TOPcast Episode #166:
High Structure Course Design for Online STEM Courses

Narrator: When you know what you want for the future, you need the present to line up with your goals. UCF Online offers more than 100 fully online programs in healthcare, engineering, criminal justice, and more, so you can get to your future and beyond.

(*Musical Intro*)

Tom: From the University of Central Florida's Center for Distributed Learning…

Kelvin: And the University of Louisville's Delphi Center for Teaching and Learning…

Tom: I'm Tom Cavanagh.

Kelvin: I am Kelvin Thompson.

Tom: And you, friends, are listening to TOPcast, the Teaching Online Podcast. Hello, Kelvin Thompson.

Kelvin: Hello, Tom Cavanagh.

Tom: How are you this fine day?

Kelvin: Fine. [Chuckles]

Tom: Fine. Good. [Chuckles] All right. For TOPcast, I'm Tom. Thanks for listening. Just checking in.

Kelvin: [Laughs] Briefest one ever.

Tom: Yeah, just getting the status. How's everybody doing? Yeah, good.

Kelvin: Yeah, yeah. All right. 'Nough said.

Tom: Cool. Coming out of a kind of long-ish holiday weekend as we're recording this, and so getting back in the swing of things, digging out of the inbox. It's always fun. You got back from a long trip of driving anyway.

Kelvin: Yep.

Tom: So, this is probably the most relaxing part of your last couple of days, recording the podcast. [Chuckles]

Kelvin: That's really true. I think that might be accurate. That might be accurate. But I have an afternoon cup of coffee, so that's going to make everything go by all the better.

Tom: I do, too. Here we go.

Kelvin: What do you have over there?

Tom: Mine is not thematically selected, but it is an iced coffee, Starbucks Blonde Roast, whatever it was today. It's good. It's refreshing on a very, very warm day.

Kelvin: Yeah, I was thinking about a former colleague who never understood my drinking hot coffee in the hot Florida summer, and I said something to him like, "Well, I like to think that you drink the hot thing, then you feel kind of like by comparison it feels cooler outside. Like getting out of a hot, hot, hot car, and you get out to the heat, and it feels cooler." He said, "I don't think it works like that." [Laughter]

Tom: Yeah, I'm with him. What do I know?

Kelvin: Yeah, right.

Tom: Well, cool. So, what is the coffee you're drinking? What's in your mug?

Kelvin: I have a single-origin coffee from Coava Coffee Roasters. I think they're in Portland, Oregon. This one was interesting for me. It's a single origin. I guess I'll say the name of the country right. Timor-Leste, which is kind of off the coast of Australia, I guess. I really felt kind of ignorant. The people of this country have been around a very, very, very long time. But the country itself is only 20-ish years old because the country that we now call Timor-Leste was previously called East Timor and it was occupied and/or controlled by various other countries for hundreds and hundreds of years and all that. So, I mean, they've got a rich culture, a rich history, and yet there's a lot of newness. They're… becoming a country and having their own self-governance. And then people like me are like, "Huh, I never heard of this country before." And they make, as with Indonesia, which is not too far away, Papua New Guinea, which is not too far away, they have a delightful coffee.

I thought all of that made it kind of appropriate for the topic du jour. So, I'll attest to the coffee being good. How would you rate the connection attempt?

Tom: Wow, I'm struggling to make the connection. I'm sure as soon as you say it it'll be obvious.

Kelvin: I wouldn't count on that. [Laughter] I was thinking of… You've got old and new, right? We're going to talk about a discipline, or family of disciplines, where the idea of bringing certain kinds of design and teaching practices into that. Those practices themselves are not new, but it's maybe kind of new to you, or new to them, in some cases. So, the juxtaposition of the… there's nothing new about Timor-Leste other than their name and the reframing, right? There's nothing new about these course design and teaching practices other than they're brought with relevance and salience to this family of disciplines. So, that was my attempt at a connection.

