

Bonni [00:00:00] Today on episode number 249 of the Teaching in Higher Ed podcast, Dr. Silvia Heubach joins us to talk about mindset, metacognition and math.

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Bonni [00:00:24] Hello and welcome to this episode of Teaching in Higher Ed. I'm Bonni Stachowiak and this is the space where we explore the art and science of being more effective at facilitating learning. We also share ways to improve our productivity approaches so we can have more peace in our lives and be even more present for our students.

Bonni [00:00:52] Today's guest Dr. Silvia Heubach is another individual who's coming to us from the California State University. Throughout her tenure at California State University Los Angeles, Dr. Heubach's passion has been to share her love of mathematics with her students to turn on the "aha" light bulb and to banish the perception that mathematics is to be feared and avoided. Mathematics is one of the greatest hurdles faced by many students on their path to rewarding careers and Dr. Heubach has dedicated her professional career to helping them over that hurdle. From the beginning she has experimented with different ways of teaching such as by incorporating the software program Mathematica into a differential equations course. Later, in a National Science Foundation grant, she developed a modeling course built around Mathematica to satisfy general education course requirements. More recently, Dr. Heubach was part of an effort funded by the National Institutes of Health to improve the quantitative reasoning skills of life sciences majors- which you'll hear her talk about in the episode. A sequence of redesigned courses was implemented in fall 2012 and since then nearly 5,000 students have enrolled. As a result of this redesign, students pass rates have increased and surveys show an improvement in student attitudes towards math. Dr. Heubach is now the faculty learning coordinator (FLCC) funded by the U.S. Department of Education. This

effort targets bottleneck STEM courses and uses the "flipped" learning method to help students master difficult course material.

Bonni [00:02:41] Silvia, welcome to Teaching in Higher Ed.

Silvia [00:02:43] Hello.

Bonni [00:02:44] I'm excited to talk to you today and we're going to begin many years ago all the way back in Germany. What can you tell me about growing up in Germany and what it was like to learn math there?

Silvia [00:02:57] Well I always liked math and I helped my fellow students in high school with math and it was different from here in the sense that math culturally is just much more important and everybody is expected to learn math. You have math every single year no matter what school you go to or what school type. And if you're not doing well, then for one thing it may make you repeat the whole year, not just the course. And parents will send their kids to tutoring and they just expect that particular math and you need to apply yourself and then you can learn it. It's not the kind of situation that I encounter here in the U.S. very often when I tell that I'm a math professor, the first thing is everybody goes "oh that was my worst subject in college" or "I never got beyond college algebra" or things like that.

Silvia [00:03:56] And it's like the smile in their face. It's not "oh I'm not doing well in math." Nobody would say "I cannot read" or "I cannot write" but with math it's just this okay thing that you just can't do it and that's fine. And I think that really creates a fixed mindset for math. You have the math gene or you don't. And if you struggle with math well that's because you didn't get that math gene and it's okay to not try.

Silvia [00:04:28] And because math is such an area where one thing builds on each other, it has a much bigger impact than say in history; if you missed out in the Romans you can still start in the French Revolution and not be impacted that much. Maybe there is some connection but not in the way it is in math. And so I think that's really why math is such a difficult subject for many students.

Bonni [00:04:56] And one of the articles that came out recently was actually talking about a study that was done is thinking about it- Yes we've been talking for a while now in higher ed about our students and the importance of their mindset and if they have a fixed or a growth mindset for themselves. But of course, it would seem obvious but still so many of us forget of our own mindsets

about our students. If we allow ourselves to think "oh that student can't do math then that's going to really hinder their learning too and that was what the studies said. I'll put a link to that in the show notes in case people want to review that but I celebrate your really wanting to draw that out in your students. And I wonder if you could share about some of the assignments that you've created to help them break down some of the those barriers.

Silvia [00:05:44] So when I talk to my students after exams in which they come to me and say "I know it all but I'm just not good at taking exams" and I ask them about how they study and how they know that they know. I often get that they just do old problems over and over again. And so they get really good at that particular problem but they cannot transfer that to a problem that I will give them because it will be different in terms of the wording but it will be the same structure. So I look at this problem and go it's the exact same problem. And the students go no no no no, this talks about dogs and this talks about runners or something.

