Episode 53 – The IGE Program at the University of Pittsburgh

Brian Mitchell: Welcome to Grad Post. I'm your host, Brian S. Mitchell, and we're here to talk about all things related to graduate school and advanced degrees. I'm delighted to have with me today Dr. Susan Fullerton and Mary Besterfield-Sacre from the Innovations in Graduate Education program at the University of Pittsburgh. Susan and Mary, welcome.

Susan Fullerton: Thanks for having us, Brian.

Mary Besterfield-Sacre: Thank you.

Brian Mitchell: The title of your NSF-funded project is a personalized learning model for graduate STEM Education, and it's based in the Department of Chemical and Petroleum Engineering at Pitt. In full disclosure, I'm on the Education Advisory Board for this project, which is how I came to know about it. But the themes and ideas you're exploring are extensible to all of graduate education, so I'm delighted to talk more broadly about the goals of the program. Susan, let's start with you. Tell us about your role in the program, how it came about, and what you're trying to accomplish.

Susan Fullerton: Yeah, sure, thanks, Brian. I became the Vice Chair for Graduate Education in our Chemical Engineering Department in 2020, and what I noticed is that the faculty in our department had really, for years that predated me coming to Pitt, had been proposing innovative ideas at the graduate level that pertained broadly to modernizing the curriculum and personalizing the learning. And then that continued as I became the vice chair, and I noticed my grad committee making these suggestions, and so what I did, my goal, sort of, for my tenure as grad director and vice chair for graduate education was to capture those ideas, assemble a team around them, and then turn them into some type of action, implement them into our program.

And so, Götz Veser - who's one of the co-PIs on this grant - he's the one who seeded the idea of, well, why don't we turn this into a research project? So, meaning that we don't just implement these ideas in our department, but we actually test whether or not they were effective, and we make contributions to the engineering education, you know, research literature, and write a proposal to get funding to do that. And so he's the one who introduced me to the NSF Innovations in Graduate Education program, and we applied for that, and this is where our research work as chemical engineers is, you know, not in the engineering education space.

But we're very fortunate within the Swanson School to have nationally recognized engineering education experts, including Mary, who's on the call, and really, you know, pulling her in to develop the model that, that she's going to talk about, later, and, how to evaluate whether or not this innovation is effective. That was essential to the success. We simply wouldn't have been successful at the NSF level without that engineering education expertise. And so, the team of faculty who had the ideas, combined with the engineering education experts, was really the recipe for this to be a successful effort.

Brian Mitchell: Okay, Mary, how did you get involved in the program? So, it started with this idea and a proposal. Where did you get involved?

Mary Besterfield-Sacre: Well, they actually came in early on, because as they started looking at, we got this proposal idea, there's an RFP. The team of faculty, as Susan indicated, they're top-notch researchers, they're passionate teachers, they wanted to do something, and it was really from a grassroots-level approach to really redesign their curriculum at the graduate level. And, you know, the more and more we were talking, the more and more they were speaking a language of "we want to create personalized learning for graduate students." And so, kind of expanding upon that and really trying to back them away from "let's look at this

as a grassroots." Let's look at what your real educational theoretical underpinnings are. And so, recognizing that we were actually doing an engineering education proposal, not chemical engineering proposal on education, if that makes sense. And so, as we continued to talk, looking through the literature on personalized learning, and then thinking through, and kind of pulling the elements of personalized education. Wiggins actually kind of pulls together all the aspects and the main steps of it.

We were then able to build a model that we intend to test and are testing on chemical engineering. But I had to pull the faculty away from the grassroots approach for them to actually kind of become their own engineering education experts in creating a smart model that we could go ahead and use on any curriculum, STEM-based curriculum. So that's kind of how we got involved and knowing that personalized learning is kind of a Montessori approach. It's been used through K-12. It's been used a little bit in higher education, usually on one or two classes at a time, but here we were attacking the entire curriculum, so kind of taking a full court press approach.

