Mark Royce (00:00):

Hey, Mitch, how are you doing?

Mitch Sweet (00:02):

I'm good, Mark. How are you?

Mark Royce (00:04):

I'm good, thanks. Thanks for taking time outta your busy schedule. I know you got a lot going on right now, so I really appreciate being able to sit down with you and chat about modeling.

Mitch Sweet (00:15):

Yeah. Happy to.

Mark Royce (00:17):

So, tell us, our listeners, especially a little bit about you, where you are, what you're doing, and then we'll get going.

Mitch Sweet (00:27):

Sure. Well, I am currently teaching chemistry at the Scottsdale Community College. And so I'm practicing modeling instruction here with all of my chemistry students. I teach both an introductory chemistry class, so similar to sort of a high school chemistry class. And then a general chemistry class that's a two-semester sequence. And so this is my fifth year at the college level. I have also taught 10 years at the high school level before that. And then I lead some chemistry modeling workshops here in the Phoenix area. Been teaching those at ASU now for probably about eight years or so.

Mark Royce (01:17):

Oh, awesome. Well, ASU always hosts a very good program for modelers.

Mitch Sweet (01:21):

Yeah, I'm very fortunate in that, this is where I happen to live and so, when I first came across modeling instruction, it was just great because, all of the workshops are within 20 minutes of my house. And there's lots of people that are coming through here. So I've got to meet folks from all across the country that have come through to take workshops and it's very fortunate, just in terms of where I happened to land and what modeling offers.

Mark Royce (01:58):

So you've been teaching workshops -- that means you've been doing modeling yourself for a while now?

Mitch Sweet (02:04):

Yeah. After my first year of teaching, I took my first modeling workshop, and so I was teaching at that time at a high school in the Phoenix Union District. And the science coordinator for the district at that time was Russ Schafer. Russ is a longtime modeler as well. And Russ was teaching the chemistry modeling workshops back then. But he had encouraged me to take a physics modeling workshop because it looked like there was going to be a physics class that I was likely gonna be teaching the

following year. And it had been a long time since I had taken any physics, myself and Russ said, Hey, I think this would be a great opportunity for you.

Mitch Sweet (02:57):

So that must've been 15 years ago I think that I took that class. It was summer 2010. I remember doing some of the readings for that class. In particular, the David Hestenes paper, Wherefore a Science of Teaching. I just remember being blown away and thinking, oh my gosh, why isn't everything taught this way? And it just got me really excited. And then I pretty much was taking a workshop or two every summer after that until I had taken just about everything that I could.

Mark Royce (03:43):

Wow, that's pretty cool. So you first heard about modeling through the Hestenes paper, or?

Mitch Sweet (03:51):

Well, it was through a colleague. The Hestenes paper was actually one of the papers that we had to read, in that first mechanics modeling class that I took that first summer. So it was a colleague that said, Hey, you know, if you're gonna be teaching physics, this would be a good opportunity for you to learn how to teach physics in particular. And as it turned out, that physics class never made the following year. So I didn't end up using it then, but I did have a physical science class that I taught that following year for some ninth graders. And so there was a little bit of physics and a little bit of chemistry in that class. And so I certainly employed some of the things I had learned from that first class. And then I dove in and took a CASTLE workshop, which is the Capacitor assisted way to teach electricity. Then I ended up taking the chem modeling workshop and the E and M workshop and chem two, and thermodynamics and just about everything I could get my hands on.

Mark Royce (05:00):

That's awesome. So how would you describe how modeling itself in your career has impacted your teaching?

Mitch Sweet (05:10):

I did not go to college to get a degree in education. I have a bachelor's degree in chemistry, and I have a master's degree in, technically it's in forestry, but it really was in wooden fiber science. So it was specifically applications of wood chemistry type of thing. I was not trained as a teacher. But Arizona, like a lot of places, has had problems finding teachers. And that's been going on for a long time. So I had been doing some other things career-wise, and when I was about 40, I decided that I wanted to give teaching a try. But both my parents are retired educators. My dad is a retired elementary school principal.

