Science Modeling Talks

Episode 83 - Middle School, NGSS, and Teaching Experiences

Guest: Aaron Mueller

Mark (01:30):

Hey, Aaron. How are you today?

Aaron (01:33):

I'm doing well, Mark, and yourself?

Mark (01:34):

I'm doing great. Thank you very much.

Aaron (01:36):

Awesome.

Mark (01:38):

Enjoying the hot weather on the West Coast here. I don't know what it's like back there for you.

Aaron (01:42):

It is the first cool day we've had in weeks. So yeah, it's like 78 and it's like almost fall so it feels really good.

Mark (01:51):

Oh, that's awesome. I know you guys have been having pretty crazy weather back there, so.

Aaron (01:56):

Yeah, it's been toasty for sure.

Mark (01:58):

Yep. So, you know, I'm excited to talk to you today about your experiences with modeling instruction and my first question to share with our audience is how did you first get introduced and discover modeling pedagogy and ideas around modeling instruction?

Aaron (02:19):

Yeah, my journey may be a little bit different than some. My journey started off with a professional development with a gentleman by the name of Dr. Brian Hand for the University of Iowa. And his concentration was something called science writing heuristic, which basically focuses on language and modeling and how does that build in students constructing their understanding of science. And that bridged off into making great connections with my high school colleagues in my school district. And they were the modelers that really got me into, hey, you need to do

this. You need to really sink your teeth into this process of whiteboarding. And it just kind of flew from there. So the origins really are my initial experience working with Dr. Brian Hand from Iowa. And I would consider him my mentor.

Aaron (03:22):

My definite mentor. As I transitioned into the formal AMTA modeling pedagogy, it really kind of just ebbed and flowed into working with Phil Culcasi, Jim, Stankevitz and Frank Novakowski. Those three are kind of like my beacons.

Mark (03:46):

You've had quite a lot of connection with modelers, it sounds like.

Aaron (03:49):

Yes. Yeah. They're an amazing group of people.

Mark (03:52):

That's awesome, man. When did all this happen? When did you first meet Dr. Hand, and what year was it when you started your awareness?

Aaron (04:03):

It started in 2012, 2013. And it just really focused me on really understanding the purpose between teaching and learning. And that was-- his main drive was trying to get us to refocus on what does it mean to teach and what does it mean to learn? And what does it mean for students and yourself? And he really focused us to be in that student mode, just like modeling does. And it forces you to think that student's perspective. And then that made me realize, was I really teaching? And I really wasn't. I was really just giving information and expecting kids to learn it.

Mark (04:47):

But you'd been teaching for quite a while at that point.

Aaron (04:49):

Yeah. At that time I was teaching 12, 13 years. And, you know, there were times where I was very frustrated. And it doesn't mean I don't get frustrated now. <laugh>. Iit just means that at least I understand. I understand my students so much better. I understand their perspectives. I understand the questioning. I understand their need for me to try to tell them something, but my journey is to facilitate that learning. And getting them to ask the questions and getting them to ask each other questions. So, yeah, it was a wide open idea of just simply asking the question, what does it mean to learn and what does it mean to teach?

Mark (05:35):

What other ways did the modeling instruction, your learning about it, how did it influence your career and change your approach to the classroom?

Aaron (05:47):

Oh my gosh. My students instantly started having to shift their mentality of, okay, Mr. Miller's not telling me the information I need. How am I going to get him to do that? So the game shifted. So the game of learning and teaching shifted for them. And that was frustrating on their end. Yeah. It was, well, he's not teaching me anymore. He's not, and it's not that. You actually have to teach the kids how to think and how to go through that language of understanding science. And it's not just vocabulary what I'm referring to. It's really the thinking part of language. So students that are, ELL to having a 504 IEP, gifted even, their sets of languages are so different. However, modeling

can bring them together really easily through observation, inferencing, gathering evidence, explaining the evidence, drawing. Simply drawing brings in the whole different perspective of understanding and brings up misconceptions.