Brian Mitchell: That's great. So you have a couple of goals. Why don't you talk a little bit more about the goals of the project and the objectives that you set out as part of this model?

Mary Besterfield-Sacre: This work is really focused on looking at two problems. So, the first problem is we know that graduate STEM education has been following the same approach, very narrowly focused on research skills, adapting slowly to emerging trends. It doesn't matter if you're in STEM or if you're in history, graduate education is really a slow-moving change agent - apart from the research. The research is definitely at the forefront, but that educational base has really been slow. We wanted really to take that and take it to the next level. We wanted to create this model where students could walk in, have their own set of goals in mind, or maybe ones that we kind of need to help them curate and mature for them, but then able to take the coursework that they need to take. And if they are going down into one particular path, allow them to do that without having to fulfill this entire core curriculum. And also have it such that maybe my background's in chemistry, and not in chemical engineering. Does the curriculum allow me to immerse myself, even though I might not have all the same background as others have? That was kind of problem number one and our first goal.

And then, problem number two is when I somewhat introduced, and it actually has history in the department itself. We know in engineering education, and actually in higher education, that many innovations in STEM have been highly successful, however, they just do not propagate. There's a few that have done very well like the CIRTL program, where we're training the next generation STEM educators, that has been one of the very few innovations that has done a wonderful job of propagating. It kind of hits home in the, Chem-E space, in that over two decades ago we had a grant in chemical engineering to redesign the undergraduate curriculum, and we introduced what we call "pillars." Pillars are very common in K-12 settings. We wanted to do it in chemical engineering. I got a grant from the NSF, produced a wonderful curriculum for the ChemE department, and we failed miserably in getting it propagated. So, literally, this ChemE department is the only department probably across the United States that uses a pillar education approach. Does it very well, but we have failed to propagate it. So our second part of this is really to figure out what is the knowledge that is needed, and (to) examine you know, what are those potentials to extend this model into other STEM fields, albeit even in our own School of Engineering, but maybe across other chemical engineering departments and STEM at large in the graduate context.

Brian Mitchell: So maybe you can get into the model a little bit. I know there's components that you use to talk to faculty about, there's components you use to talk to students about. You bring these concepts to the students. Why don't you get into some of the nuts and bolts of the model, maybe at a high enough level for a broad audience, but also talk about the activities that you're doing?

Mary Besterfield-Sacre: Let me just kind of go over what the personalized learning model really is. Based on the literature, it's kind of a continuous loop, if you will, but you start with a set of instructional goals. It's not instructional goals that we so much, as faculty, impose on the student. But the student is coming up with their own, "what do I want to get out of this program?" Susan will talk a little bit about how we've actuated that, through individualized development plans.

But then the student steps into the task environment. So, the task environment, if you will, is the curriculum. For the ChemE curriculum, it's grounded in four content areas - actually five if you include safety and ethics. So that task environment is the core curriculum. And instead of students having to take four to five classes, and they are all taking it, they're all coming in with some being very advanced in particular areas, some being maybe at ground zero. (We) wanted to kind of set up a curriculum that works for everyone, depending on where their entry level is. But it's not so much just what that content is, and how you're going to teach it over the terms. There's also this third piece which is scaffolding the instruction. So if you will, it's the pedagogy.

We wanted to take for the students the opportunity where they become - they start, within a particular module, and they might be working from a very learner-assisted perspective where the instructor is introducing active learning components, but by the end of the module the student actually has independence. They have demonstrated that they have taken on this part of the module, and that they have independence with the material. So that's kind of like our third stage of this PLM model - the Personalized Learning Model.

And then, of course, with everything, you have to have assessment and performance of what learning takes place. And we do this from actually two perspectives. One, from both the student perspective, how well did they do on the core competencies, but also the faculty are doing it from more of a formative and summative perspectives. And then at the end of all of this, you have a reflection piece. So, it's not like we just set out your instructional goals, you go, you take these classes, it's set up in a particular scaffold, and you're assessed, but there's a reflection piece and an evaluation piece that involves not only the student, but the faculty, and in this case, it also includes Susan. You go back and you revisit those instructional goals. How have they changed? Maybe they become more mature as the student is starting to engage in the curriculum, as they're starting to engage in the professional streams, as they're starting to engage in upstarting their research with their faculty members. So, it's a kind of a continuous loop that we've kind of broken down into more or less each year that the student is a graduate student.

