

Mark Royce:	<a href="#">00:00</a>	Tell me where you were before you discovered modeling in your life as an instructor?
Brenda Royce:	<a href="#">00:06</a>	I started teaching after several years of working in laboratory settings and was hired because I had the credentialing to teach physics. However, the truth was that my background for that was a little weak and I felt like I really needed some help on how to teach physics. So I kept poking around looking for things that would help me do a better job of teaching that subject. And I happened across a half day workshop that introduced modeling instruction. And when I attended that workshop in that short time, it was like that is exactly what I need. It fit all the philosophies of what I'd learned in my credentialing courses about how to teach. And it fits so perfectly with what science is like from my experience, both in a commercial lab and in a research setting.
Mark Royce:	<a href="#">01:01</a>	Tell me about your early experience with, you know, your workshop and, and your first attempts at implementing in your classroom setting.
Brenda Royce:	<a href="#">01:09</a>	Okay. So, um, I happened to come in at a time when, uh, National Science Foundation was still funding the workshops. And so they were longer as a result because there was underwriting to also provide support for the teachers to be there. So I had the benefit of eight weeks over two summers, six hours a day. So I spent time with about 20-25 other teachers in a month-long workshop. Mostly we went through curriculum, our leaders acted like the teachers in the classroom and we would carry out the labs and the activities and learn the flow and thought from the perspective of both the teacher and the student at the same time, the kind of dialogue that go on in the classroom. The kinds of questions our workshop leaders would ask in the conversations or the hallmarks of modeling is that the students use actual observations, labs mostly to understand some particular phenomenon in nature.
Brenda Royce:	<a href="#">02:18</a>	So we might be looking at little battery powered buggies moving along the floor, studying their position (vs.) Time as students learning how to graph the information, diagram it, describe it mathematically, talk about it and how to use that to look at other phenomena. So we went through significant periods of the workshop. Us being students and them being teachers so we could experience the teaching method from the student side, see it from the teacher's side. And then as the workshop progressed we would start trying our hand at actually leading from the teacher position based on ways we'd seen them interact with us primarily through questioning and

dialogue and almost none of it based on instruction, direct instruction like lecture style teaching. So it impressed me the way we had to work together to basically develop understanding. In the workshop we got a chance to see the method in action with the way that our workshop leaders interacted with us experience what the students who would be experiencing here, what the big ideas are that are being emphasized.

Brenda Royce: [03:31](#)

But we also talked about ways that students misunderstand. And that was another component of the workshop was having conversations where we reflected on what was going on, what the ideas were. We actually talked out places where individuals, including me, had poor understanding of an idea. It was really fascinating how well it actually improved my own understanding of the content, which was really beneficial to me. But we talked about ways students don't understand, where they have naive conceptions about the concepts of science, in this case physics. And when I got back in the classroom and was trying to implement it that first year, I found it was challenging to actually dialogue when I was accustomed to the idea of telling. So coming up with... With questions on the fly, uh, as you listened to what students were saying and then tried to recognize what it was that they were understanding or not understanding and how you could guide them toward better understanding using questions that drew them back into core ideas, drew them into details that they were missing and such that was challenging.

Brenda Royce: [04:45](#)

But as I did that, I was amazed at how well the collection of naive ideas students have just started showing up in my classroom. I could see them, hear them, the kids were obviously thinking this way and I had entirely missed them before because I never asked them to go to a place where those things would be evident. Before going through the training, you know, I would teach kids and I'd recognize they didn't understand, but I didn't know where it was. I just thought, well, they just don't understand yet. I didn't realize that I had this barrier of alternative ways of thinking about it that were getting in the way. On one sense, I kind of sensed it, but I didn't know what it was nor how to deal with it and I was just really amazed at how many of the things we learned like force wearing off as opposed to forces slowing things down, opposing forces, slowing things down.