Aaron (06:58):

And that's what I love about like whiteboarding. So, that whole piece of the puzzle was huge for me in understanding because I had all kids in my classroom from, you know, accelerated, to the students that couldn't speak any English whatsoever.

Mark (07:17):

Now, your experience is primarily in the middle school grades. But I know you spent a little time at least in high school. How would you describe the difference in teaching in middle school with modeling in high school? What are the differences there?

Aaron (07:36):

It's interesting that you ask that. High school modeling and middle school modeling go through the same pedagogical shifts of getting students to look at phenomena, question the phenomena, gather evidence, question that evidence, question each other, and then trying to come some sort of consensus based upon what you've observed. That sort of pedagogical progression is through all ages, even from elementary on. It just depends upon the depth of how the content folds in, how their experiences fold in. And, literally just, I think their experiences tell them even more than what just the curriculum does because that really just launches you in a direction that connects to them. But the high schoolers obviously have a little more experience. However, they are some of the most creative ways of trying to get you to tell them the information. And, my middle schoolers are starting to learn that and they will ask once or twice, but then they know that, Mr. Miller's not going to give them any information.

Aaron (08:50):

He's just simply going to look at them and say, well, you know, that's a really good question, but I think you should ask your table mates what's really happening. And see if we can come to consensus that way. Or, you know, I'd never thought about that from that perspective. Maybe you should think about X, Y, or Z. And I might just give them a little hint that way. And it just shifts their perspective about, you know what? He, he's not telling me everything. He's just allowing me to shift my perspective and go in a different direction. That's something I didn't think of. And that was the same for high school and middle school. And I love the different energies that come from each of the groups. The high schoolers are really convinced and this is, you know, I, I might be too cool for this, but once you anchor them into the modeling process, they're hooked because they love the independence.

Aaron (09:42):

They love the ability to like really sink into their group. And, you know, I switch up groups every two weeks, sometimes three depending upon my classes because I want them working with different groups and different people so they're not getting just used to the same old, same old. I want them to be, you know, sharing their ideas with everyone. But in middle school, they buy in pretty quick because of the culture of modeling is something you have to ingrain from the get go. And a part of that modeling culture for me is really showing the students that I'm a learner too. I'm a student just as much as they are. I'm just a little bit older. And, that's really, I guess the part between middle school and high school is that content. But then also, that buy-in piece can be a little tricky.

Aaron (10:35):

Sometimes high schools are a little more rigid like, well, what about my grade? Even though middle schoolers are very grade-focused. And that shift is, really once you're convinced that the learning takes place and that the assessment that they're doing is just a reflection of their learning, it's a win-win.

Mark (10:59):

That's really cool. You mentioned the modeling culture in the classroom. Talk to us a little bit about what you mean by that and how you are developing that in your experiences.

Aaron (11:12):

Okay. So modeling culture to me is the foundation of getting students to think like a scientist. And it's interesting students think, well, a scientist wears a lab coat, wears goggles. All those things that are the stereotypical science person, right? And getting them to shift the perspective that every day we do science. So introducing them to some basic fundamental phenomena is a lot of fun in the beginning of the school year. So I will -- I love this part is I will show them a small clip from Monty Python, The Search for the Holy Grail where they meet and they bring a witch up and they say, "She's a witch." And go through the whole process and they're actually doing a science method, but they're actually showing the thinking that takes place from the questioning. And it's so much fun to get them to think outside of the box like, "Well my gosh, I mean, these peasants are thinking like a scientist.

Aaron (12:16):

You guys can too." Um, and then I do some small little things that actually get kids hooked every beginning of each unit that follows like a storyline. And one of them that I use is What's My Rule? And I learned this from a couple modelers, probably about four or five years ago. And it's What's My Rule is based upon a video from, Veritasium, which talks about coming up with a sequence of numbers and trying to fit a pattern and a logic. And getting kids to see that pattern and logic is a breakthrough in understanding how to think, how to reason, and then how to negotiate your understanding. And that is kind of the impetus of what I use at the beginning of the year because I can weave math in very seamlessly and they don't even think about it.

