Mark Royce:	00:00	Tell me, Ray, how did your introduction to modeling change your approach to the classroom?
Ray Howanski:	00:07	So I kind of felt an inner struggle before I found the modeling approach. It certainly resonated with me and I felt like it kind of gave me permission with all the research behind the success of the modeling approach and deemphasizing what I had to say and emphasizing more listening to students and starting our conversation from their level of understanding that became much more important what the students were thinking. And we were able to find that out through what they said through white boarding. It was actually built into the network of the classroom experience for students that they were constantly asked to share what they're thinking and being asked to explain why they're thinking that and to provide evidence for that. And that is just centered around what scientists should be doing. A lot of the work we do here at Ridley school district is we try to put students into authentic experiences, whether it's as a writer or whether it's a mathematician or a scientist, or somebody that's studying social studies. And that just really resonated with me, the fact that students were constantly in this role as a scientist of course, kind of shrunken down to the the classroom environment. So to sum that up, really, to, to start as a listener and to be more reacting to students, to try to figure out whatever phenomenon they were trying to, describe or to explain.
Mark Royce:	01:47	You know, I saw a quote in some things that you shared before in our pre-production prep for this interview. And you said early in my career I was told to have more information ready to present than the time that's available to present it in the classroom. I thought that was an interesting observation. And, and uh, that's what you were told early as a probably a student
Ray Howanski:	02:12	yeah. And that's kind of interesting because it was almost as if like overwhelm the students with information and just keep that information coming and don't give them a second to interrupt you. And if you just keep this stream of information coming at students, then all will be well in your classroom. That was, you know, kind of the way I was trained, in the beginning of it and that's the way I perceived what I was being told. And we've kind of in modeling we've kind of flipped that on its head. I did find in my own experiences, even prior to modeling, I found it was really interesting when you kind of did listen to the students a little bit and you did consider the struggles that they were having as we went into trying to describe or explain some phenomenon.

Ray Howanski:	03:03	And again, modeling just provides a framework to do that in. It's a thoughtful, instructional design that constantly elicits from students what they're thinking and forcing them to try to provide some evidence for why they're thinking that, and ways, multiple ways to express that. Whether it's in the diagrams or graphs or equations or words, like there's multiple ways for them to express that and there's constantly opportunities for them to share with their classmates, what their thinking is and the chance to refine that thinking and a chance to refine the model that they're building to influence how they process the world that they're living in. And hopefully that's coming closer and closer to a useful and real description of, of the world they live in.
Mark Royce:	04:03	You know, that leads me to ask you about a quote I heard from you that you've made on Twitter. You said effective teaching is as much about knowing your students as knowing your content and see, I think that relates directly to what you were just talking about, but kind of push forward on that one a little bit.
Ray Howanski:	04:21	Yeah. So I think so far we've, we've kind of emphasize the content and the things, but really underlying that is certainly the climate and culture that's set in the classroom. And a lot of that is knowing the student. None of the other stuff happens in the classroom if the kids don't buy in to what's happening in that classroom, and they're going to buy in, you know, the old expression is, they're not going to care what you have to say until they know how much you care. Right? And there's a lot of truth to that. And, and so setting that environment and the other way you can do that is really truly to try to know and understand the students that are in your classroom. And I think that the design of modeling instruction just builds on that.
Ray Howanski:	05:16	You have to trust the students. And it's been a long time belief of mine that we are learning beings like we just love to learn. And in a classroom, you're just trying to get students to learn this specific thing, right? And lead them in a specific direction. The real trick of effective education is not so much deciding on what it is you want to teach and even like, you know that path of how you're going to get those last few points across. It's really trying to figure out what the student's really thinking. Where is the student and meet them there because you know your GPS isn't going to work if it doesn't have you pinged in the right spot. You know, it's not going to get you from where you are to where you need to be until it locates where you actually are. Directions aren't any good if it's not starting from where you actually sit,

