Transcript of Strengthening Teacher Confidence and Student Achievement by Integrating STEM Across the Curriculum

Amy Moritz: Good morning. My name is Amy Moritz, Youth Development Coordinator with Pennsylvania's 21st Century Community Learning Center's Program at the Center for Schools and Communities. I will be your moderator for today.

Dr. Katherine Cumings, Assistant Professor at Virginia Commonwealth University in Richmond, will be our presenter for today. It's my pleasure to welcome you to the Strengthening Teacher Confidence and Student Achievement by Integrating STEM Across the Curriculum Webinar. Please note that today's webinar is scheduled for 90 minutes. You will stay with us for the duration as I trust you will find the information to be valuable.

It's now my pleasure to welcome Dr. Katherine Cumings Mansfield. Katherine Cumings Mansfield is an Assistant Professor at Virginia Commonwealth University in Richmond. She is a first-generation college graduate with over 20 years' experience teaching students of all ages from preschool to doctoral students. Katherine is passionate about supporting administrators, teachers, and staff caregivers, particularly as it relates to excellence and equity in providing gifted enrichment, implementing non-punitive discipline strategies, and integrating STEM instruction across the curriculum.

She enjoys conducting research and has over 50 publications and 75 presentations to date. Katherine is most proud of receiving the Cooper Foundation Award for Excellence in Teaching by the Nebraska Department of Education while a K-to-12 classroom teacher, and the Charles P. Ruch Award for Excellence in Teaching while a professor at VCU. At this point, I will turn the microphone over to Katherine.

Katherine Mansfield: Hi. Thanks so much, Amy. I'm so happy to be here. Thank you so much to all the participants who are here. I very much appreciate your time. I know how precious it is. Yes, I have been teaching for decades, but this is my first webinar. I will do my best to be a good teacher today on this venue.

What got me started on thinking about giving presentations on this topic was many of the principals that I work with on a daily basis are always expressing their concerns, obviously, for their school's standardized test scores. They also give me general worries about specific students they have that are not making good progress in the three Rs, reading, writing, arithmetic. I started to think about that, and really do some research into what are some fun ways that we can provide time for students to, I call it play because it's fun, science and engineering activities, and how that leads to all kinds of additional learnings across the curriculum.

We're going to explore things like the questions like, how can we take advantage of science and engineering activities to help children and youth in math, reading, and writing, and what are some ways to transfer practices from science and engineering instructions to other content areas? Okay, sorry about that.

Today, I'm going to give it to know you a little bit more. We're going to talk about some foundational STEM terms and concepts that are really important. We're going to explore some ways that we can integrate STEM in other content areas. I'll take a moment to highlight what makes engineering unique because that's especially hard for many teachers, including me. Then, we'll also share some ideas about using technology in your afterschool programs. Then, finally, at the end, we'll take some time for final questions, and go over some future steps.

Okay. What was interesting when I was doing my research on doing this presentation with you all today, I found several research reports that were published by the Center of Schools and Communities. One of their research briefs actually addresses the problem with STEM instruction, and how it often gets superficial treatment because classroom teachers just aren't comfortable with it, and out-of-school time folks are not comfortable with it either. Then, this, in turn, leads to some negative impacts on overall achievements. It's not just to those who aren't learning science or mathematics. It also trips us over into areas like reading and math.

Research has also shown that out-of-school time providers are very educated folks. They're very highly educated, but only about 16% have a STEM-related degree. I don't have a STEM-related degree. When I first started out with this, I was very uncomfortable. I wasn't sure what to do. I worked really hard to try to incorporate STEM into my programming when I was a first-grade teacher back in the day, back in the '80s when I started. I've talked to many teachers, and caregivers, and principals, and I say that more people would use it and create these kinds of activities if they had some extra training. That's why we're here today.

Okay. I'd like to know just a little bit more about you, about your background. Let's see if this group matches the research group with around 16% of folks having a STEM background. Go ahead and answer this poll, and we'll see where folks stand.

Amy Moritz: Okay, Katherine. The results have been trickling in here. It looks like 40% of the people that responded said they do not have a STEM-related background. 30% said yes. Well, I guess, the numbers are changing a little bit on me, but close enough. Then, about another 30% said sort of. I guess, something that's somewhat related.

Katherine Mansfield: Yeah, that's wonderful. I mean, this is actually really good news for the kids and youth in Pennsylvania because we have so many people who are familiar with STEM or have had a STEM either degree or work experience. That's fantastic. We have another poll. I'd also like to know a bit about your comfort level. I have a feeling it's going to coincide or relate to how much training you have in it, but I'd really like to know how confident you are and/or how timid you are.

Amy Moritz: Okay, responses are coming in. Katherine, you were pretty much right. It, sort of, mirrors the last poll. About 50% so far said that they are sort of comfortable. Then, about 20% or so said very confident or sort of timid. Again, the second answer has the most responses.

Katherine Mansfield: Oops. Somebody just popped with a scared to death. I'm really excited to see though that half of the folks are sort of comfortable because that's excellent. Even though folks might not have any training in it or any work experience, it sounds like there's folks that are ready to maybe try it and see what happens.

Okay, one more poll. I would love to know more a little bit about the students you work with, at the very least for ages or grades. I realized some of your programs are very diverse as far as who you serve and what level they're at. Since the poll only let us click one option, just go ahead, and select the one that most closely describes the population that you work with most often.

Amy Moritz: Actually, Katherine, Mike set it up so that people could choose more than one. I didn't even know that was a feature.

Katherine Mansfield: Great.

Amy Moritz: Those of you who are joining in here, feel free to select all that apply. Just to give you another second here. Okay, results are about to pop up. We have the majority of folks choosing grades three to five or six to eight. Then, about 30% with preschool to grade two, wow. Then, 20% with high school.

