MTN Ep 21 Transcript

01;00;00;13 - 01;00;30;05
Scott J Riley II
Welcome to Moving the Needle. Casual conversations about ways big and small to impact student learning. Brought to you by the Faculty Center for Teaching and Learning at the University of Maryland, Baltimore. I'm Scott Reilly, too. Let's move the needle. Hello, everyone. Welcome back to Moving the Needle. Many of us in our academic career have likely had some experience using labs as a method for experiential learning, depending on the course.

01;00;30;14 - 01;00;52;18
Scott J Riley II
Labs can be straightforward, where students follow a protocol for a well-established experiment, and other times they can be more of a labyrinth where students need to properly navigate through obstacles and challenges to reach the end. Labs are a versatile tool for teaching because there are many ways to approach building them. I'm excited to discuss a novel approach to teaching labs with our guest, Dr. Stephen Ming.

01;00;53;07 - 01;01;17;10
Scott J Riley II
Dr. Ming serves as an Associate Professor of teaching at the University of California, Irvine. In 2021, he was awarded the Distinguished Early Career Faculty Award for teaching from the Irvine Division of the U.S. Academic Senate. Since he joined the UCI team in 2016, he's been working hard to develop curricula that focus on teaching students skills that they can use in whatever career path they choose.

01;01;17;29 - 01;01;19;29
Scott J Riley II
Welcome, Dr. Mang. We're excited to have you here.

01;01;20;10 - 01;01;21;12
Steve Mang
Thanks. Yeah, it's good to be here.

01;01;22;00 - 01;01;32;19
Scott J Riley II
Well, let's get right into it. I'd like to start this conversation by asking you to tell us about your background in science education and some of the classes that you teach at UCI.

01;01;33;15 - 01;01;56;13
Steve Mang
Sure. So in when I was a grad student, I was a grad student also at UCI, and I figured out pretty quickly that research was not my favorite part of the graduate student experience. It was the teaching and teaching part. And so I tried to seek out as many of those opportunities as could, you know, teaching for more quarters than were required in different classes and this kind of thing.

01;01;58;10 - 01;02;19;19
Steve Mang
And I asked for and got the opportunity to write a couple of journal of chemical education papers while I was a graduate student. And so that kind of got me on the track of teaching, more so than

research after grad school. So after grad school, I applied to a bunch of lecturer positions teaching only and got one at the University of Maryland, Baltimore County.

01;02;20;12 - 01;02;44;21
Steve Mang
And so that's where I really learned to teach college. I would say mostly by trial and error, really figuring out, you know, I got kind of thrown in the deep end. They give me a couple of lab classes and say, it's up to you, which is nerve wracking. And so I just started putting labs together, seeing what students liked, what they didn't like, what they struggled with, and what was too easy for them.

01;02;45;18 - 01;03;07;09
Steve Mang
And so that's sort of I worked on that for a few years, and then I got the opportunity to move to UC Irvine, where I'm now a professor of teaching track. So this is something that's kind of unique to the U.S. system, where it's it's a tenure like track for people that focus on teaching, and then they'll do research that's related to their teaching.

01;03;07;09 - 01;03;17;25
Steve Mang
So chemistry, education, research or laboratory development or this kind of stuff. So I've been here six years now and currently an associate professor of teaching.

01;03;19;04 - 01;03;41;01
Scott J Riley II
So that right there, I think, is another conversation that I want to have with you. As far as the tenure or teaching track for faculty or teaching focused faculty. But it sounds like you've had a lot of time to practice your craft and almost in a lot of ways do it through a baptism of fire. So I'm curious, our our discussion today is on inquiry based labs.

01;03;41;01 - 01;03;44;28
Scott J Riley II
Can you talk about what an inquiry based lab is and how it works?

01;03;45;14 - 01;04;15;06
Steve Mang
Sure. Yeah. So you're right about the trial by fire thing. You know, like most Ph.D., chemists don't have any formal pedagogical training. So it's been learned by doing sort of experience. And so my version of inquiry, what I would call an inquiry based lab, might be different than what other people would call inquiry based labs. My approach to including in opportunities for inquiry in my labs is to try to make them authentic as authentic to the research experience as possible.

