3D Printing in STEM Education Video Transcript

-: Hello, my name is Ainsley Latour. I am the Co-founder of IDEA-STEM. And the purpose of this video, is to talk about our session on See3D at this conference.

So before I do that, I'm just gonna describe the visual on the screen. And that is, I am a female in my thirties, my pronouns are she/her.

Am sitting in my home office. There is a brown wall behind me with a whiteboard and a door. The white board has no markings on it and the door is white. I'm wearing a black jacket with a black blouse that has some lighter colored markings on it.

So students with vision loss have generally been discouraged from pursuing science or mathematics technology or engineering fields.

In this session, we have Caroline Karbowski. She's gonna introduce us to the concept of 3D printing to generate tactile models, which facilitates science education for students with vision loss and they can also support students whose preferred method of learning is kinesthetic and through touch and tactile means.

Caroline is the founder of a company called See3D which is a nonprofit organization that organizes 3D printing and distribution of all these models throughout the world.

In this session, Caroline introduces us to a variety of 3D models with applications of biology, art science, engineering, physics, and math.

Since both teachers and parents are able to make requests for the models, we're actually encouraging educators to consider the following.

Number one.

What are some ways that 3D models can facilitate learning in STEM for all students?

And the second thing that I'd like you to consider when you're watching the session is, that some of the ideas for how all students could benefit from these 3D models is that you could ask students to design a 3D model as an assessment either formative or summative.

You can ask the students to describe the 3D model and words to literacy activity. And sometimes the visual observation as you'll see in some of the other sessions as part of this conference is not enough. So what's available to a student visually from a drawing or painting, maybe more or less obvious in a 3D model. And so 3D models can reinforce the concepts students are learning through hearing and vision or other senses.

So if you have any questions about this session, you're welcome to contact myself individually or submit a comment or a question through the general conference email and we'll discuss it at the Q and A on Thursday.

And you're also welcome to follow See3D on social media and reach out to Caroline Karbowski on your own. She's more than happy to discuss any concerns or questions people may have.

So with that, I'm hoping that you enjoy the session and we're looking forward to your feedback. Thank you.

Hello, my name is Caroline Karbowski and I'm from Cincinnati, Ohio and I'm the founder of See3D, Inc. And my presentation is See3D-3D Printing in STEM for People Who Are Blind and Partially Sighted.

My email is info@see3d.org. That's i n f o @ symbol s e e the number 3 d dot org. Thanks so much to the University of Toronto, Scarborough and IDEA-STEM for inviting me to present at this conference.

I have an image on the right of a collage of 3D models including an alligator, United States maps showing the mountains, brain, Eiffel Tower, chicken footprints a boxer mimic from Dungeons and Dragons and even a fish in an enemy.

And this collage was done by See3D graphic designer, Patrick Smith.

The photos in this presentation are taken by me unless otherwise noted. I have an accessible version of this presentation and also a Google Doc of presentation links and resources relating to blindness, access technology in 3D printing.

And I also can provide that as a word document, just email me at info@see3d.org.

And if you want to find more references and information about research in 3D printing, you can check out my article called, See3D: 3D Printing for People Who Are Blind and the Journal of Science Education for Students with Disabilities.

I'm the founder and CEO of See3D, Inc which is a 501(c)(3) nonprofit. I'm a third year undergraduate studying biology and chemistry at The Ohio State University. My email is info@see3d.org. And you can connect with me on LinkedIn, just Caroline Karbowski.

And please message me just saying that you found you at the conference so I know who you are.

Overview.

See3D is a place where we have volunteers that connect on Slack to organize and print requests that we get from see3d.org. And on our website, you can request the model and also request to join to become a volunteer and anyone who's blind, partially sighted visually impaired, teachers of the blind and parents can request a model as long as you are over 18.

And so if you have a kid, just to have a teacher parent make the request, and we will work as hard as we can to provide that model for you and mail it free model. And we can mail internationally as well.

We can also just send you an STL file if you have your own printer. I have a photo of a screenshot of our website with a blue background in the See3D logo and the logo, the letters See3D and print underneath with the SIM rail for See3D and the print for 3D Printing for the Blind. Above the letters See3D is a black 3D printing extruder with a little bit of filament coming out of the tip and sneaking down to the top of the letter D as if the letters See3D are being 3D printed. And our website was mainly designed by Garrett Carder.

The Slack Workspace is a place where volunteers around the world can connect on different channels for model design, model printing, model descriptions, braille and accessible printing. We currently have 38 people who've joined. Just go to our website or the link in the slide notes to fill out a Google form to select which channels you'd like to join., and we'll send you a link.

Since 2017, we have distributed over 1,250 models to people in 17 States in the US, eight countries and 20 organizations. We've made connections in 17 countries and nine organizations have awarded us grant, funding or in-kind donations. We're also on AmazonSmile and PayPal. Initiatives.

Our recent initiative this summer was creating human anatomy and United States related model kits. Each kit comes with about five models and includes learning guides in either braille, large print or an electronic format. And these learning guides are walkthroughs and descriptions describing the model as you go through it.