Susan Fullerton: One of the driving forces for this personalization is addressing this issue that most academics tend to prepare graduate students for the job that they have. That we tend to be, by default, preparing our students for academic careers when the data and the reality is very obvious - especially in our department - that the vast majority of our students go to industry, and some of them go on to pursue entrepreneurial careers. Few of them go on to academic careers, and I'm sure this is largely true for many STEM and engineering fields. The reason that's relevant is it really drove our decisions on curricular and co-curricular changes that are part of this model that Mary just laid out.

So, on the curricular side, we have a panel of subject matter experts - a couple dozen from outside of the university, industry, entrepreneurship, national labs, some academics - who helped us to develop the body of knowledge, that core curriculum, and identify in particular the stuff that's missing, the more contemporary concepts that they would like to see our students know so that they can be prepared for career success on day one on the job. That's really the main objective here. We've brought in those voices and that input in order to help us craft that core curriculum. Examples include a lot on communication, project management, machine learning, business practices, these sorts of things. Some of that can belong in the

core curriculum, and some of it needs to be part of electives or workshops or things like that, and they've also helped us figure that out.

This modularized classes as part of the curriculum is also part of addressing the need for bringing in modernized concepts and personalized learning. So the modern concepts - now, if these classes are modularized meaning they're these one-credit stackable courses - we can be more nimble and responsive to emerging trends in the field. And we're seeing some of those begin - actually, this spring - those one-credit modules get deployed. The personalization piece comes into the curriculum, because now you can come in and you have to fulfill so many credits, but now you can pick and choose a little bit more. And if you want to focus on polymer engineering, then maybe you need a lot of transport, and maybe you're not going to do as much, I don't know, reaction engineering or something. And so that curricular piece allows for this personalization.

But I want to get to the co-curricular side of the model, which is these things we're calling professional development streams. So, there's three of them: industry, academia/national labs, and entrepreneurship. A lot of these activities were actually already happening in our department, but they weren't organized in this type of fashion, and they weren't sanctioned by the department. We weren't sending out emails from the leadership to say "students should engage in this." Some of the activities that they engage in now, we offer about two, on average, two in each stream per semester. The entrepreneurship stream, those students often go visit startup companies local to Pittsburgh and get to know their stories and some of the challenges and successes in that area. Academically, we'll connect students who want to be professors with having them have lunch with some of our really high-profile seminar speakers. The industry stream, we're seeing a lot more summer internships and co-ops at the graduate level, which I think are really important and is something other disciplines do often pretty well. And we're seeing a lot of successes come out of that in terms of students being offered jobs at those companies, even before they defend their PhD. And so, again, these co-curricular activities were ones that we were already kind of doing in some sense, but this personalized learning model really gave the framework and the structure to sort of advertise to the students that this is something you should be participating in to lead you to success on day one on your job. We're sanctioning this, we want you to do this, you can participate as much as you want, you can switch streams as you move along, and we want to work with you to set you up for success, knowing that many of you will not be in academia.

Brian Mitchell: Do you make any distinction between your master's and your doctoral students in terms of what they can do with this personalized learning model?

Susan Fullerton: At this moment, we do not. The master's students, there's two flavors, right? They can be professional master's students who aren't doing research, or they can be research track. The professional master's students take the same core classes, and so do the research master's students as the PhD students, so that's all the same. They're experiencing the modularization of the curriculum. They're also invited and welcome to participate in any of the co-curricular activities. The research master's students benefit from the IDPs, so we encourage them to engage with the faculty and the individual development plans, and so the answer is, yeah, they're welcome and encouraged to participate in the same way and at the same level as the PhD students.