Tom: I get it. All right. Thank you. I did need to be led by the hand a little bit through that one.

Kelvin: Me, too.

Tom: Do you want to share how that connects a little bit, and then I'll maybe set up the conversation for today?

Kelvin: Sure. Maybe I'll say by way of prelude that we've been working on this in response to feedback through our listener poll from a few months ago. Listeners might've noticed that we've had recent episodes that have addressed things like core online teaching topics like, say, Episode 163: "The Online Syllabus: 'A Welcome Mat for the Course'," and Episode 165: "Why Still Prepare Faculty for Online Teaching? If You Know, You Know (#IFYKYK)." And so, I'd say that today's episode kind of follows along on that trajectory.

Tom: Yeah. Yeah, I agree. So, Kelvin, you recently interviewed Dr. Justin Shaffer about the importance of "high structured course design in online teaching." Dr. Shaffer is the Associate Dean of Undergraduate Studies, Ben L. Fryrear Chair for Innovation and Excellence, and Teaching Professor in Chemical and Biological Engineering, and Quantitative Biosciences and Engineering at the Colorado School of Mines, which makes us unqualified to barely talk to him about much of anything, given all his expertise. [Chuckles]

Kelvin: I'm thinking that's right. I think that's well said.

Tom: Dr. Shaffer also has a bit of a side hustle in providing faculty development work with various institutions. And not to be outdone by anyone else, because he doesn't have enough on his CV, he has a book in the works with Macmillan Scientific Teaching series on the topic of high structure

course design, which I know you talked to him about. Anything you want to set up in your conversation with Justin?

Kelvin: Yeah, maybe not so much setting up the conversation other than to say, I think everybody will find it good. Justin's brain is jam packed with stuff, and it comes out fast, so listen up. He's got a lot of good things to say. But I will say that, check out the show notes, because this is not the first time we've talked about teaching and effectiveness in the STEM discipline. So, we'll put in the show notes along with resources that Justin has recommended. We'll put in some links to past STEM-related episodes as well.

Tom: Great. Through the magic of podcast time travel, here is your interview with Dr. Justin Shaffer.

(*Musical Transition*)

Kelvin: Hi, Justin. So good to have you on TOPcast today.

Justin Shaffer: Thanks, Kelvin, for having me. I'm looking forward to our chat.

Kelvin: Yeah, me, too. We're always interested in speaking with folks who have something valuable to say about STEM education and STEM education online especially. When you and I got acquainted not too long ago, I think we honed in on you've got something to say about that. [Chuckles] And so, maybe I thought we might start just kind of level setting with maybe broadly, how does your work fit within broader work that we might characterize as evidence-based practices in the STEM disciplines?

Justin: Well, I appreciate the confidence in me from the get go, and so we'll hope the listeners agree that there's some value here in the next 15 minutes or so. But yeah, what I do, and I focus on high structured course design, I can get in the details, in the weeds there in a little bit. But generally, I'm trained as a chemical engineer. I'm trained as a bioengineer, molecular biologist. And as researchers, we like to use evidence to inform our investigations at the bench or the design moving forward. Same thing when it comes to teaching. We have a big field of discipline-based education research, or you might want to use SoTL, Scholarship of Teaching and Learning, where we're trying to build on evidence to inform our teaching practices to improve our student outcomes or whatever it is we might be trying to achieve.

And so, what I do in the broader cases, there's been a lot of calls going back to 2012 with the PCAST report from President Obama's office saying, "We got to add more evidence-based teaching pedagogies to our curriculum." In biology, we had the Vision and Change Report, which

came from the National Science Foundation that showed, again, the need for evidence-based pedagogies to improve student learning, and student outcomes, engagement, things like that.

And so again, ever since I started going back to 2010, '11-ish now as a faculty member and getting trained in evidence-based teaching, I've been trying to not only use those practices, but then research my own, do my own work, and try to add to the literature base, but also add to the broader community to help faculty use these techniques to improve their student outcomes.