Katherine Mansfield: Wow. That looks like a pretty decent spread out there. I'm surprised though. I thought maybe it'd be a little bit heavier on the early grades, and wasn't sure how many would be involved at the high school level. It's heavy at grades three through eight with a portion of folks from the preschool to grade two, and a smaller portion in the high school.

A lot of my experiences are in the primary grades as far as classroom teaching, but I do have experience, as Amy said, in preschool and all the way through graduate school. I will do my best to share some examples today that will, hopefully, speak to all of you, at least, a little bit, and also give you an idea of how you could adapt these activities.

Earlier, I said we would learn some foundational STEM terms and concepts. Right here, I've split those up into three ... We call them three dimensions of STEM. Some of you folks might already be familiar with this because you've been immersed in the science standards and things like that. These dimensions are important for teaching and learning STEM and are foundational to help mathematicians, scientists, and engineers think, and how they do their job, and how they relate to each other.

Also, having an understanding of these dimensions opens our eyes to ways we can integrate these dimensions, or ways of thinking, and doing, and relating in other subject areas like reading and social studies. Another important reason for understanding these three dimensions is that they can be implemented in a variety of ways with diverse children and youth depending on what state their age is, or developmental levels, perhaps some of the kiddos you work with are identified learning disabled or have other special needs. All of these spheres of thinking can be adapted.

Now, we're going to talk about ways people with STEM jobs think, what are the specific skills they practice on a daily basis, what are the STEM concepts they engage in that could be integrated into our afterschool programs. On these three dimensions, the first is spheres of thinking. That's what at the top. You can see that. I like to refer to this as habits of mind. It's just easier for me to wrap my head around that, but [inaudible 00:11:15] STEM spheres of thinking, but I like to think of it as habits of mind.

The second important thing that we're going to talk about and have an understanding of are the practices that STEM folks engage in on a daily basis. These are the types of skills that scientists, mathematicians, engineers, computer designers all engage in, at least, in one state or another in their daily work.

Then, the third one over here is STEM crosscutting concepts. What that means is these are the concepts like cause and effect -- We'll talk more about those in a minute -- that come in to play across all STEM areas. What's wonderful about it is these are things that can be integrated with other content areas as well.

Let's take a look at these one at a time. We will start with STEM spheres of thinking. The first sphere of thinking or habit of mind is the idea of investigating. People, in general, are really naturally curious about the world. If they're anything like me, they love snooping around and scrutinizing everything from dead bugs to what happens when you mix paint colors. Folks in STEM professions have been exercising this way of thinking throughout their lives through their training, their careers, in their playtime. Stem folks advocate for parents, and teachers, and caregivers to harness that natural curiosity by giving kids opportunities to explore, investigate, and discover.

After students get some opportunities to snoop around and use their curiosity to ask questions about the world, it's time to guide them as a caregiver or teacher into the next STEM professionals' way of thinking, which is evaluating. They start with investigating. Then, we move to evaluating. For example, after playing with bubbles, learning about what they are, what their properties are, how they behave, and so on, we can further harness that curiosity and fun by having students test different soap products.

You can see there's a little science display over here, like a typical toaster session, but kids of all ages can do this. Little ones start to verbalize beginning research questions. They might not call them those, but we are saying, "What do you want to know?" or "What are your curiosities?" A student might say, "Well, I wonder which soap will help us produce the biggest bubbles," or "I wonder which soap will produce bubbles that float the longest." Then, of course, you're bringing in timing, and mathematics, and all of that with measurement.

Likewise, exploring the plant kingdom outdoors can lead us to guide students to evaluate what happens to plants when they don't get enough sunlight, or they get too much water. Depending on the age of developmental level of the student, you can create an evaluation guide, and you can see this youngster has some pictures and some sentences, using sentences to circle. Even younger kiddos or special education kiddos could maybe draw pictures or circle a picture of the element of the plant it's lacking, it needs more of. Older youth could develop a more sophisticated evaluation tool.

Then, over here, you see, we have some self-evaluations and peer evaluations that you can use. Then, these little girls up here are evaluating each other's work and helping each other. Again, depending on the age and developmental level, students can learn a version of how STEM professionals conduct what we call peer review.

For example, my doctoral students evaluate each other's work using a rubric that's almost exactly the same as most of the journals that they would publish in if they could. Similarly, depending on the age and developmental level of the youth, you can do similar activities. Students can also do some self-evaluation. This is a habit of mind that STEM professionals would like to see developed and nurtured in all students.

After exploration and evaluation, STEM professionals work to explain why things work the way they do, and how they need to change something to make it work better. Explaining how things work is especially a strong trait in scientists, and trying to figure out how to make things better is especially a strong trait in engineering professions. For example, after evaluating whether a plant needs water, sunlight, whatever, they have seen their evaluation tool, they decide what they need to do to solve a problem. The plant is getting in a plotter. They water it. Then, investigate it further over time, and evaluate future changes, and the cycle goes on.

Students could build things, here are some over here, with just found objects, try to build the tallest thing, and see which stands best, how wide is the bottom, how wide is the bottom compared to the height of it. That really prepares kids for later mathematics and helps them explain why things work the way they do. If it falls over, what do I need to do? For example, maybe this one stays up and this one fell down. The child said, "Okay. That means I have to maybe make my base wider, and then move the sticks," or "Maybe I need to make the sticks shorter."

Similarly, with building kites and things like that. I know that you probably have very tight budgets, so it's very important to find junk that you can use, and sticks, and things like that because students can build things out of pretty much anything. They enjoy that. Even paper airplanes, there's a lot of stuff online and books on how you can use paper airplanes to do engineering activities. Even playing on the playground, having the teacher wonder out loud with the kiddos, "Why is the teeter totter higher on one side, lower on the other? Why won't they be balanced even though we have got two people on each side?" or whatever. Test out solutions and explanations for that.