Bonni [00:06:22] Yeah.

Silvia [00:06:23] So they just really memorize and I've realized that students don't ever get training in how to study for math and how to actually assess whether they have learned. In high school they may have been able to get by with this strategy really well and so they come to college and think yeah this is just going to go I study just the night before the exam, I'll just memorize all this stuff and then I can do well on the exam.

Silvia [00:06:54] So when I probed them, I realized the structural stuff is not at all coming through to them. So I have created assignments where I give them a bunch of problems that are very similar. Here are some functions, get the average rate of change. And some functions are given in their equation expressions, some others are given as a table, they have different intervals. And so students will when I ask them you've done these problems, what's the same? What's different? After they've actually worked with them and had an opportunity to maybe see why I'm doing the same steps over and over again. Initially they will just say "oh they have different intervals" which is a correct statement, but it doesn't go to the structure because it doesn't really matter what that interval is.

Silvia [00:07:46] So then I get them to think deeper and say OK so that doesn't matter. And then after it I say now that you've gotten the differences and the sameness, can you write down an algorithm on how to solve these problems. So

another assignment is sort of here are 10 problems and we're not going to do the problems but tell me what type of problem they are. Are they a problem about an exponential decay? Or are they problem with a rational function? What's the type of problem? What's really the essence? Never mind what words are used. And I find that that really helps them get to the structure. I mean it doesn't- it's not instantly because this needs practice but at least it starts them thinking in that direction.

Bonni [00:08:37] Math is certainly not my expertise but I was fascinated by a video that they showed actually at my children's school talking about the differences in the way they teach math today than when I was growing up. And one of the big things that just really sticks with me has to do with a lot of what you're describing and that is that we would learn how to do things- and I think the example they gave was long division although it's been a while since I saw it. But they'd say but why do you do that? Or why do you carry the one? And it was just like well that's just what you do. It's just like a series of steps that I memorized but they have no meaning to me. That doesn't make any sense to me why you would do that. And how they've really shifted to have the whatever steps or methods that they use to teach children to do it, they have sense making behind it. And that's so often in education in all of our disciplines what gets lost is when we just have them doing things that they've memorized but they don't actually mean anything to them. It's just this data in, data out but there's no mind actually being leveraged in that process.

Bonni [00:09:49] So I'm hearing you talk about context and I'm hearing you talk about I think a little bit is also them being able to discern what data isn't important. So not just giving them the important variables, but do you also do it where they have to sort out what actually do I need to solve this in a given context? Is that something you help them with as well?

Silvia [00:10:08] Well in this particular example that I talked about the differences- in this all this information there is actually needed but it's seeing whether this piece of information is structural or not is the fact that this is an interval from two to three and this other one is from minus one to two. Does that matter for the process that you use to solve it? And the answer is no because you take whatever those two values are and you substitute it in the function and then you take the difference of those values and so on and so forth. So the process is you take these end points and you put them into the function and it doesn't matter what they are. That's the process. Yes, they are different numbers but it's not anything to do with the process.

Bonni [00:10:56] You said the phrase "thinking about their thinking" and that that sometimes is something that they're lacking. And those exercises that you're doing that's helping them think about their thinking.

Silvia [00:11:06] Yes. This question about what is the same and what's different, that is really metacognition because you're not just doing something but you're thinking about why are you doing it. You know that's the structure, why am I doing it? And what am I doing? And then that's also the kind of things that will help you to better understand whether or not you understand something. Because if you can explain what is the difference then you have understood at a deeper level and not just the surface level where you say oh this number is different from that number.

Silvia [00:11:39] It's interesting I find a problem where I had students compute in very detailed structured ways, you compute that function line, you take the difference, you divide, blah blah blah. Then you'd come out with a sequence of numbers and that was really the thing we were curious about. We wanted to see do these numbers get close to some value. And so for the exam this is way too long. So in the exam I just gave them the sequence of numbers and I said tell me, do they get close to something? And the students came to me and said I've never seen this problem, you've never done something like that. And that was the eye opening moment. I thought "Well I took out some of the work to get to these numbers but the whole work that we did was to get to those numbers." And I made it step by step so you could see, but they did not from what I did in class grasp that really ... that point is the important thing because that was probably the hard new thing and that's plugging in values and computing them and following step by step procedure. Never mind why we're doing it was the thing they were looking at. And so I think the discrepancy between what students see as important and what we see it as important, that's one of the things of making really clear expectations pointing out the thing that's really the goal. Because we know this stuff and we need to step back and say "do I make myself really clear enough? Do I give students clear directions and guidance on what we're doing and what are the important pieces?"

