

Mark Royce ([00:58](#)):

Hey, Mark. How's it going?

Mark Lattery ([01:00](#)):

Hey, Mark.

Mark Royce ([01:01](#)):

I'm looking forward to our conversation today, and I know it's gonna be really interesting to our listeners 'cause you've got this wonderful experience and you've been involved with a lot of really cool things. When I was reading about you, I saw that one of the things is that you're a member of a group called the PANDA Collaboration at Fair, and I have no idea what that is. Now, maybe some of our listeners do, but I don't know what that is. So I'd love for you to explain that to me.

Mark Lattery ([01:33](#)):

Right. I am surprised that you noticed that, but, yeah, a little background: I'm a professor of physics at the University of Wisconsin Oshkosh. So I am an experimental particle physicist by training. In addition to my work in physics education, I'm also a member of this PANDA collaboration. What can I tell you...PANDA stands for Antiproton Annihilation at Darmstadt, which is this city in Germany. And the PANDA Collaboration is a group of several hundred physicists who work at the PANDA Experiment, which is this Collider and particle accelerator at the facility of antiproton and ion research. So, problems that I work on there, and the problems I always find most interesting and challenging are the ones that have to do with teaching and learning. So, I'm in the midst of a book project, actually right now. And we're using modeling method, model-based inquiry to train physics teachers and university physics students in experimental particle physics. So it's a lot of fun. It's a book, something like 300 pages now that has been piloted with six undergrads and a couple of practicing physics teachers-- it's the latest project that I'm working on.

Mark Royce ([02:59](#)):

I've always kind of wondered, I've heard about particle accelerators and is it what the Halan colliders or... Once you've collided particles

Mark Lattery ([03:10](#)):

<laugh>,

Mark Royce ([03:11](#)):

What is it that you guys learn when you do that? What's the end goal?

Mark Lattery ([03:17](#)):

I get this question a lot. The important thing about what you're doing at these colliders is it's not about the particles. That's centrally what you're interested in. It's about the models. Ultimately physics is the study of how things move and the rules by which nature follows. So you can anticipate how a particle moves ahead of time and leverage that to your advantage in creating things. And so, yes, we collide particles. And we can create new particles in those collisions. Often the particles we create are really unstable and they bust into a billion pieces, and we're trying to reconstruct the explosion and everything. But all of that, our interest is centrally not about the particles.

Mark Lattery ([04:15](#)):

It's about understanding the underlying rules by which the particles move and interact with one another. So here's this focus on modeling again, where you're trying to construct models that extend your view of the universe. And hopefully you can come up with a simple set of rules by which all particles obey so that you can kind of consolidate your knowledge in a relatively small area of intellectual space. And so that's what physicists are up to with those colliders. And there's a really successful model that we've been testing and revising for decades called the Standard Model of Interactions. And our goal is to basically push that model, to try to find its weaknesses. And once we do, it might mean replacing that model, or correcting it somehow. That's the work of a particle physicist.

Mark Royce ([05:27](#)):

It's fascinating. And, you know, I never would've thought about the fact that you're involved with creating models to understand what's actually going on in those collisions and stuff. You've done a lot of study in modeling theory. Tell me a little bit about that, and especially as it relates to modeling instruction, like the focus of AMTA

Mark Lattery ([05:59](#)):

Modeling theory. First before I answer that question, I just need to throw in here. My pre-college teacher friends and colleagues are gonna be asking, well, what in the world do you mean by modeling theory? I mean, do we really need to be talking about a theory, a theory of modeling? Do we have time for this kind of thing? I mean, as a teacher, they're like, I have enough on my plate with questions like, what do I do when my students are talking during a whiteboard presentation? Or how do I manage my classroom time so I can get in all the subject matter, cover all the stuff in my AP curriculum? How should I be communicating with my parents and administrators?

Mark Lattery ([06:47](#)):

Those are the questions that they, principally want answered. But having said that, nothing is more, as they say, nothing is more practical than a theory. And a good theory of modeling, sort of a top level description of how scientists engage in the scientific modeling process, that's important. How they make discoveries. It provides a crucial framework for both the teacher and the student experience in the classroom. And because ultimately, science learning is greatly improved when science classroom reflects scientific practice, having a grasp of modeling theory is important. So a modeling theory, what can I say? A modeling theory is gonna, provide answers, to basic questions like, what is a scientific model? What makes a scientific model unique? How are they created and developed? So, for example, let me ask you a question, Mark. Is a scientific model the same or different? Or I ask your audience: Is a scientific model the same or different than a scientific representation?

Mark Royce ([08:03](#)):

I'm not a scientist.