Kelvin: Thanks for that. We'll work with you to get some of those key resources that you've mentioned there, and we'll put them in the show notes of this episode in case folks want to have those at the ready, especially if those are unfamiliar.

You use this phrase "high structured course design," and I wonder if you might operationally define that for us. What is high structure course design?

Justin: Sure, yeah. So, this goes back, kind of came out of the biology education world, 2005, 2007-ish. It started with Mary Pat-Wenderoth, Scott Freeman, University of Washington. It's definitely grown in that discipline of biology education and teaching since then. And then more recently, you look at someone like Kelly Hogan and Vijay Sathy in their book on Inclusive Teaching. It's all about structure.

What do we mean by structure? That's just the idea that we're trying to help students learn by scaffolding. We're trying to help support them through the different stages of the course experience, from pre-class to in-class to after class. So, what that looks like, a way where before class you have some kind of content acquisition, whether that's reading, or watching, or a mix of both. Some kind of pre-class assessment as well, because we know that you sometimes almost certainly got to add some points on something to get students to really want to do it, unfortunately, is the truth of that. But some kind of pre-class formative assessment, really low stakes, basic concepts to help them get ready for class.

So now, everyone's got a baseline of content that we're at this foundation base. Now we move to in-class, we can up it up, we can bring it up a level. So, we're aligning what we do in-class to what happened before class and we're stepping up a little bit. A lot of active learning, a lot of group work, a lot of problem solving. Individual, it can be group work, whatever it might be. As long as the students are being actively engaged with the learning process. It doesn't mean you're not talking though, so I'm not an anti-lecturing guy. I'm a guy though that says you should be carefully

choosing and selectively thinking about what you lecture. So, I have a word for that. I call it “selecturing.” You're going to “selecture” on certain things that might need clarification, or help introduce an activity, or debrief an activity.

But then we got one more stage, after class. We're going to build one more time. We're going to align that, again, back to what happened before class, in-class, also our learning outcomes, which drive all of this. In after class, we got more formative assessment, practice quizzes, exams, projects, authentic assessments, whatever they might be that ultimately result in some kind of cumulative assessment, whether that's a weekly quiz, again, a type of project, midterm, whatever it might be. But we're helping students, again, scaffold them through the learning process before, during, after class in smaller chunks, so they can learn how to manage their time, and manage their self-regulate learning skills, manage their metacognition, get a lot of practice opportunities to achieve the desired outcomes.

Kelvin: Well, that's great. Now what you've described makes a lot of sense to me for “moment in time,” “four walls and a door,” kinds of settings, where you don't necessarily have structure, they just exist. One has to bring and impose design, one might say even, that structure, and put it in place for the benefit of students. What I think we see, at least certainly pre-COVID in our classic approaches to online education though, is that there's quite a bit of intentional course design and structure already brought to bear in terms of effective practices. You could argue that that might've shifted a little bit with a big on-ramp of folks who were kind of new to online education because of their exposure to emergency ad hoc remote instruction and so forth. That's me just laying a little groundwork on the online side. But what would you say is the key characteristic of high structure course design online, and maybe especially in STEM disciplines, based on what you see in your direct practice and in the practice of your colleagues who teach in STEM fields?

Justin: Yeah, it's a great setup to that question, and I totally agree with you that intentional design of online courses is totally key to success, even going back probably to correspondence days with VHS tapes. I mean, I'm old enough to have VHS tapes. My kids don't know what they are, but I remember them fondly. And you got to design it well, though, to include the structure for success. It can't be too open, and it has to be somewhat well laid out. So that's already there with a well-designed online class.