Bonni [00:13:23] The story that you're sharing is really related back to that question of mindset because this could just be a story that you tell yourself about "oh they didn't do good on that test. They probably didn't work very hard or they just probably not very good at math" and instead you're saying what does this tell me about my teaching when I notice this pattern and how might I go back and revise the way that I went about building up and scaffolding those skills along the way to help them build more confidence. But also you are describing

the importance of curiosity; if we can get curious about the numbers and that's telling the stories that are relevant to us somehow or at least some kind of a mystery that's of interest that can really help with a motivation as well.

Silvia [00:14:07] Yes I mean when I say do math people go "oh you must be good at memorizing." And my answer to that is always I like math because I don't have to memorize. First of all, if there is a formula and I know where it comes from I can derive it. I can get it back. I don't have to memorize it. And while there are some things that we memorize, derivatives and whatnot because we use them a lot and it's convenient to know them, but in principle we could rederive them.

Silvia [00:14:36] And if we have a story with a formula, what does it say? It's not just little symbols, but here we're looking at an average difference over a difference that gives us a rate. What are the units? When we look at a formula as a story, then it helps us connect. And I mean the- what you mentioned before with just learning an algorithm without knowing where it comes from and why we're doing it, that is exactly what neuroscience tells us about what we need to do to learn something, namely make connections and having just an algorithm without any context doesn't allow you to really remember it very well. So the more you can make stories and connections and reason, the better it allows the student to learn.

Bonni [00:15:25] I know you've had some lessons in the area of flipped learning as you worked with faculty who are flipping their classes. I would just love to have you share some of the lessons that you took away from that work and what we can learn from flipped learning, what are some of the lessons?

Silvia [00:15:41] So flipped learning for those who may not be familiar with it, it's the idea that really learning happens when students do work. Right. You don't watch and learn math, but you learn it when you're doing it. And so in order to make more time in class for active learning you need to have something go out of class. So the idea there is that students learn some basic knowledge and basic being on a cognitive level something like learning definitions, doing very simple computations outside of class before they come. And then in class you build on and you have more advanced problems that students work on while you are around. So basically usually you would start with the simple stuff in class. And then you send students home to do the hard work when you're not around and flipped says let's do the easier stuff before class, students on their own. Then we do more of these advanced things in class and then we send students home to do some work deepening those skills.

Silvia [00:16:43] So I was the faculty learning community coordinator for a grant where bottleneck courses were targeted to implement flipped learning and many people think when you do flipped learning it's about making videos. That's how we started out. And so we spent some time on making videos. And while that's a component, but not the only component, really the thing that we didn't focus on initially was the planning of what you do in class.

Silvia [00:17:13] And so we're very grateful to Robert Talbert who wrote a book and flipped learning and the main thing in that is to really how do you have a process of planning a flipped class and identifying the learning outcomes for your class and dividing them into the basics for before class and then more advanced ones in class?

Silvia [00:17:35] And so when I worked with the faculty on our campus and also when we gave workshops to STEM faculty and this year it's going to be also non-stem faculty on how to flip the class, that's really been the key thing about thinking about what you do in class because now you have freed up time. How do you use that time carefully and deliberately to have students work on something actively but then also provide closure on what they've done. And that takes some skills and trial and error. It needs thought. It cannot just be "Oh I'll just go and put them in a group and have them work on a worksheet? That's not going to really be very effective. There has to be some deliberate planning for that.

Bonni [00:18:26] You've shared too that a lot of talk at least I see a lot of the talk around flipped learning be what happens outside the classroom. If people decide to create videos or read articles and there's a lot of discussion and emphasis on that but that really what you discovered is it's what happens in the class. That's really the key to making this method work.