Mitch Sweet (06:13):

My mother is a retired elementary school reading teacher. And so for me, teaching was the family business I wasn't going to go into. There's gotta be just something in the blood isn't there, you know, you think you get away from it and, and there's just something inherent. When I started teaching, I just tried to mimic the teachers that I had. I taught in the way that I was taught. And I thought I was fluent and caring and funny, and I tried to be as engaging as possible. And I think the students enjoyed my classes, but I'm not sure that they learned as much as they could. And so, once I took that first

workshop, I really began to think about, okay, this lecturing, no matter how smooth and fluent it is, is not the way that most students are really gonna learn best.

Mitch Sweet (07:22):

And it absolutely transformed how I started teaching, and how I think about teaching and how I communicate with students, how I answer their questions. Because the idea is, no matter what it is we're doing in life, we're constantly building models in our head of how we think things work. And that's sort of inherent in the nature of learning. And, so many instructors, they already have well-developed models in their head, and they think, well, if only I can explain it in a more elegant way, these students will clearly just build that same picture in their head. And we know that that's not terribly effective. We've got lots of data that supports that. And so you need to learn to set your ego aside and say, okay, well maybe there's, there's a better way to do this.

Mitch Sweet (08:20):

So I started modeling, really my second year. To some degree, it was still a little limited because at that point, I had only taken the one mechanics workshop. After my second summer of taking a modeling workshop, I had switched schools and the headmaster at that school had said, you teach however you wanna teach. And I just said, okay, I'm going all in. I'm just gonna do modeling just a hundred percent. And the first year was a bit of a struggle. And that's, that's normal. And, and students come through and take, take my workshops, and I tell 'em, you know what, the first year you're gonna be really excited and you're gonna have all these things you wanna do, and it won't go as well as you think it will, and that's just part of the nature of the beast. You've gotta figure out really how this is gonna work for you. You've gotta figure out a way that you can make this work for your students. Because we all have different types of students, different demographics. Different cultural expectations from wherever you're teaching. And so you've really gotta figure out the best implementation of what that looks like for you.

Mark Royce (09:46):

It's different for everybody. And it takes a little while to find your groove, you know? I'm learning a lot. And I'm not a teacher, but watching my wife grow and all the conversations I've had with the podcast here it's really become quite evident that it takes a little bit to really get a handle on your approach in the classroom with modeling instruction. It's really cool. So you were teaching in high school when you first got into modeling, you were a high school, not not a college teacher?

Mitch Sweet (10:24):

Correct. Yeah, I was a high school teacher. I just had really started teaching at that point. And so I taught for nine years at a high school in Phoenix and Tempe, so in the the general Phoenix area. And then I started at Scottsdale Community College, and I had a colleague, Phil Root, who was already teaching here. And he has been a long-time modeler as well. He came from a high school teaching background as well, and he really wanted to implement it at the college level. And when he came to Scottsdale, no one else was doing anything like modeling. And he had a big uphill push for quite a while. And then when I got hired, then there became two of us, and that was two out of three.

Mitch Sweet (11:24):

And so suddenly we were sort of the majority. And, and then we started to get some momentum going. And we've made a real conscious decision to make sure that our adjuncts are kind of following along and are modelers, or at least open to modeling here because we're trying to build a culture with our

students where they're really responsible for their own learning, and we're trying to get them to be independent thinkers and to be able to engage with their fellow classmates. And Phil has done a lot of the heavy lifting before I ever got here.

Mark Royce (12:04):

When you say it was an uphill push for him, are you talking about like convincing the administration or in getting acceptance to the methods?