Mark Royce:	06:13	that's a great analogy. I like that. I know that you're a fan of physics first or the sequencing of physics, chemistry, biology, and some people add on, you know, other sciences at the fourth year. Sure. Tell me about like, why you made such an effort, because I know your school follows that sequencing. Why'd you make that effort to make that happen? And then the second half is, do you think it's working?
Ray Howanski:	06:44	So we just kinda sat down to ask that question, about why do we do things the way that we teach them? Why is the sequence, you know, the traditional order of courses and biology had been changing quite a bit in the last generation or so. So if you really stop and think about it, uh, it made perfect sense 40 years ago to teach biology to a ninth grader, because you're mostly teaching about things that they could experience. And it was a lot of categorization and a lot of things that a ninth grader could concretely understand. That isn't the case anymore. You know, today, if a student goes on and studies more biology, there could be some study of ecology and such, you know, some branches of biology like that.
Ray Howanski:	07:51	But even in those branches, there's always a connection back to what's happening at the molecular level. So, I had read some research and saw that there was a tremendous number of concepts that biology today relies on chemistry for, and it's not fair there. We saw it just always unfair to ask biology teachers to, uh, try to teach both chemistry and biology and squeeze it all into one course. And that was really what we're doing. And kind of what happens is you get this really shorthand version of chemistry that is oversimplified and kind of leads students in a direction that is hard for them to then build on. You really have to then when they go and learn that chemistry again, they really have to kind of forget the first kind of introductory models that were used, if you want to call them that or, representations and build again.
Ray Howanski:	08:56	I mean, energy is a great example, a very common for a student to learn about energy falling out of the breaking of a phosphate bond on ATP like candy out of a pixie stick. When in reality, energy is not stored in a bond and it's really in their rearrangement of the particles that if there's, if it reaches a lower energy state in the rearrangement it's, it's in the forming of bonds that energy becomes available. So, that's just one example, but there's lots of things happening that students are learning about in biology that they would be far better off if they had had chemistry first and then the physics experience, uh, you can, you know, drop balls, you can roll cars across the floor and you can then ask students to explain like what's

happening there and you can build their understanding and experiences that they have.

Ray Howanski: 10:01 And for a ninth grader it makes a lot of sense 'cause they are concrete experiences and then, you can build equations and graphs and diagrams based on that experience as they start there. Then you get a little more abstract with the chemistry. But again, a lot of things that you can see the change occurring in front of you and the chemistry and you're kind of locked into that. What's happening at the, you know, the micro level of the, of the molecules and the atoms, and we're trying to then look and say, okay, well what am I actually seeing happen in the physical world? And they can connect those two. You go to biology, now you're talking about a whole host of hierarchy of levels of looking at a phenomenon. So now you have to run the gambit from looking at things that are occurring at the molecular level all the way to the biosphere.

Ray Howanski: 10:59 So you're saying, okay, now let's explain, let's talk, look at the system in terms of the chemical reactions that are happening. Let's look at what's happening on a cellular level, right? Let's look at this happening on an organism level, what changes do we have? Oh, okay. Now we might want to look at how those organisms are interacting. Oh, and by the way, those interactions are, the organisms are affecting what's happening at the cellular level. And so all these things are connected. It's a really complex and to give them a fair starting point. Yeah. We just felt like they should have some background in that molecular level to allow them to connect that to all those other levels of understanding.

Mark Royce: 11:42 So what kind of results, since you guys have shifted to the physics first, what kind of results are you seeing at your school?

Ray Howanski: 11:50 So that's a great question. We do have... One of the struggles that we recently have now is that, you know, with state testing and the test is a rigorous test by giving it in junior year, there's a lot of pressure for them to do well in that first time they take it. So that's a little bit of a struggle for us. What we did see is, initially when we started this some years back with the restructure, we saw a lot more students able to take AP courses. So that was a big change after this first occurred. Our struggle now is really figuring out the biology and we're doing it. It's a very good course that we want to make, even better. But there's just this, it's not a course that you can just go out and say, Oh, you know, here's at least a framework to start with having students in high school that have had chemistry. Uh, you have to really rethink how that biology is taught and really make

some, some connections. So that's that's kind of our journey right now. Um, fortunately right now we're working with Ingrid Waldron, a professor emeritus from University of Pennsylvania has been a great resource. She does have some really, really thoughtful materials that we were basing our adjustments on. And through a dialogue with her and Larry Dukerich... Larry is doing a lot of work in taking that framework that Ingrid has developed and with a really deep understanding and explanation for these different models in biology and we're trying to ramp them up and say, okay, now how can we add on? Or how can we adjust this? Given that students have had chemistry prior to this and even, how can we emphasize students developing and deploying models as they go through and learn the biology.