The problem that arose with the pandemic, and I faced this myself, I ended up, I had taught online before, but then when we had to switch to remote, I taught online for three semesters. Here at Mines, I taught Introductory Biology, Anatomy and Physiology, as well as Chemical Engineering courses, so a lot of different STEM disciplines. But the problem was, we

were taking these face-to-face courses, which have instructor presence. You're there with them. You have the four walls as you mentioned. And we're just throwing it online. And sometimes when you do that, I think that structure can get lost. So, I can look at you on Zoom. You might not be looking at me. You might have a black box. I don't know how well you're engaged. So, I lose that presence.

So having the structure in the online format, I believe, is even more important than the in-person sometimes. The great thing about high structure course design, and I'll outline this in the book that I have coming out later this year or early next year, is that you can easily port the principles of this from a face-to-face course to online sync or online async. It works exactly just as well.

And so doing this before class, let's say you have asynchronous online, we're going to meet on Zoom for 50 minutes three times a week as remote experience. You can still have pre-class videos to watch, pre-class readings to do, something I do called reading guides that help you read the textbook. But then that pre-class quiz. You can still do active learning online. All breakout rooms for what they are. They do work. I love the chat box, actually. That's one thing I kind of miss from teaching on Zoom is the chat window. I think it works really well for student engagement. And then you can still do the after class.

So, the high structure format is very adaptable, not only to different formats such as online, but also different disciplines. I mentioned I do it in Chem E, I do it in A&P, I do it in Biology. I also teach biomedical engineering. But you can do it in Chemistry, you can do it in Physics, you can do it in non-STEM. You can do it anywhere you want. Any listeners out there that use this kind of model in Art History, for example, I'd love to hear from you because I'm still waiting to hear a concrete example of it. I know it would work; I just don't have the exact example to give you all, now.

But yeah, it's very portable, it's very adaptable. I like to say it's discipline agnostic. It's even format agnostic. And again, in those online situations where that instructor presence is minimized, engagement and community might be minimized, having the structure, I believe, is even more important to student success.

Kelvin: This phrase that you've used several times, I think I've got it right. You talk about pre-class activities, and during, and then after or post-class activities. Certainly, that draws one into a “moment in time” kind of framework, right? Class being an “at a moment in time” kind of thing. How do you conceptualize that, and how do you talk about that with faculty colleagues who are designing asynchronous online experiences

where a “class” isn't a moment in time? How do these principles adapt in that situation?

Justin: Yeah, perfect. So, in that async model, you might not have that, and you don't have that on time 3:00 Monday, Wednesday, Friday class meeting. In STEM, what I tend to see is, and I've done it myself with async, you tend to have a class recording for the day. So, you can still set the class up or the course up such that you have, let's say, a Monday, Wednesday, Friday lesson, and I'll use the word lesson now for this, where it could be you watch a prerecorded video of me going through the PowerPoint slides. It could be where you listen to and watch me doing a numerical problem solving on OneNote. And along the way, though, you can have, and how I do it, I'll say, "At this point, pause the video, try to do this problem on your own, and then unpause it when you're ready to go." So, you can also incorporate active learning there in a way through these types of video recordings. You could have readings that they have to do as a lesson, and then again, have kind of questions built in along the way to try to engage them. And there's software also you can use, other companies that have things that help you do those type of in time questions.

So, even if you don't have that formal meeting time, you can still provide the structure. So maybe you call it like a pre-lesson activity, a post-lesson or after lesson activity. And then you have whatever that interaction with the material is meant to be. It doesn't have to look that way. It can be more open, more project-based. But you still provide that structure, so that you have lots of different deliverables that students can check in with you as the instructor, whether you have that, again, pre, in, and after component or not. Just adding that level of structure, and deliverables, and check-ins is going to help students be able to manage those.

Now in an async, I think truly sometimes really disconnected type of class, you might never talk to your instructor or a classmate, other than a discussion board perhaps. So, whatever you can do to have those check-in points and the structure can provide that, whether it's the true pre, during, and after, or a little bit more of an amalgamation will help.