01;04;15;06 - 01;04;37;20
Steve Mang
So I teach senior level labs. And when you're doing undergraduate research, when you're a senior or when you move on to graduate school, the problems are typically not very well defined. They may not even have a correct answer. You're going to have to figure out how to collect the data that might answer the question. It's not going to be very good data sometimes, but you still need to extract meaning from it.

01;04;38;08 - 01;05;01;03
Steve Mang
So my approach is to write lab manuals that tell the students, here's what the problem is and here's background on that problem. Here are some measurements and some instruments that you may be

able to bring to bear on this research. QUESTION And here's your goal. At the end of it, you want to be able to say these things and answer these questions and then just let them go and not quite see what happens.

01;05;01;03 - 01;05;29;02
Steve Mang
You know, I and it's in the lab, so we we do guide them through the process, but we leave a lot of it up to them. We let them struggle. We let them argue among themselves. We let them talk to other groups who already did the experiment, see what they did. So the process of having inquiry in that kind of curriculum is more leaving the direction, the specific steps up to the students, giving them a guiding question and a framework to answer it.

01;05;29;02 - 01;05;33;21
Steve Mang
Like you're going to use a flow emitter for this one, and then letting them go and seeing what they do.

01;05;34;02 - 01;05;59;22
Scott J Riley II
Wow, that sounds awesome. On multiple levels. It's really testing students on their ability to do independent research, do critical thinking, and collaborate with people to solve a problem that, like you said, may not have a cookie cutter answer. Right. And on that note, I'm curious, you mentioned data collection. Do you find that in these labs, data analytics skills are important?

01;06;00;26 - 01;06;22;25
Steve Mang
Yes, I do. And I wish I could. I wish it was easier to convince my students of that fact. So we do we do a couple of experiments where the students can't open the data file in Google sheets because it's too big, too many data points. So one, for example, is an article in J Canard that I pretty much just took wholesale, which is using FTI AR to analyze food oils.

01;06;22;26 - 01;06;46;04
Steve Mang
So like olive oil, sesame oil, you know, bunch of different all these are basically just all mixtures of fatty acids. And so the FDR spectra, all of them is really, really similar with these very subtle differences. So if I ask them to take the spectra of some known oils and then here's an unknown figure out what it is that's basically impossible to do by just looking at the FDR spectrum.

01;06;47;03 - 01;07;09;29
Steve Mang
So what we do is we use MATLAB, which they they fight me on a little bit, and we apply a technique called principal component analysis, which is sort of like a quote unquote big data, you know, chemo metrics thing. And using the principal component analysis, you can figure out which oils are which based on the positions of the vibrational transitions.

01;07;10;00 - 01;07;27;14
Steve Mang
They move around just a little bit based on the chemical environment. And if you get a whole bunch of data and you run it through this principal component analysis in MATLAB, you can almost always do the oil identification, even when it's not obvious from the raw data, but that. So the problem is to do this, you have to collect this huge amount of data.

01;07;27;14 - 01;07;45;28
Steve Mang
And so the techniques that the students are familiar with, like opening up in Google sheets and plotting everything, that doesn't work anymore. But, you know, it's this authentic problem. Is this oil adulterated or not? You go to the grocery store, you buy olive oil. Is this actually olive oil? You know, no, probably not. Right. So how do you know what it's adulterated with?

01;07;45;28 - 01;07;49;29
Steve Mang
While you you can do this experiment and you can actually address that problem.

01;07;50;06 - 01;08;09;26
Scott J Riley II
Would you say there's a large gap in students skills as far as being able to independently use MATLAB to do these principal component analyzes? Do you feel like there's they come in and they pick it up really quickly? Or is this something that is lacking in their educational background?

01;08;10;09 - 01;08;32;15
Steve Mang
So in our curriculum, we have a class called I think it's called computers in chemistry. Anyway, it's chem five is what I refer to it as. And it they learn computational skills in this the freshman year course and then it sort of depends on what they do in the interim before they get to me as seniors, whether they keep reinforcing that or whether they just forget about it.

01;08;32;15 - 01;08;49;19
Steve Mang
But I don't count and then transfer. Students are a whole different problem. They wouldn't have taken that class, so I don't count on them being able to pick it up right away. We do a lot of scaffolding. We start with MATLAB in week one doing very simple problems, extend it to slightly more complicated problems in the second and third week.