Brian Mitchell: I've talked about IDPs - Individual Development Plans - before on this show, and I'm curious whether you've developed your own IDP, have you adapted one? How has that process with the IDPs gone?

Susan Fullerton: The answer is we adopted one initially, and we tried that on for size for a year, and then I met with all the graduate students at the end of that year and collected some feedback, and the feedback that I got was that the format of that individual development plan wasn't suitable for their needs. I used it

myself, and I could see how it wasn't the best format. So, our team actually developed, in collaboration with some graduate students, a Gantt chart-style format. I sold it to them as like, “hey, look, we require you to do this in your proposal exam for your PhD, have a Gantt chart and a timeline, so let's just start this now, and you can draft it and continuously refine it.” That tool has been better received by the students. I'm also careful, though, to really emphasize to them that I don't actually care what tool you use. This isn't about the tool, because I feel like once it becomes about the tool, then it's like a checkbox. This is like a lifestyle. You need to be checking your goals and refining them and communicating with your advisor on a regular basis, and however you need to do that is fine, as long as you're able to write goals that are specific and measurable and timely and so on and so forth, that meet that SMART acronym.

And so what I found, with the IDPs - because this is an NSF grant - so we're getting feedback from the students. We need to do that anyway to refine and make this better, but also to provide data for the grant. What I've found is that most students and most faculty are definitely favorable towards this. The students like it because it does drive communication with their advisor, sometimes in a way that they can just use us as an excuse to do it, like, “hey, Dr. Fullerton says I gotta talk about my IDP with you this semester,” and it drives that discussion in a way that maybe you wouldn't have, normally.

One student, I can give you a quick success story. It was a student who was in her fifth year. She was late in the program when we started this. But doing the IDP caused her to have a conversation with her advisor that made her realize that she didn't actually need to do an academic postdoc in order to get the industry job that she wanted. There was, like, a misconception there. So, the faculty member fixed that misconception, connected her with someone, she got a summer internship, and boom, she got a job offer at the place she wanted, like, instantly, right? Not instantly, but after she completed a great summer internship. But my point is, she would have literally delayed her career by a misconception that was clarified by opening that IDP and saying, “well, here's my career goal,” and having the faculty member say, “well, why are you doing this?” So, there's one success story.

We had another student go on an industry summer internship, and he came back, and he wasn't really sold on IDPs or Gantt charts before I could tell, he was lukewarm about it. He came back, and he said, “this entire company uses Gantt charts to do everything,” because it's all about timing. It was like a biotech firm or something. It's all about timing, and you have to align yourself with the timing of the other processes. And so he came back with a real renewed appreciation for why goal setting and timing was really important, so that was exciting to see.

And then I would say that on the faculty side, they're mostly favorable toward it. I've only had a few faculty maybe be a little bit lukewarm about it. Some have said that they should have been doing this all along. Some have noticed that the first drafts from the first-year PhD students and master's students are pretty abysmal. Which is kind of good, like, that's good to see, they kind of need to be, that's expected, right? They haven't been practicing this skill. The point is that they're seeing it improve with time, right? And so that's one of the whole goals. And so, yeah, I think IDPs, if, you know, if that was, like, the only win from this whole effort, I think that's been kind of a big win, because it's facilitating communication with advisors. It's goal setting. It's having them think about their careers sooner. And for me, as a grad director, it helps decrease the amount of friction and conflict that students and advisors have, because my experience - although not too many years of experience - is that those often just boil down to misunderstandings and miscommunication.

Brian Mitchell: Mary, you talked about formative and summative evaluations. Can you talk a little bit more about the assessment piece? What are the tools you are using, and how those results feed into evaluation of the model in general?

Mary Besterfield-Sacre: Okay, so we're actually still in progress of, you know, like, we're finally implementing the model in its full. So, in terms of the assessment and evaluation pieces, the IDPs themselvesare an evaluation piece, because it's part of what the student says. What have I done? What have I failed to do? What needs to change? So that by itself is an assessment piece.