Aaron (13:14):

I can weave in graphing and I can weave in obviously that method of negotiating and questioning and whiteboarding all those pieces come together. And it's not about science. It's not about, you know, learning bio or earth science or chem phys. It's literally just taking a topic and learning about trying to figure out something. And the goal always gets me to the next step, which I usually do an ecology unit after that. And I do something very similar using that rule with rolling dice. And then rolling dice, finding patterns and logic and reasoning. And it really forces students to move back and forth between that idea of inductive and deductive reasoning. And they don't even know what that means. But for an educator, and everybody moves in between those two functions of deductive reasoning, observing, recording information data, but then inductively questioning and coming with inferences and trying to make sense of those items.

Aaron (14:18):

And we move back and forth as we learn. And I'm doing that all within that first couple weeks, and go through that process. And it takes time. It's not just, you know, we're all done. It's continuing that process.

Mark (14:32):

Yeah. But you're establishing in their minds that idea of the culture within which we are working together. In the classroom. That's really cool. That's really cool stuff. I know that at both the state and the national level that you've been involved with the NGSS science standards, as they've been implemented and brought into play in the educational circles. How do you see those two things, the NGSS and modeling instruction kind of working together and do they support each other? Do they, you know, tell me your, your observations about that with your experience.

Aaron (15:24):

Yeah. I think sometimes when, well, I should say this is that when modeling and NGSS first came into play, it was trying to figure out from my perspective, how do they blend together? And obviously that modeling pedagogy is a

small component of the NGSS science engineering practices, like making a model. But pedagogically modeling goes even farther into understanding how to think, et cetera and moving kids through the process. NGSS takes these three different domains or dimensions from science engineering practices, disciplinary core ideas and cross-cutting concepts and weaves them together to help us understand how the nature of science works. And it's K-12. Modeling is just basically that understanding and pedagogical use of science reasoning and thinking. That's my way of kind of explaining it. So when I got involved with NGSS, back in 2016, I was part of the Achieve Group, which was an organization that evaluated curriculum, science curriculum submissions by teachers and organizations to evaluate the level of three dimensionality.

Aaron (16:49):

In other words, how many levels of differentiation are taking place based upon those three dimensions? So, are students learning just the basic, one dimensionally of just science engineering practices or just disciplinary core ideas? Or are they doing two levels? Or is it all three levels wound up into one and how that progression works across a lesson and a unit? So it really made me dig in pedagogically and from a building progression of understanding science, was amazing. And AMTA's modeling pedagogy is, I think, a cornerstone that makes NGSS even better. Because it's still problematizing or using phenomena, which is the anchoring of any good science teaching. And NGSS is focused really on that component. And then obviously the gathering of data, that storyline that feeds through with all the problems that students are trying to figure out to come to that resolution at the end of the lesson or unit.

Aaron (18:06):

And it weaves its way through. Modeling does the same thing. It uses that same concept, but it focuses students on really negotiating, coming together with consensus and evidence. A big thing is that claim evidence reasoning that the NGSS really focuses on, where students are being explicit in what they understand with a claim, using that evidence, and then supporting their reasoning behind that evidence. So yeah, they work really well in tandem. I feel like a way to describe NGSS is like that framework or backbone and modeling to me is that key to turn it on and let it go.

Mark (18:50):

I've never heard the term, the three dimensions of science instruction that you were talking about. Is that something that our listeners are gonna mostly know about or is that something it'd be worth describing a little more?

Aaron (19:04):

There's a big emphasis on how we're shifting our instruction in science. Modeling using the three dimensions of learning science.

Mark (19:16):

And that's part of the NGSS is presenting that?