So you start at one part of the model and move your way to the other side of the model and we'll give you fun facts about what is in that model.

So, and I also have some photos here. So one is the digestive system model. It has an esophagus, liver, stomach and intestines. And it's photographed right next to a tactile graphic showing the same thing. And so you can use models along with the tactile graphic to get the best of both worlds.

You can have the graphic for braille labels and the model to feel the three-dimensional structure.

There's also a photo of an inner ear showing the spiraling cochlea. And it's great with the model because there's a lot of overlapping loops. And in the tactile graphic, it might be kind of hard to

understand where all the loops are overlapping but if you pair it with the model, you can clearly see where all the individual loops are.

There's also a photo of a brainstem with braille labels made out of puffy paint because we tried to use clear labels but then since the models curve, the labels fell off. So we have a braille label for an eye for the midbrain, a P for ponds and an ED for medulla oblongata. And those braille labels correlate with the learning guides. And we also have written part of the learning guides to be able to understand the model if you didn't know braille. And we use descriptions on how the model feels to differentiate the different sections of the brainstem.

We also have initiative in working with accessible 3D printing. We work with the Model Club at the Ohio State School for the Blind known as OSSP.

There we work with students in person pre-COVID and now we're virtual doing OpenSCAD 3D design work which is accessible with braille displays and screen readers. And we're working on making it more accessible.

And students also with low vision use a lot of magnifiers to look at STL files on websites such as Thingiverse and load them into Polar3D which is an online slicer.

We also have taken printers and connected them with a Raspberry Pi to OctoPrint to make a printer that originally couldn't connect to the internet become WiFi enabled. And that allows us to take the printer and connect it with Polar3D, an online slicer or any other online programs which can then be used with a screen reader magnifier to make aspects of the printer accessible. Students also use visual interpreting apps to describe what is on their screen. And this is great for when they're designing models in OpenSCAD or if they're trying to orient a model before they print it.

One thing that's exciting is some people have also been using tactile graphics displays such as the graffiti. Neal McKenzie show me a video where he and Ken Perry are using the graffiti to feel models of two cubes on a computer. And that is designing the two cubes with OpenSCAD. So that way you can feel your model design in real time.

Collaborations.

We worked with HTW Berlin- University of Applied Sciences in Germany to do designs this summer. So in German, that university is Hochschule fur Technik und Wirtschaft (HTW) Berlin. Sofia Fernandez is the teacher and this summer we worked virtually with her students to design models.

One of the models is an adjustable bar graph. And this was originally used to show how COVID data had been changed over time. So we have a box with four circular holes in the top and four cylinders that go through the holes and the cylinder hoax out of the box depending like how much you push the cylinder in the hole. And they're not just on the cylinder. And you can twist the cylinder as you're putting in the hole and the notches will get caught on the box so it will

stay at the value you designate it to be and then you can rotate the cylinder and move it to change the height and show different data. There's also braille labels on the top of the box and you could then remove them and put like clear labels.

You could have 3D printed braille to have the cylinders represent different data. They also made a model showing the reproduction value or R value to show how the disease can spread and the number of people who were infected.

And this model still needs to be adjusted and so we have the models from Sofia and we're looking for the people to help make this model work to its full capacity. The general idea of the model right now is it is a box with pieces inside and then the outside is a casein. So you only feel what's on the outside. And on the outside, there are holes in a triangle shape and the top of the triangle has one dot, then the next of line of the triangle has two holes then four holes, eight holes and 16 holes.

And then the inside of the model has pieces with dots that are raised and so depending on how the inside is moved, different dots will poke up through the lid of the holes with the triangle, kind of like how a braille display has braille dots that poke up from the bottom and there's a stick that moves inside and you can adjust it to show different R values and different dots will poke up from the surface.

And it doesn't work fully yet, but that's a good start and we'd love for someone to edit this.

We also did a collaboration with the Newport Aquarium in Kentucky for their All-Accessible Night. And this was in collaboration with the Cincinnati Association for the Blind and Visually Impaired.

We made a toad model, whale shark, frog, seahorse, and fish, and then an anemone. And so that way, guys could feel some of the animals that couldn't be touched in real life.

We also provided a strong new models for the SciAccess Zenith Mentorship Program in Ohio with The Ohio State University. And this was an online afterschool camp hearing students with visual impairments, with mentors at The Ohio State University doing astronomy. And we provided 3D models. And this is for people all over the world. And some models we have are the Milky Way with the Nebula background, a black hole model with a story background and a collage with the Hubble Space Telescope, International Space Station in James Webb Space Telescope, and as if they are like line and space and underneath them is Mars with a model of the Curiosity rover, the earth and the moon.

And a lot of astronomy models can be found on Tactile Universe, NASA and A Touch of the Universe. And they have some links at the end where there's even more places where you can find a lot of astronomy related resources.

And this SciAccess Zenith Mentorship Program will be continuing. So check out See3D and SciAccess social media to find out when the next one will be.