Ray Howanski: 14:00 So very fortunate for us, Mark, is that in the next generation science standards is very consistent with what happens in modeling. So our state is going in the direction of using NGSS. I don't know exactly what the timeline is. We know it's happening and we know it's coming. So we're kind of feeling like we're out in front of that, you know, developing this course because that's what will drive things is the standards as we know, drive things. So we're very cognizant right now aligning to our state standards, but we also have to be ready as our state adjusts or adapts or adopts, whichever they end up doing the next generation science standards.

Mark Royce: 14:43 It's kind of exciting time for the biology thing because it really hasn't been solidified in the modeling workshops as yet. I know there's been some, am I wrong here? Correct me if I'm.

Ray Howanski: 14:54 Sure there's been, there's been lots. There are schools, there's schools out there certainly doing and working on uh, the biology in a physics, chemistry, biology sequence and a modeling approach. It just, they just didn't fit like what we were emphasizing and doing and our standards. So yeah, we just kind of, uh, had a different take on how we were going to go about that. Most of what's happening in the modeling biology is a biology first course. Right. And that's a much different approach than what we're taking. Sure. And the other thing, and I'll say about all this, it takes years. Like you three talking about David Hestenes and Malcolm Wells and those guys who did all that early work, it takes a long time. So anybody that makes contributions to a curriculum, especially high quality curriculum, like the modeling units, I just take my hat off to like, it's a lot of work and if you're out there trying to do it by yourself or you're doing it with, you know, a couple other folks, it's really, really hard.

Ray Howanski:	16:10	And it really takes a lot. And I have to say like, I count myself so lucky knowing the folks that I've known, like I have worked with Brenda Royce and Larry Dukerich for years on modifying a few of the units and the chemistry. And it would take us years to modify and revise and to rewrite one unit. Sure. Uh, you know, we'd been doing it all over emails and Skype and all of that because Brenda's in California and Larry's in Arizona and I'm over here in Pennsylvania, but it just takes so long to do this. And now as you know, we're trying to connect the way we teach the biology to the chemistry and physics. And I believe we're on our way there. And if I can just, the other thing I wanted to throw in there is about the community of folks that I work with here in our school district.
Ray Howanski:	17:06	'Cause that is so important. Like having that relationship. Like, we just have a super group of teachers and administrators and support folks here, you know, to make an effort to bring in the highest quality of curricula and educational practices, uh, instructional methods that we can possibly find. So when the superintendent here sees something that makes sense and even though it's an effort and we have to kind of figure out ways to do it, figure it out. We figured out how to get the best materials that are out there. And it's not about publications, it's not about a program. It's about bringing in these practices and it's usually comes down to people. You know, when we look at what's successful, it's about people, the teachers that we have here. We just have a fantastic group of teachers, students, parents. I mean that network, that community are just willing to say, okay, what's best for our kids and let's work hard and let's make that happen for our kids to give them the best possible future.
Ray Howanski:	18:13	That's really what drives it. You know, the other stuff, the nuts and bolts and all that is great, but it's really about that vision of saying, okay, what experience can we give these students to challenge their thinking and to give them opportunities to really practice and problem-solving and some effective communication skills and collaboration. How do we really challenge them to do that at a higher high level, and kind of leading them into a path of success somewhere, somewhere down the road.
Mark Royce:	18:44	You said learning is accelerated when we collaborate. I want you to elaborate on that a little bit. Elaborate. Collaborate.
Ray Howanski:	18:53	Yeah, for sure. Um, so it's, social is one of the things that modelers certainly believe and, I think across the board and David certainly --David Hestenes -- certainly espoused that, that we are social beings. And like I said, I very much believe it's

innate in us to be having a desire to learn. And so it just makes sense that if you look back, like we certainly learned socially. If you were to think of it in terms of like a crowdsourcing or you know, on a bigger scale or if you think of a computer with networks, right? So what's happened with the world web, all those things. When you connect all this information and do it somewhat systematically, then you can really ramp up the kind of information you can gather and what you can figure out from that. Uh, and I think it's the same thing in a social situation. So when you get groups of folks together and they start collaborating towards some goal, everybody brings a little different perspective. Everybody has ideas. And when the welfare of the group, and especially in this case of the students, is at the forefront