Aaron (19:18):

Correct. Yes. So they came up with the K-12 framework. Back in, I think it was 2012 and 2013 actually going back. They, actually it goes back a little earlier, but they formally presented it then. And, a lot of states have used it as a primary source for their standards and learning expectations. Some states rewrote them, so they use them in a way that they feel comfortable. But the foundation is through those three distinct dimensions of science and engineering practices. So if we think of the science method, it's really kind of those seven, uh, concepts. So, uh, identifying the problem. And then, um, that problem could be an engineering based, it could be a science experiment based, but phenomena based. And then, building, um, progressions through understanding the problem, gathering evidence, designing a problem, an experiment, gathering your evidence.

Aaron (20:23):

And then there's other facets of it. So creating a model specifically like modeling. But a model, and I learned this from Colleen, when we did our training. A model is just simply a model. And modeling pedagogy is just a model itself. Which is very unique. I can explain that later too. But there's seven different science engineering practices that we go through. Disciplinary core ideas is really the content of science and from life, earth and physical. And those go into great depth. There's a lot of research and foundation that comes from the 1996 benchmarks all the way through to 2000. And then, the new iteration obviously is the K-12 framework of NGSS. And then the last one, which I think gets overshadowed by the first two is the cross-cutting concepts.

Aaron (21:23):

The cross-cutting concepts I feel like help modeling the most. And for new science teachers out there, this is something that should be taught within their curriculum as they're going through their undergrad, et cetera, and their training. For us as older science teachers, this is something that was presented new to us. And some people really bought into it. Some people are like, it's the same old, same old, but it's really not. It is really a different dynamic in shifting our thinking of how students do science versus just sit there and get science. It's 413 pages. It's not necessarily an amazing novel to read or something like that. Maybe a bathroom reader, but it'll definitely put you to sleep if you read it for too long, so. Yeah,

Mark (22:10):

I gotcha. <laugh>. You know, it just triggered my thinking. You mentioned new science teachers. And so what would you say to like a listener who is a new science person or even considering teaching science? What would you say to them would be some tips for them to get involved where, to help them jumpstart their career as opposed to have them maybe struggle through discovery like you did for 12 years before you found modeling? What would you say to that person and in encouragement?

Aaron (22:49):

Oh, that's a great question. And I've though about this. I've had student teachers before. I've had clinical teachers in my classroom. And one of the things that they ask me is how did you do that? And, what I've always said is that you're going to build a journey and where you start in that journey is all based upon your own reflection and where you want to go. So new teachers coming into the profession should be getting their dose of the K-12 framework and of the national science standards. But those that are like, say, doing a second career -- love that people are doing that. I think that's an amazing thing. But no matter where you're at, it's a journey. My journey started basically in 2012, 2013, shifting my paradigm of what is, you know, teaching and learning.

Aaron (23:50):

For them, it's gonna be how can I make this work and how do I connect with students? Um,

Aaron (24:01):

A lot of student teachers that come out are like, I wanna be friends with students. It's like there's a fine line between being friends and being a teacher, and connecting with people. People coming from a second career. It's still different because their perspective is trying to shift their mentality of learning content to how do I connect with students to help them understand and learn science. So there's two facets there. But what I would tell them is literally you're going to experience some successes and failures, but understand those failures are your ability to connect with students. And when you connect with students, they're going to connect with you knowing that you're a learner and you're that same person that is always learning. So the better that you are at teaching kids to persevere through failure, persevere through difficulties, have grit, the better off you are in your journey in being a science teacher.

Aaron (25:03):

So where would you start with that perseverance? Personally, if I would have known about modeling earlier, I would have been like, boom, right there, AMTA. Would have been there. 'Cause I taught physical science for my first 14 years of teaching. I should say 16 years of teaching. And I mean, modeling is perfect for physical science. I mean, it just, it's seamless. And I teach life science now, which is a little more challenging. So, if I would have known about the AMTA and going that process, that's where I would start. Because they have the pedagogical understanding. They have the teaching of those workshops that they use. And they're developing even more opportunities online and smaller cohorts and workshops to get people at least a taste of modeling to understand what can you do with this?