We have a couple of assessments. One is actually walking into the classroom and doing a COPUS (Classroom Observation Protocol for Undergraduate STEM) assessment. It's watching the classroom unfold and doing a behavioral observation. We're also using a instrument called CUCEI (College and University Classroom Environment Inventory). It gives you an assessment of what the environment is in the classroom. We did this prior to changing the curriculum over into the new model. We're implementing it first for the fall, and now in the spring we've implemented it again, so we've got kind of a pre- and a post-.

Other pieces that we're using to evaluate the model is one of the things is we were hoping to kind of help students upstart into their research by changing how we're laying out the curriculum. We're hoping that if students can determine which of these classes they want to take, that they can get aligned with their mentor - their faculty mentor - and in the research in a faster and more productive. So, we're also using the ERLA (Entering Research Learning Assessment), which is a kind of a student takes its and turn and kind of evaluates where they think they are aligned with their research at the PhD level. Then the faculty member also takes kind of an alignment instrument of the IRLA as well, to kind of say, “Well, this is where I think that student is,” and then between those two they can have a conversation around where the student is, and areas where the student thought they weren't doing as well as they should. The faculty can turn around like, “No, no, you're right where you need to be.” Or, in some cases, the faculty member's like, “Wow, I haven't given you an opportunity to explore this area.” Now is kind of feedback to them to say, “I can now move you into that state space of your research so that you can develop those set of skills.” So those are some of the instruments that we are using, and of course the traditional things in terms of how well students are doing on the courses themselves.

One of the things that has come up in the redesign of the classes is - if you do have students that are coming in that might be more advanced - is really to do a pre-test in each of the classes, just to know. It's more to help the faculty know where the students are coming at. Actually, to their surprise, when they've implemented it, they found out students actually aren't as far along as they would want them to be.

Hopefully, that gives you a little bit of a broad brush of some of the instruments that we're using. We're not trying to be overarching in terms of there's these three instruments that we're using. We're using a whole, kind of portfolio of instruments to look at different aspects of the program.

One thing that we are doing is our external evaluators - they've based on kind of how we've laid out this program - they pulled together and create an instrument to actually measure how we've moved through creating the innovation. So that's been very revealing for us, and it's going somewhat as anticipated, so we're happy to see that, but it's nice that someone from the outside is kind of looking at us, seeing how our innovation is growing over time, and actually measuring it for us.

Susan Fullerton: And I'll add to that, Quality Evaluation Design also does a lot of student interviews, that are anonymous, so they interact privately with the students, and then collate that feedback - keep it anonymous, and then give it back to us, which I really appreciate, because it gives us an sort of an unfiltered view of how things are going. They've talked with alumni who experienced the old version of our curriculum, and now the new version, so they've been really wonderful to work with.

Brian Mitchell: You said that things are going as planned, and that's fantastic. Susan, you outlined some vignettes and stories of students who have benefited from this. Maybe what are some of the barriers that you face that you didn't anticipate?

Mary Besterfield-Sacre: Yeah. We're really blessed in that the faculty - this is what they wanted. But when they start engaging in it, they also start seeing, “Whoa, I didn't know we're having to do this!” Or, each faculty member is coming to this, even though they're all kind of aligned and want to do this, they all each have their individual perspectives as well. So, kind of one of the big ones - and we all have to laugh at it = is cutting material from the curriculum. All faculty think all that material is important, and you have to get every single page in from that book into the curriculum. So, they've had to learn to kind of pull back on it. Part of modularizing the class, the first module is kind of based around the fundamentals. The second module is around graduate-level concepts, and then the third module is around these specialized topics. And in doing so, we took a step back when we were developing the body of knowledge to create for every class, what are the learning outcomes associated with the class? The faculty contributed those learning outcomes. They were taught how to use Bloom's Taxonomy, so they derived really good, well-grounded learning objectives, learning outcomes.