Mitch Sweet (12:15):

Yeah. And it probably was less administration than it was fellow instructors here. Lots of folks at the college level in general, whether that's four-year universities or community colleges, think they're pretty bright and they know how to teach, and why would you do it any differently? I mean, I would say most of the resistance was coming from other instructors, but also students. Lots of students had showed up here, and they had been used to someone just talking at them. And they were used to just taking copious notes and then somehow regurgitating that information on an exam. And suddenly they were being put in a situation where they didn't know exactly what they were supposed to do.

Mitch Sweet (13:09):

They were just kind of presented with some questions, and they were supposed to talk to the people sitting next to them. And that was a challenge, overcoming that. So, now that we've been doing this here for a while, we definitely have more momentum going. We just hired a new physics instructor here in our department who's a longtime modeler, Kirticia Jarrett. She's fantastic. So we're building our modeling base here at Scottsdale. I had also taught for a couple years before when I first came and before I returned, at Estrella Mountain Community College, which is in Avondale. It's in the other side of the Valley from where Scottsdale's located.

Mitch Sweet (14:05):

And there is a big contingency of modelers over there. Levi Torrison is there, Jeff Hengesbach is there, Dwain Desbien is there. So some folks that really know their modeling instruction very well. Russ Shaffer retired from the Phoenix Union high school district. And now he is teaching there as well. So there's some big heavy hitters in terms of people that have taught workshops and really know their stuff. And now we're sort of building our own community over here at Scottsdale. And we regularly collaborate with them. They're all friends of ours and colleagues. So we're trying to build momentum.

Mark Royce (14:55):

Tell me what you would say are the differences between teaching high school and teaching at the college level. I know the junior college, community college is a little closer than maybe a four-year might be, but what have you discovered are differences in those teaching environments?

Mitch Sweet (15:15):

So the biggest differences are the amount of time we have with students. If you are teaching at a high school, you've got 180 days with your students, pretty much, maybe 50, 55 minutes with them. But you've got a substantial amount of time. We have, typically here in what would be an equivalent to a high school chemistry class where we teach in one semester, and we would see them for about four and a half hours a week, for 15 weeks. So we really see them about half the amount of time that we would, if we were teaching sort of the same material at a high school level. So we don't get quite as much time

to kind of, I won't say leisurely go through things, but times where we might feel at a high school, Hey, let's dive a little bit deeper. Oh, you know what, we're running a little behind time, not, not a problem. Well, we'll pick up with this tomorrow. And just knowing that we are more constricted in our time, we have to just be cognizant of that. And while we do want discussions to be able to play out, we really just have to keep in mind we've only got so much time before that semester gets over.

Mark Royce (16:39):

Interesting.

Mitch Sweet (16:39):

But you know, often, especially at the two-year college level, we get students coming to us that are really a lot like high school students, and some of them are straight out of high school. They're 18 years old. And some of them even come out a little bit younger, so they very much are like high school students in terms of their background. Some of them are struggling with their math level, some of them are coming in at a higher level. So we have lots of different skill sets within the same class. That part's very similar. I just don't have to have parents calling me. So that's the big plus at a college level versus a high school.

Mark Royce (17:23):

So you mentioned the differences in the students' math skills and their understanding in the math world. And my wife has talked often to me about the issues of students coming in with lower math skills from the school previous to high school. And I know that you have done some work looking at math involved with chemistry in something called proportional reasoning. I know you've focused on that. I don't understand exactly what that means, or what it is. Can you talk to us a little bit about your work there and what you're discovering?

Mitch Sweet (18:02):

Yeah. In chemistry the very typical way to approach quantitative sort of problems is a technique that is often described as dimensional analysis. And there's ways to kind of set this up, but it's often approached as sort of an algorithmic approach to calculating some type of answer. So, let's say, sort of in a simple sense, if you were thinking about, I'm gonna be driving my car for two and a half hours, and I'm gonna drive at 60 miles an hour. If you were looking at this in terms of dimensional analysis, you'd say, okay, well, I've got two and a half hours, and then I have 60 miles per hour, so 60 miles over one hour, and then I can see that I've got an hour on top and an hour on bottom, and that those units are gonna quote, unquote, cancel each other out, and I'm just left with units of miles, and I could then calculate out how many miles I travel in those two and a half hours.