Aaron (26:05):

How does it work? And how does it work with your own teaching style? 'Cause many teachers have different styles of teaching. Not every teacher's going to teach like I'm going to teach. But modeling has those basic fundamental pieces of that phenomena, that understanding of questioning, getting into collecting that evidence of what that phenomena's doing for you. Maybe it's not doing anything for you. So you have to ask a different question. And then whiteboarding, communicating, coming to consensus, consensus and then literally, well, what did I learn?

Mark (26:39):

I hear you recommending that teachers get into the AMTA.

Aaron (26:43):

Yes, I am.

Mark (26:46):

And I hear you recommending that they, maybe that they get into a workshop, you know, as soon as posible. Uh, no matter where they are in their career in teaching and, you know, I believe that too. I've seen the success and the incredible transformations that come to people who are attending those workshops and getting involved with the AMTA community. And, so if you're listening and that's something that you would like to pursue, you wanna go to modelinginstruction.org. Modelinginstruction.org is the AMTA, American Modeling Teachers Association, website. And that's where you can find out about when the workshops are being held, where they're being held all over the US. And you can get involved there. And also becoming a member, you have access to a lot of great curricular content and information that will help you in your journey.

Mark (27:51):

Uh, that's awesome. <laugh>. I know you served on the AMTA board.

Aaron (27:58):

I did, yes. I was the treasurer for two years with the executive board. And it was an amazing experience working with the teachers, retired teachers, but also teachers that have so much experience with understanding the shifts of where instruction have come from to modeling instruction. It was amazing to see the vision of so many people come together that were such like - mindedness. And the new leadership that is starting with AMTA coming in, I am so hopeful that there's going to be a big, big explosion of modelers. Yeah. Because they're just lots of great energy, and a lot of great leadership there.

Mark (28:44):

Yeah. The board is strong. Our new executive officer is awesome. And, it's a bright future, I think, with challenges as any nonprofit organization is facing these days. You know, but, boy, that's, that's really exciting, I think, the future of AMTA. So I'm gonna ask you to concisely share the like three or four biggest tips for teachers or especially modeling

tips, that you would share with our listeners.

Aaron (29:22):

Okay. For a new modeler, my first tip would be try it with one unit. Try modeling with one unit. If that feels like it's too big, try a lesson. Try a lesson that you know you feel that you can really incorporate that phenomena, that problem, students collecting that data, working together and collaborating, asking each other questions and feel comfortable with not always knowing the right, the, knowing their answer's gonna be solved within the first lesson. Know that you can progress through that with a unit. Don't think you're gonna model all year long from your very first time, because that was one big thing I learned. It's really tough to do. The second tip would be, don't fear failure. If you fear failure, your students are gonna see it. They're gonna see it in you and then they're gonna go, "Well, Mr. Miller doesn't look very comfortable with this, so I'm not really gonna participate too much and we'll let him kind of figure it out for us." Um, so don't fear failure.

Aaron (30:33):

Three, my third tip is be that student. Show them that you are that student, you love learning, you love, and most people that are science teachers love science in itself. And don't forget that passion that you had for learning. That learning piece doesn't really change between, kids that are in middle school or high school or elementary. It's still that curiosity. It's still that whole process of questioning, be the student. Take on that student role, live it, love it and go on from there. And lastly, this is a motto that I use in my classroom ever since I watched Ted Lasso over COVID. And I'm so excited when it comes to August 4th this year when Ted Lasso season four is coming out. Be curious, not judgmental. And that's a model that Ted uses in one of the most famous clips where he's in a tavern and playing darts against Rupert.

Aaron (31:43):

And this whole concept of if you just ask questions, maybe we would have found out, you know, Ted was really good at throwing darts. And you maybe would have found something different about somebody. And using that theme in my classroom, when new students come in, because there's kids that move in throughout the year - Be curious, not judgmental. You know, when you get into that new group, be curious, not judgmental. And that goes a long way with students being kind to each other, understanding that some students have different talents in each other. Some students might be able to solve a problem much faster than you and they might not be gifted. They might be supported ed. Some of my supported ed students were fantastic problem sovers. They just didn't get the opportunity all the time to show it. And modeling allows them to show it.

