- **Dr. Streveler: Welcome *to the Research Briefs podcast.***

  I'm your host, Ruth Streveler coming to you from the School of Engineering Education at Purdue University.

  The goal of Research Briefs is to expand the boundaries of engineering education research. In these podcasts we'll speak to researchers about new theories, new methods, and new findings in engineering education research.

  My guest today on episode 4 of Research Briefs is Dr. Karl Smith, Cooperative Learning Professor of Engineering Education at Purdue and Emeritus Professor of Civil, Environmental and Geo Engineering at the University of Minnesota.

  Karl has been a tireless advocate for increasing student engagement especially with cooperative learning in engineering education for over 40 years. I've asked him to share his experience of working for decades to change engineering education. I think listeners who are also aspiring to be change agents can learn a lot from Karl's experience.

  Karl, welcome to Research Briefs.

- **Dr. Smith: Thank you, Ruth. Delighted to be a part of your Research Briefs Podcast.**

  - ***Can you tell us about how you came to learn about cooperative learning?***

- **I stumbled onto it when in my early days as a researcher I was assigned a third-year course that didn't go very well. So, I started looking for other ways of working with the students and discovered courses in the College of Education at the University of Minnesota. And, one of the courses that changed my life was a course in the social psychology of learning. And, the instructor assigned us to teams in the first class and emphasized independence and accountability and I thought, "Oh my gosh, this is the way I worked as an engineer on the job and as a researcher, and why wouldn't one do this with undergraduate students?" So, that was in the early to mid 70s.**

  - ***And, I would take it that at that time people weren't doing that?***

- ***It wasn't very common.***

  - ***At least not in engineering.***

- ***I don't know that it was common anywhere in STEM education in higher ed. I mean it's always been a part of education in the humanities with the seminar format and people coming and discussing things, and in disciplines like social work it's always…people who have worked with groups of people, I assume it's been a part of the pedagogy. But, definitely not engineering.***

  - ***Definitely not engineering. So, you were our renegade.***

- **I was a pioneer.**

  - ***A pioneer. Well, most pioneers are renegades too.***

- **To some extent, yes.**

  - ***And so, you began then trying to teach that way in your engineering class?***

- **Yes, the first thing I did was adopt it in my own classes. And, you know, my colleagues were respectful, but I always noted I was treated with benign neglect. It was, "Oh, Karl's doing that, and the students seem to perform fine and they don't complain."**

  So, I started implementing in my classes and doing systematic works or collecting data in my classes. And then I had started a Ph.D. in metallurgy and then got so deeply engaged in the education work that I switched to doing a Ph.D. in educational psychology.

  - ***And, you said you began doing research in your classes. Was that part of your dissertation work as well?***

- **It wasn't part of my dissertation work. I began my dissertation work in another context. But, I did publish the data from my classes.**

  - ***And that was pretty unusual as well, right?***

- **Well, this was ’81 when I first…I may have talked about it before that, but kind of my initial rollout was the Frontiers in Education Conference in ’81 and a JEE article. And, it was quite different from the norm.**

  A standard practice in engineering education at that time was faculty tried things in their class and often reported whether or not the students liked it. And if the students liked it, well that was a success. That was pretty much the standard of evidence in the late 60s/early 70s. And so, I mean I came with a systematic study grounded in the theoretical framework; I came with empirical data. So, people were respectful, but my sense is they didn’t quite know what to do with it ‘cause it was so different. I don’t know that most engineering faculty members at that time had ever seen a very systematically structured educational study.

  - ***So, from hearing that I think of a person who’s really very willing to do something outside of the norm. And, do you see yourself as that kind of a person then? Or, how were you able to do this thing so very different and get up at a conference where this kind of work just is not presented and present it?***

- **I never really thought about it that much. I mean I did present in engineering education conferences and so these were folks who nominally are interested in their students’ learning. And, it would’ve been a different reception, I think, in a traditional disciplinary faculty setting. But, the folks that I interacted with in the engineering education community were by-and-large very supportive. And, it was a small community and there were a few others who were doing this kind of work; others who had education**

backgrounds, people like Bill LeBold who had a Ph.D. in psychology, Helen Plants, Larry Richards who also has a Ph.D. in psychology. Like me, most of us weren't all that public about it. We got together at conferences and supported one another, but what we were doing was quite different from the norm.