Mitch Sweet (19:29):

And so it becomes about units and it becomes about answer giving. So that's sort of like the simplest sense, and that's a very traditional way to teach. And in fact, even in some of our course competencies at the college level, it specifically says, students will learn to use dimensional analysis for problem solving. Well, what we have come across, and it's not just me, I mean, there's lots of other chemistry teachers that have sort of seen the same thing, is that while students may be able to get an answer and calculate an answer, they often don't understand what the answer means, or why that answer would make sense. And so proportional reasoning really has a lot more to do with having a better sense of

what you are looking at, what you're trying to understand, and seeing if you can figure out if there's sort of more of it or less of it type of thing.

Mitch Sweet (20:31):

So the way that I would have that same type of problem where I would have my students think about this and say, Hey, you know, we already know how fast we're driving, right? We know that we're driving 60 miles per hour, so that means I can drive 60 miles, and the amount of time it takes is one hour. Well, what if I go for two hours, right? If I drive for twice as long, I should be able to drive twice the distance. If I drive for three hours, right? I drive three times as long I drive for three times a distance. Well, if we were driving for two and a half times as long, two and a half times what one hour is, we should go for two and a half times the distance of 60 or 150 miles type of thing. And so the proportional reasoning gives students, I think, a better-- it's more about sense-making than answer getting.

Mitch Sweet (21:29):

And for people that are familiar with the chemistry modeling materials, and Larry Dukerich and your wife Brenda and Guy Ashkenazi, had really developed all of those materials and they tell a really elegant story. There is an elegant storyline throughout all of those curricular materials. And in particular, when we start dealing with gases, there's this particular tabular technique that gets introduced, which is in unit two about figuring out as pressure and volume and temperature and the number of particles change, how does this affect all these other parameters? So instead of it making about a big algebraic problem, and really it's, for people that are familiar with teaching chemistry, it really becomes about the combined gas laws, is how we think about traditionally approaching it. It just becomes, Hey, if I have twice as many particles, are those particles going to be colliding, you know, more or less?

Mitch Sweet (22:38):

And then when we have more collisions or less collisions when we have more pressure or less pressure type of thing. And so these PVTn tables are amazingly elegant and powerful. And then it seems like after unit two, we didn't use that table again, and we thought, gosh, we're developing this really powerful tool. There's gotta be a way to continue to use this and maybe even start to use it in unit one. And so as I mentioned before, my colleague Phil Root, he's also led a number of workshops. And he had come away with sort of this similar idea, and I know he had mentioned it to me at one time, and I said, yeah, why aren't we using more of this? And Justin Sheets, who co-leads the workshop with me here in the Phoenix area, we started talking about this and we started saying, well, I wonder if we started teaching this with our students, what would that look like?

Mitch Sweet (23:36):

And we both kind of side by side said, okay, let's give this a shot. Instead of teaching this dimensional analysis, what if we both seemed to get some pretty good results and be pretty happy with that, and felt that the students had a better grasp of what was going on. And now, when we lead our workshops, we just, that's how we introduce sort of all the calculations and say, Hey, you know, this is gonna be a little different, but we've already asked you to set a bunch of other things aside for this class, so just bear with us, hear us out, see what you think. And, and so we taught a workshop last summer in 2022. And a couple of the folks that took that, Simone Dunphy and Zach Weiss, Simone teaches in North Carolina.

Mitch Sweet (24:27):

And Zach teaches here in Phoenix, they're in the Masters of Natural Science program at ASU. And they decided for their action research, they were going to try this out with their students and actually measure differences. So they just presented the results of their action research a few weeks ago. Generally they found some positive results. In some cases they didn't get quite as much correlation as they had thought. But they both feel like this is absolutely something that is worth pursuing with their students. And so, I think it's something that they are going to continue to revisit. I think they're looking at trying to publish this beyond just in their action research. So, certainly we're not the only people that are talking about this.