Ray Howanski: 20:03 Yeah. And that's what you're working towards and that's what's driving everything and you kind of get the egos out of the way and you get, you know, nobody's worrying about credit or anything like that. You just say, what's the best thing to do here? And you sit down and you start kind of working through this. Things just kind of fall into place and it becomes self evident almost and you just keep, that's what really I think energizes educators when you see, yeah, like it's sometimes measurable on an assessment sometimes measurable on a test, but when you see the lights go on, you know, we all talk about that. But that's really, you can feel it in a classroom when you see these kids working together and trying to figure out like they may or may not get to quote the answer, but you know that energy and you know that they're working hard towards it and you know that you can kind of help them polish it off at the end.

Ray Howanski: 20:54 But man, it's that energy. It's that light. Like when you look in the kids' eyes and you can see them really cause those wheels turning and you know, you see them working with their small little group trying to figure a problem out working different angles and coming up with different theories. And erasing things. Like that's, that's what makes it work. Like, that's, I mean, we say this all the time. We can't even anticipate half the things that these students are going to be facing in their careers, in their lifetimes. But what we do know is they're going to have, they're gonna be facing problems and they're gonna have to talk through it. They're gonna have to collaborate and they're gonna have to figure out how to solve them. Yeah, exactly. And we can't solve it for them. What we can do is just keep energizing that, that thought process, that energizing that, that desire first of all to communicate and to collaborate and

then to, as they're doing that, then we can kind of guide them along the way.

Ray Howanski: 21:48 You know, one of our district, really led by the superintendent very much focused on that experiential learning piece that you need to be in that experience to really appreciate and to really learn personally. So to try to layer something on to somebody that they can't relate to. Really difficult, especially for a high school student. But once you get them involved and once they participate in, once they're there working in the classroom, then they're much more receptive to guidance, suggestions, to tweaking, you know, where they're going with this learning process.

Mark Royce: 22:25 Well your eyes lit up. And you got excited when you started talking about this. Uh, you know, it's interesting, I hear many modelers talk about the fact that one of the dynamics that changes in the classroom is instead of an expert delivering information to an audience, you're involving everybody in the room. And I think we all learn much more in a social setting when we feel connected.

Ray Howanski: 22:51 Yeah. Like connected is a great word for that. And you also find out how really smart a lot of these kids, sorry, you're like, you know, they really look at things in a different way. And uh,

Mark Royce: 23:04 and how could you know that if they're sitting there passively absorbing information, how can you know that diamond in the rough, you know, you don't know. I also hear modelers and I want to get your take on this, talking about even the modeling community through AMTA, how it has energized them to have collaboration and to be part of a tribe, to have a sense of belonging to a group of likeminded people. You want to talk about that you've been involved now for awhile.

Ray Howanski: 23:37 I want to start at the beginning when I first started teaching and you know just was fortunate. I mean I just came in to just a great community here at Ridley, there was one assistant principal, his name was John Whitby and I had many conversations and it started me off on a on a really good path. I think one of the things he said to me was, Ray, just anything you do in these first couple of years, make sure you go in and see other teachers teach and see other classrooms and talk to them about what they're doing and why they're doing it and pick their brains. I was really happy now looking back that I listened to him. And we just have some fantastic teachers here and a great community. And the more you talk to folks, it's just the more

you learn and it really does empower you and give you this whole set of tools that you can use as a teacher.

Ray Howanski: 24:30 And it really doesn't matter the discipline. Like that's kind of where I started. Like, you know, it almost doesn't matter the discipline. So fast forward, working with a lot of fantastic folks here. Another one that you know was real influential to me was a gentleman by the name of Rich Clevenstein. You know, really supported my continuing education and thinking about new ways of instructing and giving me opportunities to develop some courses and some units. And that's all part of the development. And then it kind of landed in the modeling community, like after the searching and you're kind of on your own, you're kind of working with your teachers here and then in the modeling community. So what I found is that network, so now you're linked in to researchers and you're linked in to these folks that are in higher ed and an open dialogue with teachers in all different environments all over the country thinking the same way.