Aaron (32:39):

So, so that would be my four tips. So...

Mark (32:43):

That's great. Be curious, not judgmental.That's good life advice.

Aaron (32:49):

Absolutely. Absolutely.

Mark (32:51):

Aaron, before we go, I wanna ask you, early in our conversation today, you mentioned the importance of language in the classroom. Can you talk to me a little bit more about that and what that means to you? Because you talked about, you know, spoken language, drawing, written. Um, I think there was another, but anyway - mm-hmm. Talk to us a little bit more about that.

Aaron (33:19):

Yeah. I think that's such a critical part of modeling is helping kids understand that it's not just about vocabulary. And sometimes we get hung up as science teachers on the content piece. And really content doesn't drive curriculum. It's the questioning and language that drives the curriculum. And so if you have your classroom of, you know, 504s, ELL, gifted, and your reg students, any students that have some challenges, language is gonna be that key. And one of the books that I read, something called Science in the City by Brian Brown. And this is a great perspective for teachers that might be working with urban students, students in urban settings and trying really to understand language from their perspective. And that's really getting at the idea of how does modeling really ebb and flow with every sort of environment you could be in.

Aaron (34:24):

And it works because modeling is all based upon connecting with students, connecting with their understanding of science. And language doesn't have to be a vocabulary word. Language simply can be a description. It doesn't have to be perfect. It can simply be, well, describe in your own words, what are you seeing? Or what colors do you see? What shapes do you see? And breaking it down from as simple as that to again, expanding onto patterns, systems, energy and matter, whatever it is that you can get your kids toward. But it doesn't mean that you have to start with vocabulary. It just simply means you have to get them engaged. And then the last book that I've just started reading, is called Science Blind by Andrew, and I'm probably gonna say his last name wrong, but it's, Shtulman. And it is a, an amazing book talking about -- I'm only through the first three chapters right now because it's so rich with trying to understand how misconceptions drive our society in science.

Aaron (35:29):

And if we can help our students debunk or uncover those misconceptions, our understanding of life itself, nature, what we're in, is going to be so much better.

Mark (35:43):

Hmm.

Aaron (35:44):

Our ability to solve problems, so much better. And modeling does that. Modeling allows us to uncover those misconceptions. And that's what NGSS is all about too, is how can we uncover misconceptions to build students' foundation of understanding science? So those two books I think are fantastic. There are others as well. The last one I could actually say is also Ambitious Science Teaching. That is a phenomenal book, no pun intended. It is just, it's, it gives a lot of great examples of how modeling works within a very model driven classroom.

Mark (36:24):

You know, if you could send me the links for those three books, via email, I'll post them on the Science Modeling Talks website under this episode. So that people can, can find those. Those are great.

Aaron (36:40):

Absolutely. Love to do that.

Mark (36:41):

And anything else you wanna send me, that'd be great. It's been really awesome talking with you, Aaron, and, I appreciate the insights that you've been sharing. And I know that our listeners are gonna appreciate it too. So I just wanna say thank you so much for joining me today.

Aaron (37:01):

Thank you, Mark. It has been an absolute pleasure, an honor being here. I've listened to your podcasts for quite a while. I enjoy them. Some of them with the science teachers that are on there, I mean, I'm like, "I get the science." But the modeling pieces of it are amazing. Your guests have such a wealth of information to share. And I hope they also tie into those old - Those other episodes as well.

Mark (37:26):

It's been really fun for me as host to meet all you eggheads. <laugh>

Aaron (37:31):

<laugh> Literally, if you could see my head,

Mark (37:34):

No, that wasn't my reference. <laugh>

Aaron (37:38):

No, no. No, that's okay. That's correct. That's how I make, that's how I connect with students. I make fun of myself because it's okay.

Mark (37:44):

Yeah. Yeah. Yeah. I married one of y'all, so. It's been great. So I, I'm gonna say goodbye and, we'll talk to you before too long, I hope. Okay?

Aaron (37:56):

Sounds great, Mark. Take care.

Mark (37:57):

Yeah, you too.