Mitch Sweet (25:24):

Ariel Serkin, who's out in the Boston area, I know has also collaborated with Brenda. And they have done work with proportional reasoning and they have actually put some changes into the chemistry modeling materials and introducing the idea of proportional reasoning, even in unit one. And so, they've worked with Larry Dukerich to try and go back and introduce this as another way of thinking about math. And I'll tell you, I think there are a lot of benefits. There's the students that come in with low math skills, and they frankly have a hard time with the algebraic manipulation to rearrange a linear equation. They're just not sure whether they're supposed to multiply or divide by something.

Mitch Sweet (26:23):

So if they have some type of, some simple thing that we would sort of typically would expect our incoming students to know, that becomes a real struggle for them. And so, this gives a way for students who have sort of weaker math skills to say, okay, let's not worry about the algebra. Let's just worry about this relationship here between these two things that I know are equal to each other. And then if one of those things changes, if one of those things increases or decreases, then the other thing should be increasing or decreasing by that same proportion, by that same fraction. So for students with weaker mass skills, I think it's a big help. But the other thing, and this goes back to the Hestenes paper of wherefore science and teaching. He talks about the Piagetian levels of development, and we have concrete operational, and we have formal operational, which is really a higher level of processing. And proportional reasoning is one of those higher levels. And so I think for even the brighter students that are coming in that aren't necessarily used to thinking about proportional reasoning, we are helping to develop their higher level thinking skills. And so I think that there is a benefit really for all of our students to approach this in terms of thinking proportionally, rather just thinking about units and what do I need to do to somehow get the right units appearing in my answer.

Mark Royce (27:55):

Are you guys finding, as you guys are practicing in the classroom, are you finding kind of empirical evidence that this is effective with your students? Or is it too early in the process of study?

Mitch Sweet (28:12):

So what I haven't done-- I haven't done side-by-side comparisons. I haven't said, okay, well one class I'm not gonna teach proportionally to and one class, I am. So what I have definitely gotten is a lot of anecdotal data from my students, students that say, you know, coming in here, I was really scared about this class because I've struggled with math, but I understand now how to think about these kind of problems. And then I don't have to memorize equations. I can just set it up the same way every time and then just think about do I have more of this thing or less of this thing? And now I can solve for these answers. And they're having success there. So, you know, I have seen that. I think what we'd really need

to do is if we really wanted to get that empirical evidence is we'd need to find colleagues that are not teaching proportionately that are just sort of staying with some traditional dimensional analysis and be willing to kind of use some type of testing and looking side-by-side.

Mitch Sweet (29:23):

The challenge with that is, nobody ever wants to be the control group.

Mark Royce (29:28):

Right? Yeah.

Mitch Sweet (29:29):

You don't wanna be the person that that said, oh, this thing I've been doing for the last 20 years turns out it's not as effective as if I did this other thing. Yeah. So, I'm not sure if/when we're gonna be able to get solid empirical data on this, but that's definitely something that we're interested in looking at. As I said, Simone and and Zach were able to get some, I just think, I don't know that all of their groups were necessarily big enough to get data that would be absolutely conclusive. But it definitely showed some positive trends.

Mark Royce (30:07):

The student comments are certainly encouraging and evidence of some effectiveness with it. So that's really neat. Really great to hear. Mitch, tell me more about what you've discovered as a modeler in the classroom, some of the effective things that you're using in your classes.

Mitch Sweet (30:30):

Yeah. Well, one of the things that I think came about, maybe even particularly because of the pandemic, when we were forced to move online, and even if we were using Zoom and breakout rooms, being able to have an environment, a culture where students felt comfortable sharing with each other is challenging. It's challenging in an in-person classroom. It became even more challenging in a remote environment. And so, Dwain Desbien, who is a physics instructor at Estrella Mountain Community College, and I think, Dwain, he has really kind of got me and others thinking about that importance of building that culture within the class before you even dive into any kind of instruction.