Let's just do a little bit of review. We've talked about the STEM's spheres of thinking or what I like to refer to as just habits of mind, what you want children or what I do for myself, what I need to get into habit of thinking about, and asking.

What might be an appropriate venue to use these three spheres of thinking, you might be asking. Let's just pick social studies, for example. Let's say with younger kids, you decide that maybe this month for social studies, you're going to do the unit on communities. It seems like everybody in kinder through third grade does something on communities. That might lead to using these three types of thinking. Or with older youth, you might feel that choosing a specific topic in a course like History or Government may lead to using these types of thinking or habits of mind.

For now, just for the sake of example, let's just say that for the month of March, you are going to engage students in the unit on your community, get to know your community and surrounding region better in your afterschool program. Now, imagine you and your students are in a discussion toward the end of the unit, and try to finish the sentence, "I used to think but now, I think blank." The goal of scientists and other STEM professions is to have a question or have a thought, or a belief, investigate it, evaluate it, and develop some explanations or solutions to change the thinking, or to change their understanding, or their level of knowledge about something.

In a second here, I would like you to use the text feature to share your sentence, and just hold on to that problem. If you are teaching your level of students a unit on communities, what might be an example of a question that they might ask, how they might approach, "I used to think blank, but, now, I think blank."

Amy Moritz: Katherine, just to clarify, they're writing this statement as if it was a student talking?

Katherine Mansfield: Yes.

Amy Moritz: Okay.

Katherine Mansfield: Thank you. Yeah, that's why I wanted to clarify level of student as well because, obviously, as they age, their questions and the comments would be more sophisticated. Just to get folks in the habit of hearing how students are moving from that investigating, to evaluating, to developing.

Amy Moritz: We'll just give them a minute here to chime in. Sometimes, it takes a few minutes to-

Katherine Mansfield: No problem.

Amy Moritz: Okay. Yvette, thank you for participating. She said, "I used to think police stations were scary, but, now, I think they're safe." That's great.

Katherine Mansfield: I love that. That's really great. Yeah, exactly. Those kinds of questions where that process is being used that STEM professionals would like everybody to be using, and harnessing, and developing. That's something that can be used in a different way.

Okay. It talks a bit about those three spheres of thinking or habits of mind. Then, what goes along with that are step practices or the things that folks do on a regular basis. Practices describe behaviors that scientists engage in as they investigate and build models, especially engineers like to build models and test those over and over again to solve a problem in society. Scientists really love making up theories about the natural world, how does it work, what types of changes happen when you manipulate it in such a way, this way, that way.

The practices also describe the key set of engineering practices or practices that engineers use. If you look down at the very, very bottom, there's two specific practices. They're developing using models, and constructing explanations, and designing solutions. What makes engineering a little bit different or a lot different than the other STEM professions is that they especially use developing and using models, and they especially try to design solutions to problems. Not that scientists never do that. Of course, not because these are concepts that go across all STEM.

The thing that is scary for teachers is, how do you teach engineering? What does that mean? What does an engineer do? Just knowing that all of these practices here, asking questions, defining problems, carrying out investigations, interpreting data, all of these things are done by all STEM professionals, but especially the bottom two are done by engineers. Finding ways to integrate that type of activity into your program is really helpful.

Really, obviously, I think many teachers and caregivers really already understand the importance of these types of activities or skills listed here. I mean, folks know how important it is to ask good questions, to help kids define problems, to carry out some sort of investigation. Obviously, analyzing and interpreting data is going to vary by sophistication depending on the student's grade or developmental level.

Kindergartners might make a large group graph, let's say, where they talk about their favorite thing, and they make a graph with pictures, and they paste the pictures on blocks, and they count them out to see who likes red the best, who likes yellow the best, or whatever. That's going to vary very differently for someone who's in high school who might be learning how to use a computer program that helps them develop more sophisticated statistics models.

Again, caregivers and teachers, they do this a lot. They are probably working on their computational thinking. Maybe in reading class, you're engaging in argument from evidence. How do you know what you know? What are the parts of the literature that are supporting your answer? Those types of skills. I have found that most people do not realize how closely a lot of the things that they're already doing are related to the STEM professions, and how important it is to emphasize these different skills or practices in a variety of disciplines. Find ways. Maybe you've never tried to develop bringing some model in social studies, but there are ways that you can do that.

Everything listed here are considered STEM practices. All are used in engineering, as I said, but we're going to talk a little bit more later on the uniqueness of engineering. For now, let's go back to the prior slide. Remember, we're pretending that for the month of March, you're going to engage students in a unit on your community and an afterschool program. Now, let's take that idea and grow it a bit more. Amy, can you read again the phrasing from our participant?

Amy Moritz: Sure. Actually, I did get another response. Is it Jacinda Williams? Jacinda, pretty name. Yvette wrote, "I used to think police stations were scary, but, now, I think they're safe." Jacinda, and I apologize if I'm saying that wrong, "I used to think that going to the doctor was always for bad health, but, now, I think it's also to find out good health."

Katherine Mansfield: That's excellent. That's excellent. Those are really good examples. Let's think about those two examples, and try to think about that would be at the end of the unit. Let's go back to where it'd be at the beginning of the unit. Maybe the students have chosen to study dinosaurs or whatever, but we're going to pretend that the students chose communities, or you did because that's something that is tested on one of your standardized test, or whatever.

Let's grow this a little bit more. First, think about what is the question about your community that students might not know the answer to. When you're introducing this to students depending on their level, you can be saying, "Well, what do you not know that you wish you know?" That's thinking like a scientist. What mysteries about your community are there that nobody ever talks about that you would really like explore and really would like to know the answer of?