Ray Howanski: 25:29 Like how can I do this better? You know, there's some real limitations in the way I'm teaching and how can we kind of restructure the classroom and make this a better experience for students. Just give you a couple of quick examples here. So I was talking to a group of our teachers this morning about this sharing cause I said, I can't believe it was this long ago, but, quite awhile ago, sitting there in a chemistry classroom and a student raised his hand early in the class and says, uh, Mr. Howanski, uh, you just draw a picture of the atom up on the board. And I thought that positive and negative things attracted. How come those electrons don't crash into the into the protons? Like we're not really ready to talk about that yet. You know what? I know that I do. I know that.

Ray Howanski: 26:23 And then he starts saying, well then these electrons, they're supposed to repel each other. How come they're all out there all kind of hanging out together. And it kind of hit me that the structure of the class just wasn't conducive to being able to build a student understanding. So that was a kind of an example where things I hadn't even thought of. So when you get into other folks that have kind of asked those same questions or maybe a little farther along in their journey, I'll try to figure out new ways to approach instruction, instructional design, sequences of learning. You can really come up with some really, really cool ideas and really make some progress in addressing some of the students' hurdles and misconceptions. So that's just kind of like one little example of the kind of thing you run into and you just have this light bulb.

Ray Howanski:	27:16	You're like, I really don't know what I can do about this. It was so troubling to me, but I felt really frustrated. And then you become connected with like I was saying like this, this network of researchers in higher ed and there's all the other teachers, you know, try and all these different approaches and it kind of falls out like what you should be doing. If everyone's open to it, you kind of see, Oh, this is the path. And then you start measuring and tracking your results. And so far, you know, it's been lots of positive data linked to the modeling instruction. So that's part of the answer. But then, then there's actually the people. So, and again, I want to build like, so fortunate, you know, like what the people that have work here, uh, work with here at Ridley. It's just we have a really good group of folks and kind of pointed all towards the common goal of trying to figure out how do we provide a good solid learning environment for kids and how do we get them ready for the future? But then, man, that just blows up exponentially when you go out and you network in with all these other folks that are also doing the same thing, you know? And they're also on the same journey from different perspectives and in different situations with different knowledge of background and sometimes different roles. And you start having these conversations and that synergy just keeps building and yeah, you know, what Hestenes started but some, I guess 40 years ago when it's thinking about modeling at the philosophical level, and you just continued to grow into that framework of what can you do when you really work with open-minded, caring people, towards the goal of helping students learn science better.
Ray Howanski:	29:10	So that kind of makes it all worthwhile. You know, all the late nights and the early mornings depending on time zones and all that of folks you're working with. Yeah. Well then there's the personal end, so you get to then really know all these other folks at a personal level. And that's really important too. You know, because you see and just know them as individuals and that so many people are overcoming so much and we'll make so much, so many sacrifices, you know, and then they move of figuring out better ways to educate and, and further further kids. It's, it really does kind of strike you when you see what people are out there doing and just figuring out a better way to do this and for no really no other reason than for the kids
Mark Royce:	30:03	Listening to this podcast, we will have a lot of different people at different stages in their modeling experience and, and then we will even have some, probably some brand new people who are just learning about this that will hear this podcast. So I have two questions. One, what would you say to encourage those to

keep on that have been involved and what would you say to those who are investigating -- the curious right now?

Ray Howanski: 30:30

Wow, that's a great question. So those of us that have been around it for, for a while and looking at the modeling, um, I guess I would say like, it's more than the models, right? It's this, it's then that work. It's, it's that synergy that we all have from working together. I would say appreciate those that you're working with and around and stay open to the fact that our model still needs refinement. We still need to develop and deploy more models. And there's things that we can't even anticipate or work yet to be done, but opportunities will certainly open to us if we're open to those opportunities. So new modelers, I was just coming into modeling, I guess some of it would be the same, that it's more than, than the nuts and bolts of developing and deploying models.