Brenda Royce: [05:46](#)

Just stuff like that. Motion naturally comes to a stop, you know, forces continue to act after, say you've thrown a ball, the force of your hand, it continues to act on the ball after it leaves your

hand. Those were things that I thought, oh really? But then there they were. As I started probing, I would hear them. So one of the things that modeling did for me was give me ideas about what students might not understand, the way they would misunderstand it, competing ideas they may have. And then tools for finding those and helping me hear them and helping the students recognize that there is a better way to think about it than what they were thinking. That has played out not only in physics but in chemistry as well as I've translated this over to chemistry. So.

Mark Royce: [06:37](#) So tell me about the emotional impact that this new knowledge had on you. Tell me about how it impacted how you felt about teaching, about how you felt about your students.

Mark Royce: [06:51](#) I'm curious.

Brenda Royce: [06:53](#) Well, on the physics side, which is what drove me to this, I felt inadequate to teach the class. I felt like my words for it was, um, I kind of inherited as the only physics teacher in a one high school district. I had nobody to go to, to be my mentor and I was handed what I thought of as a dusty book. Yep. A disorganized room of equipment in the back. And I knew the kids weren't deeply learning it, but I didn't know how to guide them to do it better. When I discovered that I could actually help students develop a deep understanding and that they could in fact articulate it, I didn't just have to get them to approximate the idea. I could bring them to a place of articulating the actual core idea clearly to represent it in a variety of ways and use those to understand new problems. Not just plug and Chug, put numbers into equations and come up with answers. But they could talk about the problem itself. It was, well, the whole reason you go in the classroom is so that you can help people grow as persons in their understanding and knowledge. And there it was -- all of a sudden I was being fulfilled as a teacher. It's like there's no turning back from that once you know what that's like.

Mark Royce: [08:20](#) Tell me about how modeling instruction may have influenced how you feel it in your identity as a teacher.

Brenda Royce: [08:32](#) Ah, um, I, I guess there's a couple of things about me. One, I've always been sort of drawn to teaching. I taught piano to get my degree in chemistry. As a musician I have taught children's stuff. I've worked with youth and adults in my church. Teaching is something that I have been drawn to. So it's kind of a a core thing in me that has always been there for about as long as really since late teen years that I've recognized. I, I like teaching

people when I was working in the lab training others was something that I got a lot of satisfaction out of. So teaching has been something that, um, helping other people learn new things and grow in their ability has been very satisfying to me all along. As a person, I like understanding things. Coherency of understanding is, I've come to find is a driver for me.

Brenda Royce: [09:38](#)

I can remember in college hitting this one thing where I was taking both chemistry and physics classes in my pursuit of a chemistry degree and we hit the concept of thermodynamics and I was getting this conflicting presentation of what energy is and how it plays out in these scenarios. And so I remember feeling really frustrated that I couldn't seem to come to one coherent idea that could allow me to really deal with the thermodynamics in chemistry, which deals primarily with temperature changes and such as matter changes. Whereas in physics, the temperature piece wasn't as big as it was, um, about objects moving around. And so the language was really different and it really was just one of those where I can still remember the feelings I had in college of why can't I put this into one coherent idea. The training with modeling and looking at energy through models actually finally gave me a sense of coherency on this where I had a way of talking about it and thinking about it that allowed all the pieces to come together and make sense.

Brenda Royce: [10:54](#)

This is a driver to me. It's something I just push on until I find this idea of teaching around a set of models as opposed to a bunch of topics really resonated with me deeply to have the means to talk about it from multiple perspectives, whether we were using graphs or equations or words or diagrams, relating it to physical experiences, these things gave a multidimensional coherency to the ideas and I find found it extremely satisfying and then add to it that it gave me the ability to draw students to a similar coherency of thinking and move away from a vocabulary, equations, procedures, into understanding. And um, I just can't even imagine having any other approach to it in it has brought me to a place where I feel like as an educator I am not bringing people to understand that I'm not doing my job.