Mark Lattery ([08:05](#)):

So, these are the kinds of questions we engage science teachers in at workshops. It's like, yeah. You know, is a data table a model. So this kind of stirs up those questions underlying everything we're doing with the modeling method of instruction. Because it would be a terrible shame to go to a two- or three-week workshop on modeling and leave not really knowing what a model is or what we mean by scientific modeling. Because, ultimately daily, as we implement the modeling instruction, we're trying to

communicate to students that the intellectual core of what we're doing are these scientific models. So we absolutely have to have a picture, sort of a model of modeling, that we can use to motivate everything that we do in the classroom, one that we understand that we can communicate to a 16-year-old. And that's important, and that's what modeling theory gives you. So I guess the most important thing I've learned about modeling theory is just the richness and diversity with which one can describe the scientific modeling process, and how we use that process to learn new things. How's that?

Mark Royce ([09:28](#)):

That's great. It's an important question for modeling teachers, teachers who follow the modeling method, but my understanding, and you can correct me if I'm wrong, is that developing models in the classroom is about establishing a storyline for the students to follow, to understand the principles that are being taught. And does that kind of resonate?

Mark Lattery ([10:00](#)):

Yeah. I mean, once you make this distinction, there are the models themselves. The models are stories. The models are stories that we tell about what nature is like. But when we talk about modeling storylines in the classroom, that's different. That's sort of like the intellectual journey that we're gonna take in the classroom. Maybe there's a central route that maybe the teacher has in mind, like, students will encounter this first and that, and this is how we're going to develop the concepts, but also give some flexibility for student exploration and maybe side routes can be taken as well. All of that falls into what we call a modeling storyline. Is that distinction helpful?

Mark Royce ([10:55](#)):

I think so, yeah. You teach at the university level?

Mark Lattery ([11:02](#)):

Right.

Mark Royce ([11:03](#)):

Do you use modeling instruction in your classrooms?

Mark Lattery ([11:07](#)):

Oh, yeah. For the past 25 years, it's central to everything that I do. So I teach a physical science classroom. And these are 18, 19, 20 year olds just outta high school, non-science majors. And it's full-on wall-to-wall modeling in my classroom. All the things that you think about or associate with modeling are happening: the whiteboards, the dry-erase markers and all of that. And nobody in else in my department-- I'm a physicist in a department of physics, but they don't wanna teach this course for the non-science majors. I think they're afraid of it. So they give me complete freedom. They're like, look, Mark, you do whatever you want here. Let us teach the upper level courses. It was so funny when I first started at the University of Wisconsin Oshkosh, the course is called Physical Science, has this really general name, and I was told that the guy before me who taught that class was so afraid of teaching this course that one time he was found hiding in the bathroom during his class session.

Mark Royce ([12:23](#)):

Oh, my.

Mark Lattery ([12:24](#)):

Anyhow, so I went in there and after three or four years, this is back in the early two thousands, I was already doing the modeling method of instruction, and I was connected with the Arizona State University Group and Jane Jackson and all those people way back. In fact, we were doing summer modeling workshops at the University of Wisconsin Oshkosh for four years, from 2002 to 2006, I believe. So I've been doing modeling for quite a while now.

Mark Royce ([13:00](#)):

Yeah.

Mark Lattery ([13:01](#)):

And then I do elements of modeling in other courses I teach, even our algebra-based physics. And like I said, even today, I offered a graduate-level course in particle physics work modeling. The modeling theme was at the core.

Mark Royce ([13:18](#)):

How did you get introduced to modeling instruction? 25 years is a long time. What happened back then that got you going with modeling?

Mark Lattery ([13:29](#)):

That was kind of quite the intellectual revolution for me. 1999. I got my PhD in experimental particle physics at the University of Minnesota. Got this job at UW Oshkosh. I'm like, what? I have to teach these classes. Even back in the nineties, I was beginning to try to envision myself as a teacher, and I was trying some different things when I was first at UW Oshkosh that weren't working so well for me. And a high school teacher, colleague of mine said, why don't you go to this workshop? I forget who, I can't even tell you who it was. But I ended up going to a modeling workshop in 1999, I believe it was with David Boradschwag, and he was out of Madison, Wisconsin.

Mark Lattery ([14:24](#)):

And it was just a short workshop. It was like a week. So I came out of that workshop saying to myself, nothing will ever be the same again. And I immediately went to the Menards and got some kitchen paneling and started cutting up things. And they were all into fan carts at the point. So I wound up going to the hardware supply shop and buying fan parts for fan units and created a fleet of fan carts that kinda goes with a lot of the force and motion stuff they were doing. And, you know, the dry erase markers. I was taking my first steps of trying to get my students to talk to one another with these whiteboards.