01;08;50;04 - 01;09;11;24
Steve Mang
And then once they get into the, you know, lab rotations where they they run into the FTI them, eventually they've at least seen MATLAB. They've used it to do a few things. There are a bunch of tutorials posted all over the course website. And so yeah, there's, there's an element of handholding in the MATLAB because the backgrounds are going to be so varied.

01;09;11;24 - 01;09;25;19
Steve Mang
But the important, the learning objective that I care about is that they know that MATLAB is a tool that they can use in this way to handle a lot more data than spreadsheet software can, and it can do more advanced calculations than spreadsheet software can. And so I do think that they learned that.

01;09;26;16 - 01;09;52;28
Scott J Riley II
Speaking of learning objectives, one of the things that I'm interested in with these inquiry based labs is this idea, like you said, there's a there's a professor and a T.A. in the lab to kind of guide the students. But you always want to make sure that you hit your student learning outcomes or your objectives for the course. Is that more difficult with these inquiry based labs where you have to add some kind of additional component to make sure that they get all of those student learning outcomes?

01;09;52;28 - 01;10;00;01
Scott J Riley II
Or when you go to assess them, you find that these inquiry based labs meet that that goal or that expectation every time.

01;10;00;23 - 01;10;22;17
Steve Mang
It's a little of both. There are some learning objectives that I'm not confident that they'll they'll bother to address in the inquiry based labs, because they would skip over the step because it's sort of obvious to them or whatever. Or on the other end, it would be too hard. They wouldn't think to make a given measurement or they wouldn't think to check a certain thing or whatever.

01;10;23;00 - 01;10;43;22
Steve Mang
But I do care about them learning, you know, that fact. And so some, you know, I'll cheat a little bit. I'll say, okay, this is an inquiry based lab, but in the Prolog you got to make these three measurements, right? So there's a method for inquiry based labs that I taught with last summer in a colleague's general chemistry lab class called argument driven inquiry.

01;10;44;09 - 01;11;05;10
Steve Mang
And I really like it for this kind of thing. So this was pioneered in chemistry by Joi Walker at East Carolina University. And the idea is the way that my colleague does it anyway is that each lab experiment, there are these four experiments that they do and each of them is two weeks long. And then so in the first week they call them fundamental skills.

01;11;05;10 - 01;11;24;02
Steve Mang
So they there's an overall problem that they're trying to solve. But these are freshmen in their first chemistry lab ever. And so the first time they come in, they're going to learn how to make a melting point measurement, or they're going to learn how to do, you know, use a little ovens or something like this. Right. Just skills that they don't have yet.

01;11;24;02 - 01;11;46;21
Steve Mang
They're going to learn the skills and then they're going to make a prediction about what's going to happen the next week when they come in and use those skills to address some sort of authentic problem, you know, determining the composition of a mixture or making a beer's law, a plot to do quantification or whatever it is. And so then the next time they come in, they do what's called the original investigation.

01;11;46;21 - 01;12;07;15
Steve Mang
And in this part, this is the inquiry part, it's less well defined and they have to like build an argument. So this is argument driven inquiry part. We have these tables, they can write on it with chalkboard markers and so they'll make a little poster on the right on their table and say, here, you know, here's our plan, here's our justification for the measurements that we're going to make.

01;12;07;25 - 01;12;30;11
Steve Mang
Here's the kind of data we expect to collect, etc.. Right. And then students will go around, visit each other's tables and look at their posters and say, Oh, that's a good idea. I never thought of that. Or they'll argue with them and say, Oh, don't do that. Do this other thing. You know, it's fun to watch.

And then they so they do a little report for the fundamental skills, a little report for the original investigation and a big report for the overall lab.

01;12;30;23 - 01;12;49;10
Steve Mang
And so you can really make sure that you hit a lot of different kinds of learning outcomes with the combination of those three assignments. So you can one learning outcome can be, you know, do they know how to make a calibration curve, right? And so because you walk them through, you make sure that they collect the correct data and then another learning outcome can be less well-defined.