Mitch Sweet (31:26):

And so, we now have sort of come up with a series of different culture building activities that we'll do across that first week in our three different level chemistry classes, in terms of our intro and our gen chem one and our gen chem two. And so they are things like, in our intro chem class, we will have students do some whiteboarding where we have students broken out into groups, sort of random groups usually at the beginning and say, Hey, why don't everyone figure out a place you'd all like to go visit, and then, talk with each other and figure out what that place is. And then what you're gonna do is I'd like you to draw out a series of three clues using the whiteboard markers and whiteboards, and then you're gonna share the clues with the rest of the class.

Mitch Sweet (32:24):

We're gonna try and guess what that place is. And I say the one thing I'll caution you is that if the place you're gonna visit is Paris probably don't draw the Eiffel Tower as your first clue. Right? So we want

wanna sort of think about how to go from broad to narrow. And it gets them just talking to each other because they're showing up and they don't know each other from Adam, and they would like to be able to converse with one another. And they might talk a little bit about like, oh, I went to this place for vacation, or there's this other place I saw a video on, I think looks really neat and gets them talking. Um, and the other thing it it does is it gets them used to that idea of trying to take some ideas that are in their head and representing them with some type of pictorial representation.

Mitch Sweet (33:16):

And, you know, a lot of 'em say, oh, well, I'm terrible at drawing things. Well, it turns out that whenever we do this activity, there is literally no clue that no one can tell what it is. As bad as students say they are a drawing. Oh, I can tell what that thing is. And so it gets them comfortable sort of putting things out there. And so we try and have those kind of activities that we do. And so getting students to share, getting students comfortable with putting things out there that they're maybe not a hundred percent sure of is a really important part of building the culture within the class. And we found it is more than worthwhile, that investment of time, as much as I said we're sort of limited in time. I would much rather not teach one little thing and spend the extra time getting students comfortable with what this class is gonna be like.

Mark Royce (34:12):

That's awesome. That is really cool. It was wonderful talking with Dwain about all that stuff too. It was great. To my listeners, if you want to go check out the interview I did with Dwain, just go to our website, science modeling talks.com and look up his episode and you'll find it very interesting. Well, Mitch, this has been great. Before we log off here, what would be the one big tip that you would give to any new modeler or, maybe even old modelers, but what's your great teaching tip or modeling tip?

Mitch Sweet (34:51):

Well, I would say that, as a new modeler, you've gotta give yourself some grace. You're gonna be super excited about this. You've hopefully come out of a workshop that you've just taken and you wanna take this back and get your students as excited about it as you are. It's gonna take some time. So when things don't work out exactly the way you want to, don't give up. Keep plugging away. Nobody that got here, got here, you know, in one year. It takes time to develop this. As we're we're fond of saying in modeling workshops, there is no modeling police. There's no one that's gonna show up in your classroom and say you're doing it wrong. You're gonna work your way through and figure out what's gonna work for you.

Mitch Sweet (35:43):

But keep asking questions. You know, AMTA has all sorts of resources. There's the Discord server, there's the list serves. There are people out there that are experienced that would love to give you help, reach out to the person that taught your workshop. There are people that wanna make sure that you're successful. Understand that it's gonna take some time to get there.

Mark Royce (36:16):

That's great advice. When you join the AMTA as a member, it opens up a whole lot of resources also for your classroom and shared among modelers, other members of the AMTA. Well, Mitch, this has been a great conversation and you've shared a lot of really interesting information that I think our listeners are gonna really grab onto and hold onto. And I just really appreciate your time. Taking time to share your insights and your wisdom in this area. I think the proportional reasoning thing particularly was very

interesting. And I'm sure a lot of modelers are gonna get ahold of that. So I just wanna say thank you. You've been wonderful.

Mitch Sweet (37:05):

Thank you so much. I appreciate. It's been a great talk.

Mark Royce (37:09):

It sure has. You take care.