Then, we worked with our external advisory board and the faculty to kind of bin these learning outcomes. Are they fundamental? Are they graduate level? Are they specialized level? A lot of them all ended up in that fundamental, and I think that took the faculty back a little bit. They're like, “Whoa, you know, a big chunk of these are all fundamentals. They're things that they should bring to their graduate program from their undergrad.” One of the things in trying to have them realize is that a review of the fundamentals is not necessarily a bad thing. It's actually a good thing in that we tend to - as faculty - want to teach in a very linear fashion: what you learned on day one, you learned on day one, and on day ten, you're learning this, and on day 20, you're learning something else. There's a tendency that you should not be circulating back to those fundamentals, but you need to in order to build up those graduate levels and that specialized level. That iterative manner, I think, is really good, and so getting that across to them, I think, was kind of one of those first barriers.

In general, one of our findings is, you know, we're kind of happy to see that the team did kind of move throughout the year, kind of on pace as what we hoped that they would do.

Susan Fullerton: That piece about the writing the learning objectives, it was so impactful. I contributed some learning objectives, too. I teach one of the core classes. It was so impactful to get feedback from one of our engineering education experts, April Dukes, who's also on the team, and have her help us write strong learning objectives. I think I could speak on behalf of my other ChemE colleagues. That didn't actually take very long for her to educate us on that, but wow, that was impactful, because it forced us to really grapple with what it is we're trying to teach, and now it blows my mind when I see a syllabus or something that doesn't have learning objectives to share with the students. So, for your listeners out there, I just thought that was an important plug for talk(ing) to the education experts at your institution, because even a modest time investment can make a huge difference.

Brian Mitchell: To kind of wrap up here, I know you're still in the middle of this experiment, this project. But maybe think about and explain a little bit about (it) more broadly. Mary, you talked about the dissemination issues you had with a previous project. What would be your hope for taking this model and extending it to other disciplines and beyond Pitt?

Mary Besterfield-Sacre: The model on its own is just a good framework to think about how you want to move your students through a program. You can take the model as a whole and do a full court press, such as what we're doing, but you can also take it in parts and pieces. For example, a graduate program can just

pick up and take the lessons learned about using IDPs, kind of setting up a process and a protocol, and we can guide, various departments or programs and how to do that. Or if you want to formalize your professional development streams. We have protocols and procedures on how we've done that. Probably the biggest piece that we have been doing is modularizing our curriculum. That does take some effort and some know-how. But one of the things that we've been learning and working with our advisory board in this area is, even though this is a model, every audience that we take this to is coming from a different space. We learned real quickly, we thought, "Oh, we could just extend this model across our whole engineering school," and then learning that each of our engineering departments actually approaches their graduate curriculum somewhat differently. So, kind of understanding where that audience is starting from, and kind of applying our Rogers Diffusion of Innovation. What knowledge do they have? What's their awareness? What are those aspects that they see themselves using? And then kind of coming up with a decision to employ it. So, I know that kind of sounds maybe simplified, but lessons learned from redesigning a curriculum 25 years ago, and redesigning the curriculum now and trying to get this out to the greater public. We're really trying to understand the different audiences and how we need to approach what we've done from their perspective, as opposed to our perspective. I think that will be something that will help make this model extend beyond just our discipline or our one unit. Lehigh has come over and asked and said, "Hey, we're thinking about doing this, and we saw that you were already doing it," and we're like, "Terrific!" We have another department from another institution that actually wants to start a ChemE graduate program, and so they're interested in this approach. So, there are opportunities, but the dissemination piece is not - if we're going to do it right - it's not an easy task.

Brian Mitchell: Well, this has been very interesting, and I thank you both for sharing your thoughts and ideas and the excitement surrounding this project with my audience. So, thank you for joining me today, Susan and Mary.

Susan Fullerton: Thanks, Brian.

Mary Besterfield-Sacre: Thank you.

Brian Mitchell: All of the links provided on my podcast are available on my website at gradpost.com. That's G-R-A-D dash POST. There, you'll find additional information and resources to help you plan your adventure for an advanced degree.

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