Brenda Royce: [12:03](#)

The young people in front of me, their growth as persons is in my hands when I can help them either have an understanding that they appreciate or a frustration at a whole onslaught of information that doesn't have coherency. And not that they don't learn anything when you do it differently than other than the around models. But what I heard from my students was so much deeper and well-rounded real conversations about "why" and "how" and not just "what" was happening. And then the

other piece is that I would find the students who actually remembered things, oh gosh, prior to modeling it was like, well Mrs Royce that was like, you know, last week, what are you expecting me to still remember that? And now it's like we can talk about things that happened last month, last semester, and the key things are still there and they still understand it. They haven't forgotten. Some of the details may need brushing off, but the core ideas are often still in place over time. So I don't wanna waste my kids' time and I don't want to waste mine. So I want a method of teaching and helping them that actually produces deep enduring understanding. And I found the tools to move that direction with modeling instruction.

Mark Royce: [13:27](#)

How do you find that other teachers who you know who are employing modeling? Are you seeing the same thing? Do you think you're a unique individual in your passion or are you finding a similar kind of thing for others?

Brenda Royce: [13:40](#)

Based on the responses of teachers whom I worked with, uh, it's a couple of the middle school teachers locally that I've worked with that we have wonderful conversations together and they get excited about this. They also feel that they get so much more out of their students with this kind of approach to teaching. When I lead workshops, especially in the last oh seven, eight years, as the idea of models has become more mainstream, the teachers are very open and they get that this is actually a better way to teach. Even in days before that was there, they would say, yes, I see it, but I have all these limitations in my district. Why I can't do it. So they wouldn't be able to necessarily implement it very fully. But I have had a number of teachers from workshops who are like, I am so grateful that, you know, I was able to do this.

Brenda Royce: [14:37](#)

Or we still sometimes contacting me clearly still working on implementing and influencing others to do the same thing. You know, meeting up with people at conferences that I've had a chance to work with in a -- in a workshop in training it's been really satisfying to see that they are excited about teaching. There's a university group in Cal Poly that found this and said, this is what we want to do to train our teachers because this seems to be one of the strongest things we've been able to find. And I've been over there a number of times helping train teachers there and it's, it's just, um, I think most teachers who find it recognize this is good. Especially like I said, as this idea of models in science has become more mainstream in its thinking. No, it's not just me. Um, I learned it from others who were enthusiastic and I have met so many people who've said it's changed their teaching career. It certainly has changed mine.

- Mark Royce: [15:44](#) The content that's covered in this two to three week workshop is a basic introduction. But if you could say like a list three things that I wish that people understood about modeling that's not covered in the workshop, what would you share?
- Brenda Royce: [16:00](#) Not covered in the workshop? I'm not sure in the workshop you get the introduction, but it becomes rich when it's implemented and I think the understanding of it grows on you when you start to see it in the classroom. So that's something that can't be put in the workshop as directly. We certainly try to make sure that the key ideas of modeling are there. I wish in the workshops we had more time for teachers to get direct practice with the methods from the teacher's side of it. But that is a limitation of how long we're able to make the workshops. I did a four week workshop now I generally teach two-week workshops and that's just really barely enough time to get enough content where people see the pattern well enough that they can see how units are constructed, how models are developed with students and see it in a variety of enough ways that it's not just, "Oh, that unit." This is a pattern repeatedly. And I see it here, here, here, and here in the various ways that different facets of nature have to be modeled. I don't know how quite, how to answer that beyond that.
- Mark Royce: [17:19](#) Well, I think you've done a really good job of answering it. Um, tell us about how your interaction with your students is impacted by using this methodology or these methodologies.
- Brenda Royce: [17:32](#) Yeah, there's kind of two big ideas come to mind. One is students who are willing to be a little vulnerable and shall we say, play the game with the teacher, take it a little bit differently than they're accustomed to in the classroom because modeling kind of upsets some of the learned school habits. And then there are those who are not so willing to risk changing how they approach learning. And it seems in more recent years I've seen more students who I really have to work harder with to make sure that they, um, they feel safe and are willing to risk and kind of chide and push just a little bit to get them to step outside their comfort zone because they've learned some very passive ways of learning. But at the same time when I finally can get through to kids like that, I see them with light bulbs going on.
- Brenda Royce: [18:30](#) You know, you see it in their face when they really truly understand something as opposed to know about it. Like just last night I had a conversation with two students from last year who we happened to pass each other on the way off campus today, uh, yesterday and they commented how much they appreciated what we had learned in chemistry. They're now in a