01;12;49;10 - 01;13;09;04
Steve Mang
Can they, you know, make an argument based on incomplete data, or can they predict the results of an experiment in advance or whatever? Right. And so there's opportunities to get all these different kinds of learning outcomes in there. It's also really cool because they look like they're doing science. You know, you go into the lab and they're they're like excited and talking about, No, let's do it this way, let's do it this way.

01;13;09;26 - 01;13;23;06
Steve Mang
They're not just have their head in the lab manual and, you know, okay, what's step three? Okay, let's do step three. What's that for? Okay, let's do step four. It's a lot more fun to be in the lab and watch people do experiments as well.

01;13;23;10 - 01;13;54;07
Scott J Riley II
That sounds great having them engaged because I was a TA for many years and I've heard exactly what you just said. You know, let's do step three, step four. And they're not even thinking about why they're doing the steps. So if you've been able to overcome that hurdle, that in and of itself is an amazing achievement. I want to segway from that and discuss your creation process behind these inquiry based labs and kind of when and where did you first discover or create these ideas and what did the process look like?

01;13;54;07 - 01;14;04;10
Scott J Riley II
Did you have pilot classes? Were there rounds of student faculty input? And how well accepted were these changes? Because you are kind of reinventing the lab in a way.

01;14;04;19 - 01;14;27;20
Steve Mang
So yeah, so pilot classes would have been a great idea, but that's no typically by my invention process, I guess has been driven by dissatisfaction. So I get a new job or take over a new lab and I see the way that people have been doing it in the past. And I say, Well, you know, that's dumb, or I do it their way once and I watch the students and I say, Well, they're not getting anything out of that.

01;14;27;29 - 01;15;03;09
Steve Mang
Or they could be thinking about this in so much more detail or et cetera. Right. And so then I just I make changes that make sense to me. And part of this process is you have to be willing to have a class go really badly, which has happened, although not, you know, luckily, not super often more usually it's like one experiment was like, well, I asked them to do way too much and nobody learned

anything because they were they got stuck on the first step of the inquiry process and they never got past it and or they got past it because the to help them.

01;15;03;09 - 01;15;27;26
Steve Mang
But then they didn't really understand why they got past it, you know. But you know, in terms of the development of the experiments, I've taken a couple of different approaches to this, one that I've actually really had fun with. Right now I teach instrumental analysis, so I go to like the Journal of Food Chemistry is a good one and find experiments that people are doing, really doing out there in the world of food analysis.

01;15;27;26 - 01;15;49;19
Steve Mang
So finding an authentic problem. And then I'll either spend a lot of time myself or what I much prefer is to get an undergraduate research student to come in for a quarter and turn this really complicated research experiment into something that students can do in a I have a seven hour lab period, so in a seven hour lab period.

01;15;50;02 - 01;16;09;10
Steve Mang
And so like the these experiments I do right now is like that. The HPLC lab experiments I do now is like that. The other thing that I try to ask myself, I'm not, I don't can't always answer this. So I sometimes have to go out and get the answer is if my students get hired to be an analytical chemist, how are they going to be using this instrument?

01;16;09;20 - 01;16;28;04
Steve Mang
So my chromatography labs, we don't just make a calibration curve and use it to identify an unknown. We do complicated sample preps, we do method development and then we do the calibration curve stuff. So, you know, one thing that's nice that I have this seven hour lab, so we could do a little bit of method development in the lab.

01;16;28;29 - 01;16;52;02
Steve Mang
The other one is that I've developed a little homebrew simulation software so that they can do some of the method development before they come in as a pre lab and then confirm what the simulation told them. And then, you know, continue with the the stuff that has to be in person once they get there. But you know, in both cases, my idea is that I want authenticity.

01;16;53;19 - 01;17;13;28
Steve Mang
It provides for much more interesting problems. The real world has a lot of inquiry in it, and so it provides for a lot of opportunities for inquiry. And then the students are more interested. You know, I give them they're unknown and it's a can of tuna fish or salsa or something. And here, deal with it. Right. That's a that's an interesting, authentic problem that they're presented with.

01;17;14;15 - 01;17;36;15
Scott J Riley II
I really like this word of authenticity because as you keep explaining these labs to me, I think of labs as the quintessential experiential learning model. Right, the hands on application. But the more you talk about it, the more I realize there's so much more room for growth in making it more experiential, if that's the way to say it or more authentic, like you said.