Mark Lattery ([15:22](#)):

It was an amazing time. I was beginning to see the power of whiteboard presentations and giving me sort of an ability to see what's going on in their minds as they were learning, which was just fascinating to me, learning to shut my mouth when they were starting to talk with one another, or were trying to ask me what the answer was. I mean, it was all really fun and new. And then Jane Jackson said, Mark, why don't you write a grant to do a modeling workshop at UW Oshkosh? And I was like, Jane, I don't know how to do this. She's like, no, you don't need to know what you're doing. I have this template. Just fill in your name, and add stuff to these blanks. And so to my shock, I got this grant-- four summers, like a quarter of a million dollars, run these workshops for four summers.

Mark Lattery ([16:22](#)):

Wow. And I'm like, I need help here because I obviously don't know what I'm doing. And so I basically found the six, about six teachers, the best teachers I could find who were sort of experts in modeling. And over four years while I was directing this program, not really knowing myself completely what the modeling method of instruction even was. These six teachers took me under their wing and trained me. And it took all four summers before I really got it, where I was like, okay, that's why we are doing these whiteboard presentations. That's why you do data linearization. That's why you do all these things. It took me like four years before I felt like I was fully trained. Basically participating in the workshops in a program that I was the director for.

Mark Lattery ([17:22](#)):

And after that, it took several more years, I would think. It took me almost 10 years before I really found my own identity, I think, as a teacher who uses modeling, and then I wrote a book and, and then now I'm doing modeling workshops myself for many years. And so, yeah. It's been an amazing ride. It's been a really fun career. And I owe a lot of that to the folks who created modeling and now the American Modeling Teaching Association.

Mark Royce ([18:05](#)):

I have a couple questions, but first, you mentioned you wrote a book. Can you tell us a little bit about that?

Mark Lattery ([18:14](#)):

So I wrote a book on modeling because after 15 years of this, I really need to put down my own perspectives of what I see, what I think modeling is, my modeling theory, if you will, or maybe elements of it. And so the book is called ...

Mark Royce ([18:36](#)):

Oh, I was just gonna ask you that. <laugh>.

Mark Lattery ([18:37](#)):

So the book is called Deep Learning and Introductory Physics published by Information Age Publishing. And it went out in 2017. And exploratory studies, deep learning and introductory physics, exploratory studies of model-based reasoning. And I go into detail about different aspects of the scientific modeling process. In the very first chapter, I take up the question of what is a scientific model? I go into what should modeling look like in the classroom? And then I launch into some of the research that I did about how students think and learn and reason with models and the principles, the ideas, concepts in that book were fed into, the modeling workshops that I currently run.

Mark Royce ([19:40](#)):

Yeah. That's awesome. You know, you said that when you got introduced to modeling those many years ago, it was transformative for you and really launched your trajectory as a teacher. And I've heard that so many times from modeling instructors as I've done over 50 of these interviews with the podcast, and it's just astounding to me how many people say that same thing, that it transformed them as a teacher and became a pivotal point. And so I just wanna mention that if you're listening to this show and you haven't been exposed to one of the workshops, you need to do that. If you're a teacher, you need to get

going and sign up for one of the workshops. They're offered in many different online and face-to-face options. And you can go to modelinginstruction.org. Modeling instruction org. That's the home website for the AMTA, American Modeling Teachers Association, and find out about what workshops are available. So that's a little plug because I think the AMTA is just outstanding and my wife is the one who's taught me about it. Hey, Mark, you're a member of the board. Of the AMTA. Tell me about what that's like. I mean, what's been your experience as a board member and what kind of stuff you guys do?

Mark Lattery ([21:11](#)):

So there's this board, it's a nine member volunteer board. We hold elections annually, by the way, we're always looking for new people. And so our goal is to provide guidance to the American Modeling Teaching Association. The executive team help the organization grow and carry out its mission. And so I'm on this board. I'm in a three year term, and my niche as a member of the board has been to develop the international branch fo AMTA. So after I got settled on the board I became chair of the AMTA Ad Hoc International Committee. Did that for a while. And after over a year in that role, I became president of modeling teachers, international, which is AMTA's International branch, and their newest subsidiary.

Mark Royce ([22:15](#)):

So the, AMTA has been focused in the US and now it's expanding beyond that. Is that what this is all about? It's like getting modeling into schools and with instructors around the world?