I did this with high school students in tenth grade, and they wanted to explore why is it that the east side of Interstate 95, most African Americans live? On the west side of I95 is where most of the white kids live? Why is that? Why are the high schools on the east side more black? Why are the high schools on the west side more white? That was the main focus, the main question of that unit about their community.

I'll talk a little bit in a minute how we got to that, but go ahead. I'll give you a few minutes to just think about one question that you can imagine your students asking, something they don't know about their community, but they'd like to know.

Amy Moritz: Okay. It looks like we'll count on Jacinda today to be our participant. Thank you. "Why are so many people taking their children out of public schools and putting them in charter schools?"

Katherine Mansfield: Excellent question. That's fabulous. I love it. Okay. Let's think about that question. Let's go back to our practices. If this is our overall question, why are parents taking their kids out public schools and putting them into charter, how would we go about answering that question? What would we have to do in order to solve this question? Would we do any mathematics? Would we ask questions? Excuse me. How would we obtain and evaluate information? I'm just doing think time. Teachers do think in time and wait time so that you can just digest that a little bit, just be thinking.

Let's think about Jacinda's question. How would we find out or how would we guide students? Let's say we're working with eighth graders. How would an eighth grader or how would you guide an eighth grader to find out the answer to this question? What would you do? You might direct them to go to the library to find some books. You might direct them to do some research online. Using mathematics and computational thinking, perhaps they would show some graphs. Eighth graders are very capable of doing that, show some graphs of how the growth of charter schools has happened over time in the State of Pennsylvania, so on, and so forth.

Now, let's just look at it at another way. Let's just put together what we've talked about so far. We've learned about the spheres of thinking or habits of mind. Here they are down here. Investigating, evaluating, and developing explanations and solutions. Then, we learned about some of the practices, the things that STEM professionals do on a daily basis that we need to help students do more if they're not doing a lot of it. That would be over here.

While folks are investigating, first investigating, they're asking questions. They're observing. They're experimenting. They're measuring. In the case of charter schools, measurement would be obviously looking at how it's changed over time. Exactly, how many parents or families in your particular school district have left the public schools.

Then, over here, with evaluating, students would be arguing, and critiquing, and analyzing. I'm thinking about English classes, the language arts, how when they're reading a newspaper would they argue their evidence of how and why charter schools have become so popular. How would they critique the news that they're using? How would they go about analyzing the data that they do find?

Again, STEM professionals would say that engaging children in using these types of activities, investigating, as well as engaging students in activities that argue, critique, and analyze that that is helping students build important habits of mind, and develop specific practices that helps them, professionals, evaluate a situation. Again, these are things that a lot of folks are already doing with their students, but unless folks know that these are directly related to STEM, and they work to actually build these habits of mind, and practice these skills to strengthen them. If it's not done purposefully, if done haphazardly, then the chances are obviously that it's not going to change as far as teacher confidence, as well as student performance.

Then, we have the third box here. The final tier of thinking, developing explanations and solutions, and how you would do that. It's by using your imaginations, learning how to reason and think things out loud, being able to calculate. Over here, you might be gathering data. That's part of investigating. Then, you critique the data, "Is this worthy? Does it come from a good source?", that kind of thing. Then, how would I use that data? What will I calculate? How would that influence my predictions of why this question is either true or false, or exactly the reasoning why parents, for example, have left public schools?

If we really take a look at this slide, and see how it all goes together, if someone told you that you had to develop an afterschool program, this is your chart. You have to develop an afterschool program based on STEM theories and practices, and that's all they said. You might freak out. I mean, I might have freaked out, or, at least, be a little bit concerned or perplexed like, "What do you mean I have to develop an afterschool program based on STEM theories and practices?"

By looking at this model, you can see that STEM theories and practices can be cultivated in a variety of ways. Those ways can be really fun, and can be made appropriate to students depending on their grade level, and their developmental level.

Let's think about this for a minute. It's pretty easy to recognize that using the computer, or memorizing the times tables, doing experiments, that feels and sounds very STEMish. We recognize that as STEMish, or mathish, or whatever, but the STEM ways of thinking and ways of doing can be used across the curriculum. These so-called STEM theories and tools are actually essential to thinking critically in other subjects like in Writing and Social Studies.

That goes along with a lot of the research that's out there where folks are caught talking about soft skills and things like that. People who are hiring agents for different companies, they 're saying they really need people who know how to investigate, evaluate, and develop explanations and solutions. Even though they might not be a STEM career person, that's some of the skills that they're looking for. The ideas that most use these spheres of thinking, the more they'll be able to translate these habits of mind to other areas of study.

Within the STEM discipline, whether we're talking about biology, or chemistry, or algebra, or software design, there are some crosscutting concepts. What that means is these are concepts that are embedded in each of the STEM areas. Hopefully, the internal links on this page will work for us. Let's cross our fingers. Anyway, these are the concepts that the foundation for STEM, and how they cut across each because sometimes when you're in the math class or in the science class, sometimes, it's hard to tell what you're actually doing as far as the discipline.

I remember my own personal children coming home from chemistry class in the last couple of years, and saying, "We weren't doing science. We were doing math." It's like these things just go across each discipline, and their ways of linking the different domain of science. We've got patterns, similarity, and diversity, and so on. These concepts need to be made explicit for students. They provide an organizational schema for interrelating their knowledge that they're learning from science, and helping them in a coherent way, and build a scientifically-based view of the world.

Students in the science classroom would be talking together about patterns they see in the world, asking questions that deal with cause and effect, engaging in experiences that help them see that structure and function are closely linked. I'm sure you can imagine how some of these concepts can be transferred to other content areas.

Again, the whole bits of students who engage in a rich science environment will then go in to, let's say, their Social Studies classes, for example, will have more-developed mind that will recognize patterns and data, will look for similarities and differences, and cause and effect more deeply than they would otherwise.