01;17;37;03 - 01;17;58;02
Scott J Riley II
So thank you so much for kind of giving us some insight into your process. The next thing that I want to ask is what are some of the challenges with using this approach? We talked about some of the challenges developing, and I think we touched on it earlier. Participation doesn't seem to be a problem. Like you said, your students are more engaged.

01;17;58;02 - 01;18;23;26
Scott J Riley II
But I'm interested with things like students level of communication skills. When you're talking about them talking to each other in groups, do you see students giving other students, you know, bad advice and how is that handled? And then it's unique in your situation, you mentioned that you have a seven hour lab. So do you have trouble filling the time for that whole 7 hours to make sure the students are continuously doing something towards their education?

01;18;24;23 - 01;18;42;20
Steve Mang
I actually try to design experiments that most students can do in like five of those 7 hours or maybe six. And then this gives people an opportunity if they go down the wrong path for an hour to make up for it, but 7 hours a long time. And it's a long time as they focus in on task and learning.

01;18;43;00 - 01;19;03;11
Steve Mang
So I actually tend not to use the entire thing, but in terms of talking to each other, in terms of continuously solving the problems, no, there are certainly some groups who will get frustrated and sort of shut down. And, you know, it's it's hard. I can design an experiment where nobody gets frustrated, but then the stronger groups aren't going to learn anything.

01;19;03;29 - 01;19;21;16
Steve Mang
And I can design an experiment where everybody gets frustrated. That's easy. I've done that before. But trying to hit the sweet spot in the middle where the strongest groups are working hard and learning things, and then the groups who have, you know, they're missing a piece of background or whatever or they didn't do their pre-planned. They can still actually get something out of the experiment.

01;19;22;27 - 01;19;45;18
Steve Mang
That's the tough part. And then it goes to training as well. So you need to prepare your Tas for the idea that here are some points that that every group is going to get stuck. You need to identify when a group is going to get stuck and be able to work their way through it or they're going to get stuck and then they'll just sit there and stare at their desks for half an hour and wait for somebody to give them the answer.

01;19;45;18 - 01;19;59;23
Steve Mang
So helping to identify that point and then knowing when to give the groups that need a nudge nudge is a big part of this, really, because. Yeah, people people certainly get frustrated.

01;20;00;09 - 01;20;05;20
Scott J Riley II
Yeah. And I just thought of something that made me frustrated. You mentioned students not doing their pre labs sends a chill down my spine.

01;20;06;02 - 01;20;25;08
Steve Mang
Yeah, well, people are people and they got a lot of stuff going on. They did. So, you know, you're everything you design needs to be flexible. You know, that's my students. The jobs take care of family. They have a two hour commute because they can't afford to live near the school. You know, there's a lot going on out there.

01;20;25;08 - 01;20;28;19
Steve Mang
And so everything needs to be a little bit flexible to account for that.

01;20;29;24 - 01;20;55;19
Scott J Riley II
Agreed. And on the topic of flexibility, kind of segueing into our next question, how do you measure success for these strategies because of how open and complex this approach is to labs, to lab reports still work the same way? Are there lab is there a lab final that you use to assess the students ability because you're now giving them these very open problems that don't have exact answers?

01;20;55;19 - 01;20;59;09
Scott J Riley II
How do you measure stronger students and students who need to improve?

01;20;59;19 - 01;21;25;06
Steve Mang
So okay, for the freshman class that I mentioned earlier, the argument driven inquiry, when we do a lab final in that class and mostly it's focused on the technique, they demonstrate a couple of techniques, they demonstrate that they can do data analysis, and then they'll also do a little bit of interpreting portion. Like one of the things they do is try to identify which mixture would make the best sunscreen based on the wavelengths it absorbs and its melting point and etc..

01;21;25;06 - 01;21;51;23
Steve Mang
And so they get all this data and then they need to to do a little bit of interpretation. What does it mean to be a good sunscreen? Well, it means that it has this wavelength absorption and this melting point, etc.. And so they do a little bit of drawing conclusions from the data in my instrumental analysis class and my my pecan lab class, I don't do a lab final because these classes are like way too much work already for the students, not me.