Mark Lattery ([22:29](#)):

Yeah. I should say the AMTA has already always served teachers who were using modeling outside of the US. But you have this name, American, in the title. Right? And so many modeling leaders have traveled outside of the United States to give modeling workshops abroad. But it's always been, okay, this is the American Modeling Teaching Association. Does that mean you only serve teachers in the US? And the answer is absolutely no. We serve all teachers. And so it's natural to then ask, if a new organization or a subsidiary should be created to emphasize our international mission. And so last year I'm very excited to share the AMTA board created modeling teachers international.

Mark Royce ([23:40](#)):

Okay.

Mark Lattery ([23:42](#)):

Its mission is to support what we call international modelers. These are just teachers outside of the continental US who are using, or exploring, the modeling method of instruction in their own classroom. And so, like the AMTA, we provide PD workshops for teachers, but we travel all over the world to do it. Just in the past year, we've given modeling workshops in places like Latvia and Hong Kong. And in a few weeks I'll be in the Netherlands giving a modeling methods workshop. And in the next year or so, groundwork is being laid for trips to Egypt and Panama. So it's all good fun.

Mark Royce ([24:27](#)):

Wow. That's really cool. So, are modeling instructors from the US going out into the other countries, or are there people in the other countries who are grabbing ahold of this and kind of helping take it forward? How's that unfolding?

Mark Lattery ([24:47](#)):

All of the above. So we're going out there, but often we'll have local support. We'll have people who have some background in modeling and are helping to organize things locally. And basically it's a partnership. In some cases, for example, in the workshop I gave in Latvia that grew out of a suite of modeling courses that we teach at the University of Wisconsin Oshkosh called the Next Generation Modeling Courses for Teachers. And that's an international outreach. 'Cause these are online courses. And so we'll get international modelers into those courses, and that will create relationships that then evolve into modeling workshops for people new to modeling in those countries. And so these things can happen lots of different ways.

Mark Lattery ([25:49](#)):

In Hong Kong, we had a long-time person who had been part of the modeling community for a while. So then Ray Howanski, the AMTA XO, and I, gave that workshop at Hong Kong this past fall. It could be different every time. But we're getting out there and the more we do it, the more experience we have, the easier it becomes. But it's always fun because right away we see the impact that modeling has on these teachers as they begin to explore it. And the workshops have been shorter, like just a couple of days. But we're hoping to return to those countries and give longer and longer workshops. So things really take hold in those places.

Mark Royce ([26:52](#)):

Yeah. That's cool. Do you guys find that there's a language barrier at all in all these different countries with the language of teaching these methods?

Mark Lattery ([27:02](#)):

There can be. Like in Latvia, their English was pretty good, sort of half and half. Sometimes the teachers that are further out in the country would come in and, I have this, basically what I like to do, and I'm gonna do in Netherlands too, is I memorize a paragraph of their language so I can give a paragraph introduction in their own language. Which they think is really fun. But it's funny because I dunno where in the paragraph I am, I just have memorized all the sounds. But yeah, you know, English, like science, English is gonna be the central language I think of our modeling efforts. And Netherlands, their English is actually quite good, so I won't have to do much there.

Mark Lattery ([27:56](#)):

But you know, in Latvia, I had to come up with a vocabulary list of modeling in Latvian. We're gonna be going to some pretty interesting places, I think, in the next five or 10 years. Some of these places you'd wonder if I should be going there, but I won't go into anymore of that. But we're gonna go wherever the need is, and in some of those countries, the language will be an issue. But this is part of the journey of creating, of expanding our modeling efforts globally, creating a global community, a global modeling community. That's the vision that I have that, that I'd like to, I guess, end my career with these last 10 years.

Mark Royce ([28:52](#)):

That's really cool. Mark, I guess physics is the same around the world. It works the same no matter which country you're in.

Mark Lattery ([29:01](#)):

And when you have a science conference, usually there's a significant English component, but it's important for those local modelers to have a place where they get that support, teaching, modeling in their own language, in their own country. Of course, you have teachers, a slice of who we would like to serve, are teachers who are teaching in specialized international schools. That's normally in English, but our vision for Modeling Teachers International is everyone in the whole globe. And, sometime, everybody is welcome. If you go on to modeling teachers international website, it's modeling teachers international, one word.org. You can get on our website, see what we're doing, get on our email list, get involved, and, that's there. But despite our international reach, the focus is the same. Despite our language barriers. The focus is the same: scientific models and modeling as a means to improve science education. So, it's the same ideas. Things that you'll hear at our international modeling workshops are the same words, phrases as you'd hear at a local workshop. Like, science is a discourse. Lead by nature. Concept first, name second. Use multiple representation. Ask a question. Ideas, like models can be changed. Models make guesses. Models are scholarship. And importantly, modeling is not a curriculum. These are all ideas that, we would emphasize in a modeling workshop, whether here or abroad.