Again, maybe our youth is asking questions about how the demographics of the United States has changed over time. Not only how has it changed, now looking at the data, but why that might be. They might discuss how these changes took place in terms of scale, proportion, and quantity. They might discuss different models that they can design to help communicate the data they find. Perhaps they design a color-coded map, or maybe a line graph that displays the statistics they find. Of course, that automatically, when you're studying social studies, is bringing in the habits of mind of a scientist, but also integrating math concepts as well. Let's look at patterns. Yay, it worked.

Let's take a brief moment to examine these models. Both of these models convey some sort of analysis of data. The first one is from the United Nations Department of Economic and Social Affairs about world populations. Maybe the unit of study is for fifth graders. You're studying how the world's populations have changed over time, or how does the United States differ from the rest of the world, or whatever. They find that over time, from 1950 to 2010 to 2050, now, look there's a prediction, how the population has changed over time, the median age? Then, they look for the patterns. There's a pattern. They both go up higher, and higher, and higher. Then, ask the question, why might that be?

I mean, you could talk for an entire day pretty much on just this model talking about the patterns, how are they similar, how are they different. Both of them go up. Every time, the United States number is higher than the world's number. Why would that be?

In the elementary classroom, we talk about social studies. In high school, obviously, they're taking classes like History, Sociology, Economics, and so on. Using these types of models and graphs, and things, and tables would, obviously, be more sophisticated, and probably more specific to whatever they're studying.

In the first model, the question might be something like, how has the median age in the United States changed over time? How does the US compare to the rest of the world? The guiding adult involved, again, say, "How are these numbers alike? How are they different? How might you explain the median age. Why it's continued to grow overtime? How might you explain why the median age in the United States is higher than the rest of the world regardless of the decade you look at?

Similarly, you could connect these STEM ways of thinking to Social Studies by guiding students with your questioning. For instance, over here, you could do something similar but you're talking about families. How is the diversity in families change over time as far as two parents, away marriages, cohabitating, single parent, no parent, and so on?

The models represented here are, obviously, science. They're obviously established. They're things that folks study in science. Little guys a lot of times study dinosaurs, the basics of that. As students age, they learn more and more details about human development, about evolution. Even in art classes, students study anatomy, so that they can draw and paint things more realistically. Notice the various ways that students can convey that similarity or difference.

Let's take this one for example. We've got a human arm. Here's a cat's. Other animals here. You can talk about where the parts are that are very similar, where are they different, and why that would be because some things fly, some things swim, some things dig, and so on. This, over here, shows a family tree of sorts. You could be talking about the faces of the dinosaur era, and how those changed over time, that kind of thing.

Then, these are models that are much more advanced, but they still show patterns of similarity, diversity. They also lend themselves to using technology in a really meaningful way especially for older students. This is an example of how older students might portray their data that they find. It's a good example for us students. We'll move from looking at patterns to starting to ask cause-and-effect questions.

For example, the first one, if you look at this here, here's Southeast Asia. Their language is developed pretty homogeneously here. Here in Africa, similarly got some differences here. Look at the Americas, North and South America. Look at all of these different languages. Students would find the data that shows what has happened with languages over time, but the question remains. Why are the languages in the Americas sectioned off into so many? Why do certain religious groups cluster together in certain areas of the United States? What else is going on historically? Who have played socially and economically that may have contributed to these patterns?

Again, studying patterns leads us to start to ask questions about cause and effect. If we look at this first one here, we have a very simple outline of a structure of a cause and effect essay. It looks very simple, but I'm telling you, I've used this even with college students because students have a really hard time writing. As time has passed, has gone, I'm finding more and more difficulty understanding students writing, even adults writing. I mean, I wouldn't have them this because it looks like pre schoolish or elementary schoolish, but I do make outlines similar to this to help the structure a cause and effect essay. This can be used in an English language arts classroom to strengthen writing skills obviously.

Here's the cause and effect template so to speak. You can really use this in all the content areas, Social Studies, Reading, whatever, because you can ask them read out of an Economics book, do an outline, how to make a strong piece of statement, how to make sure there's supporting evidence, that kind of thing.

I really like this model over here too. I mean, obviously, it's got a gazillion things on it. I would probably not keep this on my clipboard while I'm teaching, I literally, though, for different lessons, would take different cause-effect STEMS. I would put them on an index card. I would keep them on my clipboard. See, like this one here. "According to paragraph blank. When blank happens, what happens next?" That would literally help guide me in whatever I was teaching so that I was really hitting on those STEM questions.

I also like using graphic organizers. I use this when I taught first grade, when I taught junior high. I actually use them today with graduate students. Different types, of course, and sophistication, but definitely graphic organizers I have found really help strengthen my students' writing. It's absolutely amazing.

Not just strengthen their writing, but actually strengthen the content of what we're talking about. We might be in a research class, which is very science-based, but they have a really hard time expressing what they're learning because their writing skills are not so good. This type of model works really well.

Here's the main idea, some details as they're doing research. This is, obviously, for second and third grade or something like that. Then, over here, you got a more sophisticated model that tries to explain what the factors are that influence homelessness. If you know you're working on your community units, and all students says, "I've noticed that I'm in 10th grade now and I've noticed a lot of homeless people as a second grader, but I've noticed there are a lot more now that I'm 16 years old," or whatever. "I'm just curious to know why that so. What's causing this?"

They can make a diagram to show the different things like government policy, the housing market, taxing policies, whether people have disabilities, that sort of thing, how many folks have education, what their levels are, how much work experience they have, and so on. Students can start developing these models, not only to explain, but also to help with their writing if they're doing a research project, let's say.

These are just a few more that just really helped guide students to use real evidence. Not just opinions, but evidence from research. They might have a paper. The causes and effect of World War I. What were some long-term causes? What were some immediate causes? What were some immediate effects? What were some long-term effects?