- ***So, you were able to find a place where it was still maybe a little unusual but not like heresy or just so strange.***

❖ **Yeah. The spirit was congruent. I mean these were folks by and large that really cared about student learning and effective practices. I think they just hadn't seen anything as involved as a systematic study grounded in a theoretical framework, pretty rigorously conducted. So, they were respectful it was just I think it was puzzling for them. That maybe unfair, I don't know that they were puzzled, but it was quite different**

- ***So, what I wanted to ask you about is kind of that transition from going from being a researcher that's talking about your own work to really sharing that approach with the community at large.***

  I would say you've presented hundreds of workshops about cooperative learning?

❖ **Maybe thousands over 40 years.**

- ***Maybe thousands over 40 years all around the world. How did you decide that you wanted to create these kind of workshops and what was***

the initial reaction of the engineering community to what you had to say?

- **I'll start with the local reaction. When I switched from doing a Ph.D. and I already had an instructor position, so I already had an appointment, was doing research, but was also working on a Ph.D. When I switched, my immediate colleagues were respectful, but they were concerned. I mean one comment that I remember is one person said, "You'll always be a second-class citizen if you don't have a Ph.D. in engineering." And so, I had heard that, and I had to take that into consideration.**

  I think my thought at that time was when I finished my Ph.D. I'll just go somewhere that values it. And then when I finished, since I was also doing reasonably good traditional engineering research, I was asked to apply for a position. I hadn't planned to stay on in Minnesota, but I was asked. I think that's how I got more involved doing workshops. There were projects like the Foundations Coalition which had put active learning as one of their foundational pieces. And so, they invited me to come and do workshops.

  And so, I think it was people becoming familiar with the work in conferences and then following up saying, "Hey, we've got this project we're trying to design a different kind of learning experience that's more research-based, would you come and talk to our faculty?" Some of those were the annual faculty retreat where they had them do something, they'd bring in somebody, and I never enjoyed those all that much because there were always a lot of people who weren't that interested.

The places I enjoyed working with the most were the folks who were really serious, they wanted me to do something. Folks like Lynn Bellamy and Barry McNeil later, they just decided to implement this in their first-year course; it was part of the Foundation Coalition again. I worked closely with them and it was experiences like that where I worked with folks who really wanted to do something.

- ***As a side note for some of our listeners that maybe are newer to the community, can you give them some background on what the Foundation Coalition is or was?***

- **It was one of the engineering education coalitions which were partnerships…**

  - ***So, they might not know what an engineering coalition is either.***

- **These were collaborations across universities…I don't recall what the overriding mission was, there were several of them, geographically distributed, and the focus was improving engineering education.**

  - ***And they were NSF sponsored?***

- **They were all NSF funded.**

  - ***And multi-year?***

- **Multi-year, multi-institutional.**

- ***And the timeframe for those broadly?***

❖ **Early 90s**

- ***Okay, so you said your first kind of coming out party was in '81?***

❖ **That was the big one. On recollection, I did presentations in the North Midwest section, I remember being at Iowa State, that would've been probably in the mid to late '70s, and that may have been one of the first places where I locally presented this.**

- ***So, then the major coming out was at FIE?***

❖ **FIE and the JEE paper.**

- ***Which I should say is, "Frontiers in Education."***

❖ **Yeah, it's a conference that was started by the IEEE Ed Society in the early '70s. They joined with the Educational Research and Methods Division of ASEE and the Electrical Engineering Division a little later; in the '90s the IEEE Computer Society joined. So, they've run an annual conference called "Frontiers of Education," since the early '70s.**

- ***Do you recall a bit then we're looking at the Foundation Coalition and the other coalitions happening in the early '90s, can you recall a little bit about that decade of what was happening in the '80s for you before the Foundation Coalition?***

- **One pivotal event was in the mid to late '80s, I don't recall exactly, I had a couple of international students show up on my doorstep; they were from the Norwegian Institute of Technology. And, they were on a tour of the U.S. looking at alternative pedagogy because they felt there had to be a better way of learning to engineer than what they were experiencing. They garnered support from their rector and they'd gotten some corporate support; Siemens was one company that supported them and there were others. And they did a tour of the U.S. and showed up on my doorstep and asked if they could sit in on my class. They had heard from Roger Johnson in the Cooperative Learning Center that Karl Smith was doing interesting things.**

  So, my automatic response was, "No, I'm sorry, I don't allow people to sit in," and they were just devastated. And then I said, "Well, because it would be a waste of time. If you want to come and join a group and do the work, or collect some data, do some observation, then you're welcome; you'll actually get something out of it." So, reluctantly they said, "Well, okay, we'll come."