Kelvin: No, that's great. Thank you. As we begin to wrap up, I wonder, no doubt we have colleagues who listen to the podcast who come out of STEM teaching experiences, folks who really are passionate about teaching. But when we think about STEM faculty who aren't, like they haven't specialized in teaching and making that as effective as possible. If some of our listeners aren't those faculty who are maybe research faculty and STEM disciplines, and they want to offer something collegially just to draw in, to hook the interest of, say, STEM research faculty to bring them into this world that you're painting us a picture of, Justin. What's one or

two little nugget things that might bring in the folks who haven't put their toe in the water of high structure course design online?

Justin: Yeah, that's a great way to wrap up. Thanks, Kelvin. So, I think, and for me as a teaching faculty, I've been a teaching professor for 12 years going on now. This is what I do. This is what I'm passionate about. But I do equally love working with other faculty. I do faculty professional development on my own to help faculty learn about these techniques, adopt these techniques, and again, with the goal of improving student outcomes.

I think one of the best ways to do this is to start small and be brief is really kind of two things in one. And it happens during class. So, if you're in a class and you're teaching the same class over and over, it's done. It's ready to go. Less work, more time for other things. I'm the same way with my research. If I have a class ready to go, I can spend more time on other things, prioritize. But you might start to get a little dissatisfied with class. Might get a little boring, a little stale. So, if you can slip in little active learning activities in-class, add a little think, pair, share, talk to your neighbor, add some clickers, maybe add a little bit of tech, or you can do analog clickers, just hold up a number of fingers, things like that. Anything you can do to mix it up a little bit, and just try them out. Try them out. Be confident, see how they go. They don't have to be whole 45-minute-long activities. They can be 30-second-long activities.

Those are the tiny little gateways to help you get started with adding some evidence-based practices into your teaching. And then maybe, okay, well that worked really cool. What if I have them do a little bit of pre-class reading and a little quiz before class? Then I can up my gaming in-class now. They read; I don't have to talk about the parts of the cell in-class. I can go right into cellular diseases, and disorders, and ask application questions on that. Then you add that piece. So, you can add little bits here and there and experiment and try and see what fits you, what's your style, what's your niche. And all of it hopefully is going to be more fun. Not the other F word, but that F word. It's going to be more fun. And I've had students tell me this, I had faculty tell me this, too.

I'll close with this. I had an interview for one of my first faculty positions. And my interviewer, they told me, "I've read every single paper on active learning, and they're all wrong. All the statistics are done wrong. None of the results are real. What do you have to say to that?" I paused for a second, and I said, "Well, even if that's true, teaching with this kind of stuff is way more fun than just talking the entire time." So, that was how I ended that. I got the job fortunately. [Chuckles] I didn't offend anyone with that comment. But again, you got to do what's right for you, what fits your style. And it does make things more fun, more energetic for your

students, more engaging. And the evidence there, as we've been saying, is there to show that whether it's just active learning, whether it's high structure course design, we're going to improve student outcomes, we're going to improve learning, close achievement gaps, improve belonging. A whole lot of things like that come along with it.

Kelvin: That's great. Thank you, Justin, for sharing just a little bit of something that you're obviously deeply passionate about and skilled in. So great having you with us. Look forward to maybe having you back after your book comes out. But for myself and Tom who will join us in the wraparound, just want to say thanks for joining us today.

Justin: Thank you, Kelvin, so much, and to Tom for having me here today. I would love to come back again, and I hope the folks listening got something out of this. We're just, again, scraping that surface, so please do reach out if you ever want to talk and learn more about this.

(*Musical Transition*)

Tom: Kelvin, that was your interview with Justin Shaffer. I really enjoyed the conversation. Anything having to do with structure, you had me at hello.

Kelvin: [Chuckles]

Tom: Because that's been something I've preached for a long time, but probably without the same kind of lens that he uses, which I found really, really interesting.