Silvia [00:18:47] Yes. And I mean there are already lots of videos out there in mathematics. You know Khan Academy, there are 10000 people who give examples and what not. And so what I think now is you should start out with using what's there, look and see, it may not be exactly what she would have wanted to do but take it and see how it goes and focus on the in class portion.

Silvia [00:19:16] And then as you teach it, then you may say ok there's that aspect that I see my students struggle in, I haven't really find a good video for that. I'll make a video for that. We had faculty this sort of the first set of courses make those videos and then you find after you put in all the time that this didn't

really work well and then you have to redo it. And so if you make some videos, don't worry about it being the best quality at first, high production or whatever. Just make something that is good enough. Because you're going to change it. And then when you really know what you want, then maybe you can spend the time to actually make it pretty. But if that's all your focus and that can take a long time, you're really missing out on the in class portion that needs as much time to be really designed well.

Bonni [00:20:18] And the part about what happens in the class is something that I mean you can have a guest speaker come in but it's much harder to replicate the amazing advantages that we have with all that's already out there, like you said. I think of myself so much more as a curator of these tremendous resources that are out there and doing it by class and by topic and by type. I'm teaching a class this semester where there's some really heavy topics. And so recognizing that those are really important conversations for us to have but it's emotionally hard to enter into those spaces sometimes so to have a perfect funny video that still makes the point but it's not like we are going to spend our 3 hour like crying and retching inside. I do think that that is a better use of my time to think of the way in which I could create room for space for those deep emotions that will be evoked.

Bonni [00:21:16] And then also still recognizing that three hours is a long time for people to sit in that state and you know almost plan it out as an experience for them the whole time and and getting them moving around the classroom and even sometimes outside the classroom, that kind of thing I just think is a really helpful thing versus me trying to create these amazing videos. And I can create a video ok but I'm never going to be as good as some of the people that are out there doing that and that's their thing.

Silvia [00:21:44] Yeah.

Bonni [00:21:45] Well one last thing I want to have you share about before we get to the recommendation segment is I'd love if you talk a little bit about the first in the world program and some of the things you've learned there.

Silvia [00:21:56] Well so the first in the world was flipped classes and we had identified some bottleneck courses that were then targeted across the three campuses San Jose, Cal Poly Pomona, and Cal State L.A. The data analysis of effectiveness of flipped learning was done with the calculus classes and we just completed our two semesters of teaching calculus on our campus. And we had six instructors total that taught each in a flipped and in a non flipped class. And

students were given the [00:22:32]MDTP [0.0s] which is an entry level exam to test what they come in with and then they were given the calculus concept inventory test to see what they had learned at the end of the class.

Silvia [00:22:44] So the data analysis is still going on but the kinds of things we've learned was for at least for calculus students came in under prepared. And between flipped the non- flipped, there wasn't a significant difference which given that this is something that's different where you often experience a dip in performance of students, that didn't happen. So again when you try a new methodology one of the things is you have to sell it to the students. In our instance, the design was that they wouldn't find out whether they were in the flipped section or not until the first day of class. And that created some dynamics that were not the very best because students felt they couldn't change because all classes were full.

Silvia [00:23:30] But when you do something like this, it's really a matter of selling and reminding the students that we're doing this because we know that learning happens not when you listen to a lecture, however beautiful it is. And the more beautiful it is the more you may think you've learned. But unless you do it yourself, it's not going to go into your brain. I actually when I talk to students about that I tell them if I had figured out how to send my knowledge to your brain I wouldn't be here. I would be traveling the country. I would put my hand on your head and say "Here it is. Calculus 1. 500 dollars please."

Silvia [00:24:12] But I'm here because you know it doesn't happen. Nobody can put it in your head. You have to do it. You learn. And fortunately most students say oh you know the teacher doesn't teach me because they're not doing lecture. But it's not a teacher teaching you. The teacher is a coach that can help you. But you need to do the practice. So reminding the students about that and talking to them about the neuroscience that we now know about learning and how the brain works, all that speaks to what instructors have known for many years. If you don't do it, it's not going to happen. So giving students that background helps [00:24:55]a culture [0.1s] them because for them this is quite a shift in modus of working. They are used to come to class, there's lecture, there's stuff on the board, I copy it down, and then I think I've learned. Then I go home. And now we're asking them to do something else.