Ray Howanski: 31:28

Uh, that's part of it, but it really is in the larger sense an accumulation of some of the best evidence based practices that can be found. I mean, in a way I do understand why it's called the American Modeling Teachers Association. I get why we're called modelers, but I do sometimes in the quiet moment sitting and thinking about it, you know, I do wonder. It's a lot more than just modeling. It certainly is modeling and certainly is models. But there's a lot more to it than that. And I just hope that that word doesn't confine folks' thinking to just being about models and modeling. You know, it is about a lot more practices. There is a lot that goes into setting up that experience the students will have as they build their models and as they deploy their models that the teacher has to do to kind of make all that happen.

Ray Howanski: 32:26

And, and a lot that happens as a result of that. So just realize that it's that in your journey, lot of it is about networking, about the people that you're with. And then there's the contribution piece, you know, like it's hard. It's, man, I was so intimidated by some of the folks and still to this day, sometimes I get on an email chain or I'm looking at things and I think to myself, wow, like this person really knows their stuff and who am I to bring up my questions. You know, it's kinda humbling, but yet that's one of the really cool things about the modeling community is it's okay. Like, that's where you're thinking, that's where your understanding is and just be courageous enough to put that out there and then like it'll just take off from there. You'll just start breaking down barriers and things that you just kind of accept limitations, and what you can and can't do either personally or professionally. And I can tell you a lot of those barriers have been smashed, and again, I will say part of it from support here

in my district by just a great community, and also by the modeling community. If we're just open to, doing the work and, and try to figure things out together that you can do things that you didn't think were going to be possible.

Mark Royce: 33:55 You know, Ray, you said it's humbling and I appreciate that. I think that's part of what I see in the character of many of the modelers that I've been talking to through this podcast. Many of them feel the same way. Appreciative about you. Your name has come up quite often with some really brilliant people. I love what you said about the, the name of modeling instruction modeling methodology that it doesn't get too narrowly defined because the learning environment, everyone that I've talked to in the modeling community has talked about exactly that in different words, but you've put it very succinctly, the kind of learning environment that you create through modeling instruction approaches, those become methodologies that you use. But that's the hub around which you build something else. Something bigger than just a modeling technique.

Ray Howanski: 34:51 Yeah. As, as lots of folks in modeling would tell you, like all models have their limitations, right? And so this is a case of that, right? So we think in terms of the interaction of the teachers or the students in terms of a classroom interaction or we think of them in terms of professional development experience, but the reality, but actually what's happening there is more than that model of just professional interaction or classroom interaction. Actually what's happening is more than that, that's all we're just focused on in that case. And fortunately I think a lot of good things come from what we hadn't even considered in our model. So maybe we need to kind of incorporate some new and different characteristics, or look at it a little differently. I'm so grateful for everyone that I've gotten to work with over the years, certainly locally here. And then I'm also in the modeling community and that journey I was just started with, you know, the first workshops that I took as a learner and that experience of refresh and a re-look at what you set out to do as an educator is so powerful. And that just kind of reignited that curiosity in me. Something that I mentioned that I probably should, like I started out as a philosophy major back in the day. Yeah. So epistemology, trying to figure out like how we learn things has always been something that was, is, high up on my list of things to...You know, that joke Steve Martin says about philosophers, you hear that, you go to college, you take a major and most people take their major and then they forget 90% of what they learned and then they go on and live their life. He said, philosophers remember just enough to screw them up for the rest of their lives.