Kelvin: Yeah, I think to your point, I think the broad concept is not anything new for, say, instructional designers, other kinds of online education professionals, online faculty. This is bread and butter. We get all this if we've been in this space for any length of time at all. But it does represent a faculty-driven interdisciplinary line of applied research, this high structure course design thing. He sort of provides some of the provenance of that. He kind of draws a little line across several different points. He talks about some 2012 US government reports, and Scott Freeman's work with colleagues, and Sathy and Hogan out of UNC, and so forth. And he's building right into that.

I'm reminded that, like our colleague, Tanya Joosten, has written about course design being connected to student success broadly, and especially to benefiting underrepresented student subpopulations. That's not a connection we made in this interview, but I think it's one worth highlighting in light of Justin's comments.

Tom: Yeah, yeah, totally agree. I appreciated his parting advice, which is kind of like start small, try something. Don't feel like you have to eat the whole apple in one bite: my words, not his. But that was sort of the message, and that resonated with me as well. I know he seemed to be talking a little bit about, he was using examples anyway from face-to-face teaching, but you could totally apply that in an online context. And we certainly give advice like that regularly. I'm thinking specifically of adaptive learning. When we've tried to accompany faculty into the world of adaptive and personalized learning, it's like, "Well, it can be a lot of work to turn a whole course into an adaptive course," but just start with one module, start with one activity, that's fine, and kind of work your way up to it. Get comfortable with it, and then slowly build it out over time. And I think that's just a strategy that makes sense. But it starts the process of improving your course, probably the experience for your students, and also yours. As he said, "You're probably going to have more fun teaching this way."

Kelvin: Yeah, I thought that was smart, by the way. I mean, how unfortunate in a job interview, somebody, "Yeah, let's just dismiss this whole line of inquiry." [Guffaws] But I mean, he just took that in stride, right? I mean, it's such a brilliant response. What would you say? "Well, it's more fun. More fun for me, more fun for the students." So, I mean, there's that. Even if you think all the research is bunk, at least it's more fun. I mean, I thought that was smart.

Tom: Yeah, yeah, yeah, I agree. It was a good way to handle probably a tough interview question that was a bit challenging. Yeah, this whole domain of Scholarship of Teaching and Learning. “Yeah, that's not true.” Eh, well… [Chuckles]

Kelvin: Which is kind of funny in light of Justin said, "Faculty are scholars, researchers, data." So, he said, "Same thing when it comes to teaching." And for some faculty, that's true. But as he pointed out himself, clearly not for everybody. [Laughter] Can I just plug the fact that he didn't name it as such, but Justin used a portmanteau, my favorite thing. You know I like a portmanteau. He talked about, there's another little tip wrapped up in this, selective lecturing, not just kind of throw in the whole kitchen sink, but being selective with lecturing. And he called it “selecturing.” I love that so much.

Tom: I knew that was going to tickle your fancy. I knew it. That's right up your alley.

Kelvin: [Laughter] It is, it is, it is. Well, I think I can't add too much more to the conversation. What about you?

Tom: No, I mean, I really enjoyed listening to him. He's got such a wealth of knowledge and just so much good advice. Like you said, I think people should definitely hit up the resources and look at the show notes because there's going to be some goodness in there.

Kelvin: And we will include in there, he has that book in the works, and there's a link on the show notes page where listeners can sign up to get information when that book comes out. Who knows? Maybe we'll even ask Justin to come back after his book is released.

Tom: Great. You want to try and land the plane?

Kelvin: I will try to come in safely on the runway. We might say, by way of wrap up, that high structure course design benefits all students, especially students in the STEM disciplines, and especially underrepresented students. Bringing intentional design to online STEM courses is one way to make a strategic difference to students through effective teaching. How's that?

(*Musical Outro*)

Tom: Yep. Hey, that's good. Any landing you can walk away from is good landing. I think you made that one. You stuck the landing. Cool. All right. Well, thanks to Justin for joining us. Until next time, for TOPcast, I'm Tom.

Kelvin: I'm Kelvin.

Tom: See ya.