We also made models for the National Federation of the Blind of Ohio Braille Enrichment for Literacy and Learning camp in 2019. We made DNA helices that were paired with tactile graphics of DNA so students could understand transcription and translation.

We also had sharks as one of the activities. And so we had tactile graphics of sharks, 3D models of different sharks and we also had real sharks that the students could touch and dissect.

Here are some more STEM models. We have Biochemistry models that we've done. So we've had DNA helices, one that's just the helix and another one have a photo of me and Dr. Sukhai where we're holding a helix where the nitrogenous bases, the phosphate backbone and the five carbon sugar are all separate pieces so you can build your helix.

There's also a protein model and chromosome models. And what's great about the chromosome models is they're different sizes.

We printed one set in blue and one set in white to show high contrast. And with the white ones, we put green puffy paint dots so you could feel the difference between the blue and the white ones.

And then identical pieces of the chromosome can then come apart and you can swap them with different colors to show crossing over. We've also done cellular biology models including a plant cell with organelles, a chloroplasts where about half of the model is smooth so you can feel just outside and the other half is like a cutaway where you can feel I liquids and grain of steps.

We've also done a phospholipid bi-layer with integral membrane proteins. And again, most of these models are available for free online on Thingiverse. So other people post to them and we are mainly printing them. But some of the models we have designed. Most of them (mumbles) animal models.

So one of them is the life cycle of a butterfly which is requested by the teacher of the visually impaired. It includes a leaf with eggs, there's also just a monarch egg, the luna caterpillar model, a Chrysalis model, and a butterfly that flaps so the wings move.

We also did an alligator with its mouth open, a zebra finch, and in the photo of the zebra finch model has a lake background and a fly model. And we found the insects have been really popular because they are really small and sometimes people might be afraid to touch the real insects, especially like flies or spiders and so 3D printing is a great way to access that information.

We've also done technology and engineering models. One of our volunteers, Jamie Barney designed an iPhone model that has interchangeable screens. So you print one piece that is just

the outside of the phone showing like the power and the home button and then there's four screens.

One is the voicemail screen, and it has the braille for the word voicemail and rectangles to represent each of the people who have left a voicemail and then at the bottom, there's raised icons to represent the buttons. It just like how they are in real life so like a star for favorites and then above the raised star is an F in braille for favorites.

And there's also on the home screen version, there's an array of four squares by five squares to represent the app icons and then underneath that there are four squares representing the apps that are available on all of your screens so things like mail, phone, so far you're texting. And we also have two dial screens. So one with braille numbers and one with raised print numbers so people can sometimes better understand what their screen layout looks like which can be useful for learning things like voiceover and also just interesting to learn what the phone layout looks like. And then you can design different screens for even more screens if you need them.

We also did a model of an airplane, a steam locomotive, it's like a train, as well as a pump jack which is used to pump oil. And the pump jack model also moves, which is really cool.

We've also done math models. And so one of them is a hyperbolic paraboloid. So that's like a Pringles chip. And this one actually is multi-colored because the printer ran out of filament. So we first had red filament and then we put purple filament in. So it looks really cool.

And we also did a model of a water droplet so as if you took a drop of water and dropped it on the surface and it makes burbles and it looks really cool.

And we also did a math collage. So Patrick made a math collage for someone that really likes math models and one of them has a Webby spring as well as platonic solids. And we have platonic solids that are solid and also ones that are just showing the outlines of the shape as well as a Klein model and other shapes with vertices in sight. And it's really quite exciting and intricate.

And what's nice about the math models is, especially for the solid ones, they're fairly basic to make. They don't require much sanding or post-processing. And they really allow students to have access materials at home. So maybe students have models at school but what would they use for their homework?

And since 3D printing is fairly inexpensive, we can print models and students can all have their own copy.

This is a page of STL file resources in the slide notes. All of these links are hyperlinks and on the Google Doc, I'm always adding more links.

And so we have, the main one is Thingiverse. There's also on Thingiverse, we've made a 3D printing collection. So there's a link for that where it's all of the models or most of the models we've been on Thingiverse in different categories, like biology, math, buildings.

And I've also provided a link for Jimmy Varney's Thingiverse page. He's designed a lot of things for See3D as well as MyMiniFactory, STLFinder, BTactile, Touch Mapper and with Touch Mapper, you can provide an address and it will make a 3D print file of that address. So things like showing roads and buildings.

There's also the NIH 3D Print Exchange, GrabCAD, NASA, Rovingbit Star Coins, Astro kit, Tactile Universe, Nonscriptum and the Chandra Observatory and Touch This Page.

So to conclude, I have my contact slide along with the See3D logo. My name is Caroline Karbowski, C A R O L I N E K A R B O W S K I. Website is http//:www.see3d.org, s e e 3 D dot org and email is info@see3d.org. Our Instagram is the @ symbol see.3d, Facebook is See3D, Twitter is at @See3DPrinting and LinkedIn is See3D, Inc.

Thanks again for the University of Toronto, Scarborough and IDEA-STEM for inviting me to present. And please contact me if you have any questions or if you'd like any links or slide notes.

Thank you.