01;21;52;13 - 01;22;21;09
Steve Mang
So they're it's a they have a seven hour lab a week. They also have two lectures a week. It's a combined lecture lab class, which are rare in our department. And so I have way more opportunities than I need, honestly, to assess my learning outcomes, giving them an extra lab final unnecessary. But lab reports certainly do work and I certainly do get an opportunity to assess all of the learning objectives that I have for each each lab.

01;22;21;24 - 01;22;26;21
Steve Mang
So I use it's what's called specification lens grading. Have you heard of this thing?

01;22;26;21 - 01;22;27;23
Scott J Riley II
I've read the paper on it.

01;22;27;25 - 01;22;45;22
Steve Mang
Oh, you all. You read my paper. Okay. Yeah. So that one's about a writing class, which is not really applicable to the lab stuff. So for the lab, the idea of specifications grading is that you set out the list of your learning objectives for the experiment or whatever it is, the assignment. And then students get credit for either meeting them or not.

01;22;46;11 - 01;23;05;08
Steve Mang
So students initially don't like it because they may have a lab report where they need to make four figures. Let's say. And there is just one rubric item for making figures correctly. And if they miss one, if they mess up one of those four figures, they don't get that rubric right. They got to do it either all correctly or they have to try again.

01;23;05;08 - 01;23;23;13
Steve Mang
And they part of the deal is resubmission. And so it's not an all or nothing kind of thing. It's less harsh than they initially perceived to be, but it does require them to demonstrate mastery of the learning outcomes. To get credit, there's no partial credit. So on all of my rubrics, I have a couple of different kinds of learning objectives for each lab.

01;23;23;13 - 01;23;50;22
Steve Mang
I have some that are common to all experiments, which are mostly the scientific communication stuff making figures, making tables, supporting conclusions with evidence, this kind of stuff, right? And then there are some that are unique to the content of each experiment. So for the HPLC lab, they need to be able to to determine a calibration sensitivity and they need to be able to identify the best mobile phase composition from a vending plot and you know, things that you only do in HPLC.

01;23;50;22 - 01;24;07;09
Steve Mang
You don't do it for imagery, but, you know, so over the course of the quarter, they turn in these eight lab reports and on those eight lab reports, they demonstrate mastery of the course content and then also repeatedly demonstrate mastery of scientific communication.

01;24;07;28 - 01;24;32;27
Scott J Riley II
Great. It sounds like you've really thought out how to measure the students progress in a fair but strict way. If that seems reasonable, they do need to meet these requirements. But the re-assessment. I think the reassessment is something that we as educators don't use often enough to allow students to make mistakes on graded material and then have it come back for reassessment.

01;24;32;27 - 01;24;54;23
Steve Mang
Yeah, and especially for inquiry labs. Even if you're not using specifications grading, that's a vital part of it. I think having some opportunities for students to mess up go down the wrong path, get feedback and then identify the correct path. And that can be real time to doing it in real time, or it can be turning in a preliminary lab report saying, Oh, no, you didn't really interpret that correctly.

01;24;54;23 - 01;25;21;07
Steve Mang
Let's try it again. But authentic inquiry means not getting it right the first time, sometimes even the second time, right? If it's really an authentic problem, that means it's hard. And that means that the

answer may be a little messy or ill defined or hard to extract from incomplete data. And it's unrealistic to expect even most students to nail that on the first try.

01;25;21;07 - 01;25;30;24
Steve Mang
So the giving giving them more opportunities, building that into the class as you design the class, even if it means you cover less content, even if it means you do fewer experiments, I think it's worth.

01;25;31;01 - 01;25;38;14
Scott J Riley II
I agree, quality over quantity. If you get the students to learn a few things, well, that's better than them not knowing many things, right?

01;25;39;06 - 01;25;59;01
Steve Mang
Yeah. And the, you know, the process of switching to specifications grading really makes you think about what are what do I care about when I teach this class? Because you're making these big lists of learning objectives, right? And then you make this big list and then you look at the experiments you did last time and the assignments you gave last time, and you're like, Well, I didn't assess half of this stuff, right?