Silvia [00:25:11] So that takes some adjustment. And we had students that were at the end it said "I hated it, I want lecture." And there were students who in our survey responded and said "it took me a while to get used to it but really I'm now a much more independent learner. It's something I know that I can learn on my

own." And that's something that you can take to another class. That's not only something for calculus but this is I can have tools. I know that I can struggle and get it. So again, there is a growth mindset. All of these things are connected.

Bonni [00:25:51] Oh you just took the words out of my mouth because that's exactly what I'm hearing and the story is good it does go back to that growth mindset. And you're saying "I can't do this for you," but you're also saying "you can do this." And you're also saying this is an iterative process for them but also for you as teachers to constantly be looking at how you're doing things and even though they didn't get to choose flipped or non-flipped at least hopefully they knew that the leadership there cares enough about their learning to want to test this new method and see what's working and get their input. I mean it's just wonderful and lots of interdisciplinary work.

Bonni [00:26:30] Well this is the time in the show where we each get to share our recommendations and I have a really fun one from some recent travel I have been doing and I'm about to hit the road again and I'm ready to use it. It's an app that is for packing. For many many years I've been using Evernote. Evernote is a notebook program and so I've just got a little note in there, it's got little checkboxes. But sometimes I would find on my mobile devices it was hard to uncheck all those boxes and start again on a new trip. It wasn't always activating very well and that list started to get pretty long. And so they do have templates on Evernote, I could have just gotten better with my practices within that app.

Bonni [00:27:08] But I found a really neat one called PackPoint. The PackPoint Packing app. And it is really nice because I hadn't really thought about this but the reason that my packing list wasn't really working is it was a one type of packing list. But if we think about it, there's lots of different trips that we take so sometimes we would travel with our kids and then there would be special things you need to bring with whatever age the kids are and what they need to have with them that I wouldn't take with me on a business trip and there's different shoes that we wear or different jackets depending on the weather. This one actually is so smart. I use a travel app that I've talked about before called Trip It. And so it connects with Trip It and Trip It knows where I'm going.

Bonni [00:27:47] I had recently traveled to Nebraska to do some speaking there and it knew that it was snowing in Nebraska and said bring your winter coat. It just was smart enough to figure that out. And I love when these technologies are smart enough to sort of reduce some of the cognitive load on us so that we can spend more of our time and energy doing the creative work that our brains are

so much better at than for me remembering what to pack. So it's my recommendation for today and Silvia, I'm gonna pass it over to you.

Silvia [00:28:13] Well speaking of apps, I too have an app that I really have come to love and dependent on a daily basis. And it's a meditation app. It's called Simple Habit. They have some free- you can do some meditations for free but you can also subscribe. And they have meditations of all kinds of lengths, like five minutes focus, or not getting procrastination, sleeping. And there is also a piece of it that says where are you? Work? I'm out and about. How much time do you have? 5 minutes? 10 minutes? 20 minutes? And then you can have a meditation that fits that piece. And I really like that there are really short ones because if I tried to do meditation 20 minutes in the morning and that didn't always work. But I cannot really tell myself I don't have five minutes to do a meditation. So that's been really powerful for me.

Bonni [00:29:12] Oh it sounds like a great app and I look forward to linking to it in the show notes and letting people check it out. And Silvia, I just want to thank you so much for the honor it was to get to talk with you today. Thanks for investing your time to this broader community and letting us learn from some of your lessons.

Silvia [00:29:28] Well thanks very much for having me on.

Bonni [00:29:34] Thanks once again to Dr. Silvia Heubach for joining me on today's episode of Teaching in Higher Ed. And thanks to all of you for listening. If it has been a while since you went and looked at some of the recommendations, I do want to let you know that there is an entire page directed to just those items that have been recommended in past episodes if you go to teachinginhighered.com/recommendations.

Bonni [00:30:02] And also of course at the bottom of each episode's show notes, the individual things that were recommended show up there. Today's episode is 249, so that link is teachinginhighered.com/249. Hope you're enjoying your week and I look forward to seeing you next time.

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