After they do the research, and build their graphical organizer, then they could use that to incorporate into their writing. We got Social Studies. We've got Language Arts here. We've got the concept of cause and effect, which is STEM done similarly here. Really simple graphical organizers can go a long way.

We've done some patterns, similarity, and diversity, cause and effect. Now, we're going to look at scale, proportion, and quantity. We'll just go through this really quickly, so that we can move on to other things. I have found books work really, really well to teach this, especially with little guys. Also, obviously, battles. Again, I know budgets are tight. You might have to borrow some of the stuff from the science lab or another teacher.

Scale, proportion, and quantity can be used in Math, Science. It can also be used in music classes. In your afterschool program, you're teaching kids how to play a guitar or any other instrument. You can talk about how the musical scale, the way they're separated. It's by proportion based on size, that kind of thing. You've got heights here. Here's art. We've got Science, and Music, and Arts where you talk about proportion.

Similarly, we have some sySTEMs and sySTEMs models. Just a couple of things here to look at, ideas where, for younger kids, you could provide something like this on a paper or something to cut out and glue on. As you learn different sySTEMs, you label them together, or older kids in biology class, in ninth grade biology or whatever, could actually draw this themselves, and put in the different sySTEMs. Maybe even have a description on another paper. Maybe it's a poster, a research poster. Then, of course, over here auto sySTEMs. They're all color-coded to show people what they are.

It could be that in a type of class where students are learning automobile, how to put them together, how to take them apart, how to take care of them. I know a lot of high school kids take classes like this. Maybe they do a presentation in that class. Maybe it's more than just hands on. Maybe they do some research, and make dual presentation, and explain it to these sySTEMs that are in the model.

Here's some more simple ones. You've got your photosynthesis, what happens next. Again, with little kids, younger students, or students maybe who are learning disabled, you might have different things on cards. Maybe there's a little piece of Velcro under here, and students help you place the right thing on the cycle here or maybe they make it themselves. Similarly, for a little bit older kids, we produce food, we process it, we distribute it, access it, consume it. Then, there's ways. This can show their understanding of what happens first, last, and so on, but they can also talk about some of the solutions to problems like engineers would. What do we do with all of this waste and so on.

Energy and matter is one of the concepts that I struggled with. Thankfully, when I was a first-grade teacher, one of my colleagues really helped me understand this. This is just showing that energy and matter affect each other. Here's some more sophisticated one. The next one is what I really wanted to show you. My colleague helped me understand how something that we did every single day could be used as a springboard for discussion about energy and matter.

Our morning weather, it didn't take me much time to move beyond just having a student post to cloud or an umbrella on the calendar. We were able to talk about different phases using our daily weather routine. For example, if it were raining, we would discuss where the rain went after it rains. I could introduce new terms like evaporation, or we teach, or reinforce things I've already talked in Science class. I learned from some well-seasoned educators how I could integrate all of the little things that I did to help reteach what we were learning in more difficult areas.

Very quickly, structure and function. Here, again, a few models of different ability levels and developmental way of levels. I've seen things done in 3D like this. In one of my enrichment classes, we did that with fifth graders. Believe it or not, when I would say gifted and talented enrichment specialist, I worked with K through five. We did a yearlong unit on architecture, an entire year. A bunch of us got together though, and worked together to build our lessons, and build our activities, and so on. For an entire year, without getting bored once, us or the children, all students, whether they were five years old or 12 years old, we're able to really build their knowledge of Mathematics, Physics, Writing, Technology, all of those concepts. Plus, it was really, really fun.

Lastly, we got stability and change. Here's a little bit more for elementary schools. They're learning about high asynchrony -- sorry, I can't say that -- and high community stability. They're studying bugs. Maybe in literature, you learn something about stability and change, and, obviously, in social studies. Again, here's a human development type one where they develop. They grow as they age. Then, it deteriorates. Here's inflation, so the Economics class for older kids.

Okay. That was a lot to digest. Let's take a big deep breath here, and just think for a minute. How are we doing so far? Let's just take a quick poll, and you tell me how you're feeling.

Amy Moritz: Hey, so far, it looks like everybody who's voted is excited. That's good news.

Katherine Mansfield: Yay, that's exciting. Even if someone said they have no idea what was going on, that would be good feedback for me to, obviously, reteach, but we don't have time to do that. I would have to follow up with folks later. Well, thank you so much. I'm so excited that you're excited. This really helps me become a better teacher, and make things much more exciting for sure. Let's go ahead and move on. It looks like we have about 20 minutes. Time is going really, really fast.

This was put here just in case anybody was freaking out, and didn't know what was going on, and really have a specific question if they were lost or whatever. I'll just pause for a moment just in case someone needs some time, or just needs to let us know what you're thinking, like what you might need to help you get it, some more time, is it discussion with your teams, that sort of thing. I'll just give you a minute to see if anybody wants to share their ... Amy, we're still all very excited and ready to move on, you think?

Amy Moritz: I think so. Kara and I are sitting here joking that now that Jacinda is gone, our one participant.

Katherine Mansfield: Jacinda, come back. Come back.

Amy Moritz: I take it that's a good sign. People either don't have questions at this moment, or they'll send them later. Why don't you go ahead?

Katherine Mansfield: Goodness gracious. That's funny. Okay. Earlier, I said that we talked a little bit more about STEM or engineering. Most folks are scared to death. Then, I know I was. I integrated Science and Math, and those types of things first, and then I grew. I was really convinced that my C minus I got in Algebra in ninth grade, and my C minus in Geometry at 10th grade was this clear indicator of my nuttiness that I could never, ever help my students understand STEM concepts or think more like engineers in their thinking and doing because I was not confident that I could do that. It would be like the blind leading the blind.