01;25;59;01 - 01;26;20;24
Steve Mang
Do I really care about it? And so, no, maybe you don't care about it, or maybe you do and you change your assessments. But either way, it helps you zero in on what you actually think is important for students to get out of the class. And then always, I reckon I talked to a lot of people about how to do specifications grading and I always recommend Get rid of stuff.

01;26;21;07 - 01;26;41;03
Steve Mang
You're doing too much, you're assessing too much, you're signing too much. Get rid of it. So like you read my paper about my writing class with specifications grading, there's like, I don't know, 30% fewer assignments in my class that I'm teaching right now than the class. And I wrote that paper about three years ago. I just keep getting rid of stuff.

01;26;41;03 - 01;26;45;27
Steve Mang
Get rid of it, get rid of it. More scaffolding opportunities, more resubmission opportunities. You know, that's better.

01;26;46;16 - 01;27;07;24
Scott J Riley II
That's something that I've been curious about with the idea of how many reassessment opportunities you provide. And it sounds like, like you said, the mantra is get rid of stuff, really hammer home key points for students. And once they've got that down, that's better than giving them a bunch of assignments where you might not necessarily care about certain things that you put in there.

01;27;07;24 - 01;27;11;05
Scott J Riley II
You just did it to to give them stuff to do busy work as it was.

01;27;12;00 - 01;27;36;29
Steve Mang

Yeah. I mean, or, you know, something that people do with good intentions is they try to assess the same learning outcome multiple times throughout the semester. And, you know, that's fine. But if you have a student, and especially if it's in slightly different context each time, if you have a student who's struggling a little bit with that learning objective, but they're almost getting it, having them fail in three different context doesn't help them and it doesn't tell you anything, right?

01;27;37;21 - 01;28;02;23
Steve Mang
Having them try it multiple times and zero in on a better understanding in the same context, I think. Well, it's certainly counter. Right and I think it helps them really understand what's going on. You know, it is, of course, important to be able to apply understanding in multiple contexts, but you've got to get it first and giving people the opportunity to get it first and then apply it, I think is the better way to go.

01;28;02;27 - 01;28;28;17
Scott J Riley II
I agree wholeheartedly. I'm interested. Can you see this being used in other lab settings like psych or social work where the level of instrumentation may not be or the presence of instrumentation may not be there? And if so, if someone wanted to utilize this inquiry based strategy, what advice would you give them as they start their their journey of empirical study with trying these classes out in their setting?

01;28;29;05 - 01;28;45;15
Steve Mang
People who are designing the experiments are the experts, right? So when I when I look at a problem that I'm trying to adapt for an inquiry based experiment, I try to think about my own thinking. So we tell students to do metacognition all the time. But, you know, we got to do it too and try to plan out.

01;28;46;03 - 01;29;01;26
Steve Mang
How does an expert think through this kind of problem? And then if you think students could get there on their own, you just give them the problem and say, go ahead and see if they can work it out on their own. But often that's not the case. Often you need to give them sort of signposts along the way.

01;29;02;17 - 01;29;27;22
Steve Mang
And so if you identify as an expert that you look at a problem and you identify aspect A, an aspect B, an aspect C, and then you synthesize those into a solution or an analysis of the problem. You can guide students to each of those. You can have a three part lab right where they first inquiry their way to aspect A and then inquiry their way to aspect B and then, you know, put everything together.

01;29;27;22 - 01;29;42;18
Steve Mang
You're not going to like trick students into it. They they're going to need a little bit of help because they're not experts. They're not maybe not familiar with the content. They're trying to you know, they have a lot of stresses. They want to get the right answer. They want to write a good lab report, getting a grade, etc..

01;29;42;26 - 01;30;03;17
Steve Mang
And so giving them a little bit of a map for here are the things an expert would use to make their

conclusion. Let's try to figure out the answers to those things and then let's draw a conclusion, I think is the advice that I would give. And so for instruments, this is what I do like, okay, we're doing an HPLC lab, so identify the best mobile phase composition for the separation.

01;30;03;17 - 01;30;26;22
Steve Mang
Identify the best flow rate for the separation, figure out what range of calibration standards you need, right? And then put it all together. Do the analyzes, give me an answer. How much bisphenol A is in the hot sauce? You know, and the reason that I tell students to do those individual things is because I know that those are the things that I would need to do if I came to this problem and had no idea where to start.

