesota that's been using Mathshare with one of our 4th grade students where his he has cerebral Palsy and she has been able to use it and share the link back to the teacher through Google class room. In the college level the main limitation there is simply a matter of whether the math functions are available or not at this time. If students need access to Greek symbols or integrals then Mathshare won't work right now. Those are things we are adding on later. If it's traditional algebraic and geometry then go for it. I've talked with some college students using it and elementary.

>> Richard: That mostly answers a question from blind educator which concepts can be used with Mathshare with algebra. You said some geometry and you didn't mention trigonometry. So geometry and trigonometry, which concepts there relate to Mathshare please.

>> Matt Nupen: I would say for trigonometry and geometry it will be hit or miss based on what you need. One of the struggles could be the side of are they able to do all of the drawing they need to do since both of those can involve a lot of graphing and being able to draw out different parts of the equations. You can do that in the sketch pad, but it might not completely meet the needs of the materials. So I would say no Mathshare isn't something you could use completely throughout geometry and trigonometry.

>> Richard: We are going to go into a topic that has come up from a number of folks which is around the challenge of creating accessible math resources for the student by the educator or other education professionals. Knowing math ML can be a really accessible format for people but people struggling to find tools to create that accessible material in the first place. So someone says Equatio comes close. I know it's not something we touched on too much in the scope of this webinar but what about the creation of accessible math resources? Someone uses the example of in times of COVID where they need to send out work sheets to students and they all need to be accessible. So Abi, Matt, Alex your comments on accessible math sheets?

>> Abi James: I think we are actually making quite good progress. I would start with Microsoft Word because that's what teachers know and are familiar with. The built-in math tools in Word are good to cover most equations and some of the inclusion tools can read aloud some of the basic math. We now have tools like the word to EPUB that you were talking about in the webinar last week that allows you to take the word and put in an EPUB. One of the parts we are missing is good EPUB readers that support math ML but if it's in that format we have that math ML that we can put into Mathshare. So it's about having the good editing tool to make it into some sort of coded math. So I would talk about starting with a word document. There are other tools that you can create but from experience teachers prefer word.

>> Richard: Anymore? We haven't addressed the question that anonymous attendee asks what about the screen reader user creating the math expressions themselves?

>> Alex Cabral: Yes. So to the first point around creating accessible math on the teacher side, one of the tools that has come out of the diagram center is math ML cloud which allows you to create math ML fairly easy. You can upload a file and hit the process button and it generates the mathML that can be read accessibly. Though to Abi's point it can be useful to have tools that are built into tools that teachers are already familiar with such as Microsoft Word. On the point of creating the math expressions themselves because Mathshare is built on mathML, as you type the questions you can use mathML or Latec but a lot of users type using standard math equations than the math that is generated sin mathML. So it can be explored in a similar way. So the issues that arise from that are more around how to make that more understandable. I think Abi talked on this earlier, but math is never said in the same way. So if you have complex equations or a lot of parenthesis or fractions understanding where those stop and end and how they are read aloud, keeping consistent with how you read exponents that's where it starts to get into the weeds a little bit. So that is one place that I've been looking for different tools that can do that most effectively.

>> Richard: We haven't gotten into the possibility of using math type from [inaudible]. I believe that has some screen reader support with it. I have a comment from Deana who is commenting to that. We still have some questions that are outstanding but that's always the way. We want to be respectful of the time. So whoever has the control of the screen maybe you would move to the wind-up slide and we will bring this to a close. If you still have questions that haven't been addressed, it's possible for you to reach out to the presenters today and you saw their contact details.

OK, we're coming to the end of this session. Thank you to everyone who joined us for today’s webinar. Abi, Alex and Matt, thank you for sharing your wonderful information and expertise.

Coming up in the next few weeks we have the following webinar topics: on April 29 we have telling your story creating better accessibility statements with spire. On May 6 we have publishing accessibility W3C standards and on May 13 we have easy access to books and articles through a smart speaker. If you would like to suggest a subject or if you have a webinar in you that you would like to propose, do please e mail us. In the meantime, thank you for your time today and you have a wonderful rest of your day. Goodbye.