biology class. One of the things they talked about was really understanding it that they weren't struggling with recalling information because they had an understanding level to build off of. One student made a comment that when they were making some presentations near the end of the year, he recognized that my questions when I ask questions really helped students notice whether they understood the content or not, whether they understood what they had said and that expectation that they should understand the content had really come through loud and clear with these two particular guys I was talking to.

Brenda Royce: [19:39](#)

I've had students come back to me quite frequently and tell me how much they enjoyed the class, how much they learned, how it has impacted their learning in other classes. You know, like when I'm writing letters of recommendation for them as seniors and they'll say, you taught me how to learn in such a way that I figured out if I just did these in other classes, I learned them better too. So the joy of finding out that they became more powerful learners as a result of what we did is really satisfying to me. I've had a, I had a student who told me as I was in preparation for writing a letter of recommendation for her, that it was in my class, that she learned to think for herself and how she'd been really uncomfortable at first with this idea that I kept asking questions instead of standing up and disseminating information to them through a lecture, that I guided them through activities and questions more than I did giving them information and she warmed up and eventually embraced it. And then one of those kind of quiet girls in my class. But what was funny after I wrote that letter of recommendation had read those comments from her at the end of the year, she was the Valedictorian for the entire senior class. Someone who had been academically successful, all of her life took till 15 to figure out, she could think for herself. That really impacted me.

Brenda Royce: [21:12](#)

It's really fun to watch their faces when they really understand. And when I was doing more lecture many years ago, um, I saw more looks of confusion than I saw looks of satisfied understanding

Mark Royce: [21:30](#)

with all the controversy going on in the world today about gender roles and, and, uh, gender bias and equality. Can you talk to me about how in your classroom you're seeing the impact with girls? Science historically has been a pretty heavily male dominated field. Can you talk about you as a woman, first of all in the field, in the classroom now, how are you being received by boys and are you able to encourage young women? That was too much question. I'm sorry.

Brenda Royce: [22:04](#)

That's okay. I'll see what I can do with it. Um, well as a female sciency, mathy person who never was quite in step with the expected gender roles when I was growing up in the 60s, seventies as a, as a child and a teenager. Fortunately I was encouraged to become myself and not worry about that quite so much. But it is something that I find deeply satisfying. So I have worked with men and women in work settings and I've had, you know, minor experiences with not being received based on being female. But that's not the norm. I have enjoyed being well received across my career. Been respected for what I was capable of doing. I think the fact that I am a very articulate person who insists on clear understanding and clear articulation of ideas and pushes to a place of core foundational understanding as opposed to a collection of information that may hold together somewhat in a student's mind tells both my male and female students that understanding is a core value, that it's open to everybody.

Brenda Royce: [23:29](#)

And I expect both the guys and the girls in my class to be equally articulate. I don't think I favor anybody one way or the other. And they're kids in both genders who find that easy and those who find it hard. So I know that I do at some level serve as a role model for girls who may not have considered that path as openly, but maybe because of my own expectations, I just don't go looking for those biases. Instead I go looking for our personhood. And I think that's what I find, cause that's what I look for. That in and of itself will make a difference. I know with my students because if I'm more focused on who they are as a person and less on who they are as male or female, then it keeps the discussion and the interactions on a level that just minimizes the differences and enhances our commonalities. And that's important I think.

Mark Royce: [24:30](#)

I think so too. I want to thank you for taking the time to have this conversation for being willing to share your thoughts and uh, I wish you all the best in your career. Thank you. Brenda.