Just to think through, you're a little bit like me, we're just going to talk about engineering just for a little bit here. How do we teach engineering to younger students? We have three things here, define, develop some solutions, and optimize. Although engineering design is similar to scientific inquiry, there are significant differences. For example, scientific inquiry, as we said before, involves forming a question that can be asked by investigation; while engineering design involves a little bit more defining a problem that can be solved through design. Excuse me.

In the early grades, engineering is introduced by helping children learn to recognize and describe a problem. It also works well to help young children think of "problems" as something that people want to change. A first grader might define a problem as there's a problem with people hitting other people, or there's a problem that I can't eat as much ice cream as I want, or whatever. Sometimes, the little ones really need a little bit more guidance. What is the problem here that needs a solution? What is something in this what we're talking about, something that we want to change?

Then, also, conveying to students, the young students how they can use different types of tools and materials to solve those problems. Teachers and caregivers can guide children to solve simple problems and use different ways to communicate possible solutions. For example, in the earlier years, they can draw pictures. Then, verbally explain how they would fix something.

Then, maybe through discussions, students and the adult guides can consider different solutions, and talk about those, and decide which ones would work best, especially if you're low on materials, and can't actually do the development. Then, redo, and then redo, and then redo until it's perfect. Again, thinking like an engineer means thinking through needs or goals that need to be met in which solutions might best meet those needs and goals.

With older students, same thing as far as what you do. You define, develop solutions, and optimize. As children develop and grow, their engineering capabilities also evolve, and become more complex. Just take a minute to read over these three same engineering areas real quick. You can see that when you're guiding youths to think like an engineer and engage in engineering practices that it's becoming more formalized, a more thought formalized problem solving.

For example, in addition to identifying and describing a problem, older kids can be guided to list details, specify details of each solution, each possible solution would need to address. For example, it has to stay under a certain amount of money. The solution can't cost more than $50,000, or whatever. The solution can't cause poisoning of the water, or whatever. That students can research and consider multiple solutions to these given problems. Then, after that, students can be provided with opportunities to actually make something, to test and revise it several times to get to the best possible solution.

I found on the internet a really great place to find some engineering activities that are really simple, but fun and actually really challenging. I mean, simple as far as just needing 20 sticks of spaghetti, a little bit of tape, some string, and a marshmallow. You have students work in teams of four people. I've used this with children. I've used it with adults. I give each of those groups 18 minutes. The team that builds the highest, tallest structure, freestanding, you can't touch it, using just those materials with the marshmallow in the top win some sort of prize.

It's funny because there's research has been done comparing children's abilities to apply and engineer compared with adults. Each and every time, the students do better than adults on virtually everything. In every innovation, of every measure of innovation, they do better. For example, kindergartners create taller and more interesting structures than graduate students do. The reason for this is that kids, they work more like real engineers.

They spend more time playing with the materials and prototyping, and just digging in, and starving, and revamping the structure until it's how they want it. They're doing a type of prototyping; where adults spend a vast amount of that 18 minutes just gabbing, planning. How are we going to do this? what should we do first? With almost no time to actually fix once they actually build it more, and to put that marshmallow on top. It tumbles over, and their time is out. Because they haven't had any time to prototype, they have not built a structure that stands.

The internet is a great place to find stuff, just do engineering activities for elementary school or teenagers or whatever. I'm all for cheap alternatives on tight budgets because that is real life, and always has been.

What about that T in STEM, technology? I don't know how to code. I took a couple of classes in it with really basic coding. I know that's a big thing right now. Not only making technology available for students, but helping them work on a code because that's a job that lends itself to a really good career, and something that corporations really need.

I want to know one thing first. Sorry, it's not really. How accessible is technology for you and your program? Do you have access to computers? What other types of technology might you have access to?

Amy Moritz: Actually, Katherine, while we're waiting for people to take the poll, I just thought I'd share. Yvette chimed in about the marshmallow challenge. She said they've tried it with different types of pasta for each group. Then, they can analyze why some of them were stronger than others. Just a neat little variation there.

You can use that challenge, by that way, to demonstrate all kinds of concepts. It can be used as a STEM activity. My colleague, Steph and I, do a lot of training, and we use it with adults to demonstrate a few other concepts as well. There's actually a website for the marshmallow challenge. There's even some slides you can download there. There's instructions. There's some pretty cool resources there. We'll go ahead and take a look at our poll.

Katherine Mansfield: Thank you for sharing that. I really like that idea. Yvette put that in?

Amy Moritz: Yeah, Yvette was sharing the variation.

Katherine Mansfield: I really love that. Yeah, using the variations of pasta because an engineer would do that. Which material is going to do it better? Maybe aluminum would be better because it's lighter weight than steel or whatever. I really, really like that idea.

Good. We have folks who want to use technology. This is great. Either they use it often. Quite a lot of people do. This is fantastic. Maybe use it from time to time. Maybe you don't have access to it, but you really wish you did. No one is afraid of using it, so I'm happy about that. Real quick, let's move on to the next slide. Next one, do your students come to you with cellphones? If so, are they driving you batty? They put them away? Do you use it?

Amy Moritz: Okay answers are quickly coming in. I think the result will pop up here on the screen in a second, Katherine. Most people are answering B or C. Michael put the results up here for us.

Katherine Mansfield: I think it's really great that 43% of people here today use cellphones in their programming, and there might be a really cool follow up workshop of some kind where folks who are already using it can teach their colleagues how they're doing that. That would be really awesome. I actually could answer all of these, because sometimes it drives me batty. Sometimes, I make student put it away. I'm talking graduate students here. Sometimes, we use it in our programming. Sometimes, I just don't even want to think about it.