Mark Royce ([31:09](#)):

I know the origins of modeling instruction methodologies came through Dr. Hestenes many years ago. And his primary focus was with physics, but it's evolved to include many other disciplines as well.

Mark Lattery ([31:27](#)):

Exactly.

Mark Royce ([31:28](#)):

You know, chemistry, biology, I heard there's some geology stuff going on, so it's about how you teach that discipline in the classroom. So is that happening on the international level as well? Is it covering other disciplines besides physics?

Mark Lattery ([31:46](#)):

So our international efforts are just beginning. So it's like, we are now where modeling was in the early two thousands. We're learning how to give workshops to a different group of people. The Hong Kong workshop in October was, I did the physics workshop. Ray did the chemistry workshop. And so that's kind of where we are. But in the US the innovations are, the new, the new hot stuff is gonna be like the middle school modeling. And people are even getting into the mathematics modeling, which is a huge area. That's sort of the newest, latest stuff here. The international efforts, they're not gonna get there for, probably another 10 or 15 years because that's where we are. Does that answer your question?

Mark Royce ([32:57](#)):

Well, so you're still in international modeling? The primary focus is in physics? I guess that's what my question.

Mark Lattery ([33:05](#)):

Well, I envision that in the first three to five years, it's going to be the basic disciplines. Physics, chemistry, biology. I'm a physicist. And so, the workshops that I give are gonna be in physics 'cause that's my area of expertise. But for example, when I give a workshop, if I give a two-day workshop, I come up with the simplest possible content that I can think of. So the focus is not on the subject matter



content, but on the pedagogical aspects about models and modeling. And so for example, in my two day workshop, I do units on light reflection that are accessible to middle school teachers, high school teachers of any discipline so that I can concentrate on those important questions.

Mark Lattery ([34:05](#)):

Like what is a scientific model and what does it look like in the classroom? But once you get to like two- and three- week workshops, then you're drilling into the details. You're like what materials are best to use for this and that, what do you do when the student says this, how are the ways that students think and learn or fail to think and learn, in the specific discipline areas. But that's a longer workshop that we'd ultimately be building for as a new organization. Modeling is growing and changing. The modeling approach to instruction. It was a grassroots movement by teachers.

Mark Lattery ([35:02](#)):

And while there are modeling materials that we use to introduce teachers to the modeling method, modeling itself is just that, a method. It's not a curriculum, and it's evolving. And within the modeling community, there's this open invitation, please join us and be part of creating what modeling in the classroom might look like in the future. And looking at different ways that we can reach teachers everywhere in the world. And that would mean expanding the way that we do modeling workshops to make them, for example, to create more powerful and creative experiences online, because we are in the 21st century. And how a modeling workshop can be done well, that's gonna change, that's not gonna be the same way in 50 years as it is now.

Mark Lattery ([36:12](#)):

We need to prepare for that future. And, we need to continue to expand upon this idea that learning is greatly improved when what we do in the classroom reflects scientific practice. And that practice is defined by the scientific modeling process. And, in the initial stages, the modeling approach, really emphasized inductive modeling, looking for mathematical patterns, from direct lab experience. But there's more inductive-- modeling is not the only game in town. So the modeling workshops are beginning to open up to like, looking at different new aspects of the modeling process that haven't been explored or integrated into the classroom as much before. Like using analogies. And looking at how empirical models and physical models function together to create the ultimate conceptual model, the story that you wanna tell about the universe. And so there's gonna be a sort of a next generation of modeling, that will begin to appear. So, how we look at the scientific modeling process, how we envision the scientific modeling process sort of occurring in the classroom and how we train teachers in modeling. All of that's gonna change, and evolve, in the next many decades.

Mark Royce ([38:12](#)):

Yeah. That's really good. Gosh, I could talk to you for a lot longer, <laugh>. You have a lot to share. And perhaps we'll do another episode at some point with you if you're up to that. It would be really cool.

Mark Lattery ([38:27](#)):

Sure. This has been fun.

Mark Royce ([38:28](#)):

Yeah. It's really been great. And I want to thank you for taking the time to do this. I know that what you've shared is gonna be meaningful to our listeners. And I'm just really grateful to you, Mark, for taking the time to do this today. Thank you.

Mark Lattery ([38:46](#)):

Awesome, Mark. My pleasure.

Mark Royce ([38:47](#)):

Take care.

Mark Lattery ([38:48](#)):

Alright. Bye now.