Mark Royce:	36:50	Yeah. We won't make any jokes about chemistry teachers.
Ray Howanski:	36:56	Not the forum for that. Um, so yeah, so you go on and, and you know, after taking a workshop and you have that learning experience as a teacher and then it just reignites that curiosity of man, like, how did I learn this? And you know, how have we figured this out and how are we at this state of our understanding of the physical world, whether it's physics, chemistry, biology, environmental science, astronomy, whatever. And you start thinking about what can we do to kind of move that learning forward? What can we do to accelerate that learning and figuring out how to make the best of our situation in terms of the educational organizations that we have and in terms of what we know and don't know about, again, these disciplines, physics, chemistry, biology, et cetera.
Ray Howanski:	37:52	Uh, so then when you start connecting with other folks that have really innovative and thoughtful ideas about how we can rethink providing those learning environments for students and kind of breaking those barriers that are sometimes, somewhat confining, given students an opportunity to really explore and express their thinking about what they're looking at and setting a solid foundation so students don't have, so they have a clear path to a deeper understanding, so to remove some of the obstacles that we've sometimes placed in their way in terms of getting to deeper investigations of the physical world. And a lot of that is trust. You know, it's trusting that students will in fact fill in the gaps and they will figure things out that it's not about us giving them all the answers as we had kind of talked about earlier.
Ray Howanski:	38:55	But rather opening that learning experience up through learning about where they are and then giving them some foundational experiences and some tools to talk about their thinking of some of these foundational experiences to then move our total understanding the scientific community forward. These are the folks that are going to be figuring out the problems of tomorrow and what our job, we would see it as as laying that foundation, helping them build useful models, right. That they can then go on and continue to refine and and use as they see fit in different situations, but not to limit their understanding to what we think that they can learn. Not to limit them to what we think they should know, but rather to say, here's this physical event, here's what happened. Now let's build that understanding and help you understand your thinking process as well. Help you reflect on the tools that you're using and the concepts that you're building on so that you can then manipulate that as you see fit

and as the situation calls for in your future. That's what we want students knowing.

Mark Royce: 40:15 Yeah. So you've been sharing I think a lot of very important information. I want you to speak directly to those who are in the process of exploring modeling as an encouragement.

Ray Howanski: 40:28 Yeah. So, it's taken a lot of really thoughtful, hardworking people to put together some coherent sequences of model development and model deployment and even some integration between the courses man, you can really build on that and it's a really good structure to come into and you can have some really impactful contributions and it can really reset your ability to provide useful learning experiences for students. Those two things combined make a really rewarding career. So if you're able to provide to students these experiences where they're building and deploying models and really problem solving and communicating and collaborating as they do it. And at the same time have this network and conversation with, with this network of professionals that are also trying to figure out how to design and manage a learning environment where students are doing this, it really is, is rewarding. It really does kind of shift away from a job to a career to, almost, your life's passion. So, and that, that's really where, where it can take you. And, and the other thing is there's no pressure. Like, you come in and, and you say you use the modeling community as is, but you kinda come in as you see fit. Like there's no expectations, no pressure. There's people thinking I think really hard and doing some really interesting work about how we can improve things for scientific learning. But you might find this useful and you might want to contribute a little, you might contribute a lot and you don't know what those contributions can be until you really get involved. So I think it's worth an exploration for sure. And for many of us, it's been real impactful for our careers, as educators. Wow.

Mark Royce: 42:42 Well, Ray, man, you've talked about a lot of really great stuff. We talked about physics first and how it's evolving and we've talked about integrating biology modeling processes in the workshops and all that kind of stuff. We've talked about the NGSS stuff, you know, it's been really great, but I've heard a thread through your entire time about community and the importance of creating a sense of community in the classroom and the developing community of modelers. And here at the end I heard you encouraging people to become engaged and I think that's a very powerful thing if we just sit back and watch and think we're going to implement on our own. It's not the same. We don't have the same benefit and the community

		doesn't have the same benefit as when each person adds their voice to the dialogue and the conversation. So thank you so very much for taking the time to talk to us and I just wish you the very best of luck in your career and the work you're doing with innovation and in curriculum. We didn't even talk about that really. Maybe another time we can have you come back and we'll talk about some of that stuff too. Does that sound good?
Ray Howanski:	43:54	That sounds great. Mark. It was great talking to you and no, thank you. I really appreciated your patience with me and your guiding me through my thought processes. So I just, I'll say it's one thing to you, Mark. Larry would often say about me. You know, when we got talking and he's like, right, you remind me of a locomotive. He's like, he's so slow to get going, but man, once he gets going man, there's no stopping you.
Mark Royce:	44:18	I was thinking that exact thing, man. Once we got going, you were just on a fast track. It was awesome. So anyway, uh, again, thank you so much. Okay.
Ray Howanski:	44:29	Thank you. And tell Brenda I said hello, please.
Mark Royce:	44:33	Oh, will do.