01;30;26;22 - 01;30;49;24
Steve Mang
Well, let's let's figure out the parameters that we need for the solution. Let's figure out the instrument conditions in this case. So don't assume that students are going to know that's what I need to do right away. Give them a little bit of a roadmap. But then within that, there are plenty of places where you could take away details, make them answer questions, make them get a little lost and confused and work their way through things, right.

01;30;49;24 - 01;30;52;14
Steve Mang
I have a lot of lab procedures where I make students lost and confused.

01;30;53;05 - 01;31;17;03
Scott J Riley II
I know that feeling. I feel like sometimes that's more on the student than not of the procedure, but I can commiserate there. Thank you for the advice, Steve. I'd like to kind of round out the conversation by talking to you about what you think is moving the needle. So the my one of my favorite questions is, what do you think is changing the landscape of teaching?

01;31;17;17 - 01;31;47;18
Steve Mang
So I already I mentioned, you know, Joy Walker at Eastern Carolina and my colleague and actually at UMBC. See, a friend of mine, Marie Van Susteren, is doing this same thing with this idea of argument driven inquiry of good giving students these authentic or semi authentic problems, but then just giving them time to work it out, to argue about problems, to draw their own conclusions, to give other people advice.

01;31;47;18 - 01;32;14;21
Steve Mang
Right? Making the lab a more authentic place than just following a recipe and, you know, learning how to to use a graduated cylinder or whatever. I think these these techniques that people are using to turn the lab into a place that's not for that's not just for hands on skills, but is also for critical thinking and learning the practice of being a scientist.

01;32;15;12 - 01;32;54;07
Steve Mang
I think that's the most important thing that we can do with lab instruction. And I mentioned it before, sometimes it means taking content out and I'm totally okay with that. I actually advocate for that doing less stuff, but asking the students to do it better, more authentically, more like a scientist would do it. Getting them into these habits of mind for thinking through a problem, thinking about how to

design a solution or how to even approach the problem in the first place, I think is a much more use, much more effective use of our lab time than just, you know, here's how to do serial solutions.

01;32;54;07 - 01;33;04;25
Scott J Riley II
Yeah, I agree. We really want to train the next generation of scientists to be independent thinkers, not follow the recipe. So this this technique really does sound like it's trying to do that.

01;33;05;14 - 01;33;23;24
Steve Mang
And giving them experiences that are going to show up in their job or if they go to grad school, like being frustrated, like being completely lost and not knowing what you're doing and having to go back three steps and say, okay, when was the last time I knew what I was doing? Right, let's go back to that point and then let's start again.

01;33;23;29 - 01;33;57;19
Steve Mang
You know, it sounds borderline cruel, but I really enjoy watching students go through that process, not because I like seeing them be frustrated, but because I remember me in in graduate school being on my own scientifically for the first time and having no idea what was going on right. We can recreate that in a much more friendly setting, in a setting where there's there's trust between the student and the instructor and they know that there is a ladder there that they can grab on to if they need it, but that we expect them to try and figure it out on their own.

01;33;57;19 - 01;34;24;10
Steve Mang
Right. And I really would hate the idea of any of my students going into either graduate school or their first job and being expected to solve a problem and just not even knowing how to approach it. That's a very lonely feeling and scary feeling. And I think labs can introduce students to that feeling in a much lower stakes environment, teach them how to work their way through it, teach them how to think like scientists.

01;34;24;28 - 01;34;30;26
Steve Mang
Anybody who's doing that, I would say, would be would be moving the needle would be improving lab education.

01;34;30;26 - 01;34;38;23
Scott J Riley II
Agreed. Steve, thank you so much for coming on the show today and talking to us about these inquiry based labs. We really appreciate it.

01;34;39;00 - 01;34;42;13
Steve Mang
Yeah, no problem. It's good to talk to you.

01;34;42;13 - 01;34;58;00
Scott J Riley II
Thank you for joining us today on moving the needle visit us at U. Maryland dot edu slash FCTL to hear additional episodes, leave us feedback or suggest future topics. We'd love to hear from you.