Really quick. Again, free is my best friend, anything free. This first one, I don't know if it's Socrative, or Socrative, or whatever. I use this in my classroom with my graduate students. I do so because they taught me how to do it. Uh-oh, it didn't go to the website. Michael, can you help us get that out into the cloud? Thank you so much. This is really cool. I really like this because it's a really cool online tool that my students introduced me to, like I said. It's a really fun application that help students remain engaged.

By using their cellphones, you can get instant insight into student learning. They also have a way you could get it for free. You don't have to do pro. I would just do free. If they have ... I don't know if they're going to show us. That's okay. We don't have to worry about that. You guys can do this later on your own. There's easy-to-create quizzes, polls, so on. What's really cool about it too is that it works on computers, laptops, tablets, and phones. It might be that you have an assortment. Maybe you have two computers, and a couple of kiddos can be on that because they don't have a cellphone or whatever. That's just one.

Michael, can we go back to the screen? I'm not going to go through all of these because I want to give a little bit of time at the end, but I did want to share some of the really awesome websites that I think are just amazing. They're all free. They're online. TryEngineering has some really awesome things that are aligned with different education standards. There's cool lesson plans and activities there. DiscoverE, that's recommended by the National Science Foundation because of its free activities that are designed for folks, families at home, daycares, afterschool programming, teachers in classrooms, whoever is interested in using that.

Then, I have found Wordle and Audacity to be really cool tools to use with older people. I say older because it could be junior high, high school, adults, or whatever. Wordle. Actually, Wordle, you could use that with a little kid too, I think, because what you're doing is ... you've probably seen those before. I don't know if we can click to that. Let's try it. Whoops, no. Never mind.

It's like the thing I did with the computer slide where I had all of the different words that make up computer. This has been used in younger classrooms for like a visual word wall. Audacity is awesome. Let's just go back to the list please. It's an audio editing software. Students can create their own podcasts or public service announcements. It's all free. It's amazing. I'm going to just skip the rest of them, I think, because we're running out of time.

I'm going to leave you with a final model that you can study a little bit later. It's your good old Venn Diagram. It has Science concepts, math concepts, and English Language Arts. These are all standards that kids are supposed to meet. Then, in here, you see where they crossover Math and Science. This is the sweet spot right here where if you try to develop activities that do these things, they're going to hit on Math, Science and English, and Language Arts. That's a really important one that you can study on your own later.

Now, we have just a few minutes for questions or comments. There are some handouts for you to take with you to look at and to help guide you. I'm available via email. My email is there if you'd like to share some of your examples and cool things you're doing, or if you have a question, but didn't feel comfortable asking it, or perhaps you didn't think of it until you are fixing dinner tonight or tomorrow. Anyway, I will wait a minute here to see if anybody has any questions.

Amy Moritz: Actually, Katherine there was a question that came in about 10 minutes ago when I was just waiting until we got to the end. She writes and says, "Our program curriculum is infused with STEM. However, many of my teachers are intimidated by the activities. The teachers teach all day. Then, they teach after school, so there's not a lot of time for professional development. Do you have any ideas on how we can get some of the strategies out to them? Maybe some quick engaging videos."

Not to put you on the spot, but if you have any ideas and could send anything that could be used in the realm of professional development, we could send those out as a follow up.

Katherine Mansfield: Sure. Yeah. Let me write that down, and I'll commiserate with some of my colleagues doing this similar professional development, and I'll ask them. Look for more accessible, and probably short professional development. I will definitely look into that. Thank you.

Amy Moritz: Jo Beth, thank you for that question. I bet other people were thinking the same thing. We'll make sure we get that out to everybody later. Let's see. Does anybody else have questions? Again, not everyone likes to use the chat features. You can feel free to reach out to Katherine or to your TA provider if you think of something. We'll just wait another minute. Stephanie posts a question, and she asked, "Do you have any resources on STEM that are culturally-relevant for teachers?" Great question.

Katherine Mansfield: That is a fabulous question. What I have tried to do is make the topic more culturally-relevant in the work that I have done. I don't know how much time you have. If they're there for an hour, if they're there for three hours, if you have them every day, or what. Making the topic culturally-relevant with students, especially high schoolers, and having a real strong focus on social justice, "What is happening in our community that you just can't bear? What needs to change? What is something is happening that you wish wasn't happening?", that kind thing.

Then, make them very culturally relevant, it would be whatever is in their community, their neighborhood. Is it homelessness? Is it the example I used before with how I worked with high school students on why is it that people were segregated by housing? How do you get to that? I have found being able to ... Oops, my timer went off. I felt being able to help the students choose their own overarching topics or research question really, really helps make it culturally-relevant, but I will look for specific activities.

I don't have any specific activities. The only I can think of that I've used before are talking circles. I've used those with the American Indian populations, different tribal communities because their science, their way of investigating is different than western science. We call it indigenous methodologies. We've used talking circles with them.

Let me look into some specifics that folks can use with different populations. If I don't find anything, that's sad. It means we all need to work together, and earn some money on building some curriculum together. I actually have a student who studies indigenous population, so I'll ask her as well. That's a great question.

Amy Moritz: All right. Thanks, Katherine. I think that we are going to wrap up now. It is 11:30. I don't want to keep people too long. Thank you for those of you that chimed in with some questions and comments. We really appreciate that. It does make the webinar a lot more interesting when we have the interactions. Thanks a lot. Katherine, we'll look forward to getting those additional resources from you. We'll be glad to share those with everybody after the fact.

We're going to go ahead and wrap up. Just as reminder, the archive recording will be available on the 21C website within a few days. Along with that, we'll have the PowerPoint if you want to download that. We'll also have all the handouts that were sent to you by email. Again, once you log off of here, you will get a request for your feedback. Please take the time to offer some comments. We really do appreciate that. We certainly appreciate you staying on for the full 90 minutes. Hope that it was useful to you. I think that's it. Thanks everybody. Have a great day.

Katherine Mansfield: Thank you so much.