  So, they came to class; I assigned them to two different teams and at that time, especially through the Cooperative Learning Center at Minnesota which was extending its international collaboration, I had several international visitors who would show up and attend my class. And this was either an engineering systems course or it was the how to model it first-year course, all problem-based, cooperative learning, highly interactive.

And after that class those two students said, "Oh my gosh, this was really interesting. Would you come to Norway and work with our faculty?" And I said, "Well, sure I would love to." But I thought that would be the last I ever heard from them.

Shortly thereafter the telexes started coming, for those of you who know what the telex was it was an international communication form back in the '70s and '80s, and they wanted me to come right away. And I sent them back a note saying, "I would be happy to work with you on one condition, that students participate in the workshop. This was initiated by students, it's for students, I'll come work with you as long as it's students and faculty." And they were quite hesitant. They said, "We don't know how faculty will feel about having us in the workshop." And I said, "Well, if the faculty won't agree with it, fine find somebody else I won't do it." And so, the faculty agreed, and I showed up on a very snowy day in probably '88/'89 and immediately got on a train to go to Rondane, a ski resort where we held the multi-day workshop with students and faculty. And there were many, many memorable events during that but one most memorable was a faculty member said, "There is no way I could get my students to do that," after they had just experienced something. And I said, "Well, let's see. So, what do you all think?" asking the students. And they said, "Oh, yeah, we do that in so and so's class we've done similar things. Sure, we would do that." And it was quite an experience for those 30 faculty because they got to hear it from the students.

And, I think this is an important point, I don't think we involve students

often enough in these conversations about what we know about how people learn and designing effective learning environments.

- ***It's only for them, right? They're the user, why are we asking them?***

❖ **Yeah, why would we ask them? Well, they also have a lot of experience in our classes.**

- ***Yes. So, I know you have many supporters and you've won numerous awards for your work. But, I'm sure you've had your share of doubters too. What has been your greatest challenge in going forward and what has sustained you in the face of opposition to your ideas?***

❖ **My greatest challenge is folks who just claim that they know that this wouldn't work in their class. Maybe 10 years ago, I heard a comment from Ken Heller who started the Physics Ed Research for Minnesota and embraced cooperative learning in introductory physics in the '80s; and so, they used the formal cooperative learning model. And Ken uses this phrase he calls it, "Faith Based Claims." And so that's one of my major challenges; people who say, "Oh, I know that this wouldn't work in my class. Trust me I know."**

- ***With no evidence.***

❖ **With no evidence whatsoever; a faith-based claim. I mean I've really grown less tolerant. At one time I was known as someone who was very, very tolerant. Barry McNeil, whom I mentioned at Arizona State, asked me to go**

work with a group of faculty at one stage and I said, "Lynn, you have more experience in this area than I do, why don't you go? Why do you want me to go?" And he said, "Karl, you have a high tolerance for arrogance and ignorance, I couldn't do it." "All right, Lynn, I'll do it." So apparently, I known as someone who had a high tolerance for arrogance and ignorance, but it's diminished over the years as more and more people are saying, "Look at all of this evidence. Come on people, just follow the evidence."

- ***So, what has sustained you?***

❖ **Oh, the community. The community of folks like you, Ruth, and others who are doing similar work, have been in similar situations, have met similar transitions. It used to be a somewhat cloistered community; we would get together at conferences and other settings and we weren't so public about it. But, in the last few years it's just been delightful as more and more folks are coming out and saying, "This is what I care about, this is what I want to do." And my goodness, I'm not the only one.**

- ***I know you and I are big fans of Parker Palmer's movement approach to change.***

❖ **I'm a big fan of Parker Palmer, period.**

- ***Well, yes, yes. And, in our earlier discussions about this, we had said how we could see some of Palmer's approach the chronology of what happened here. Would you want to explain that model a little bit and***

talk about how you see that your life is unfolding as Parker might say?

- **Oh, thanks. Yeah, Parker Palmer's movement approach to change is based on his reflection on movements like the civil rights movement, the resistance to apartheid. And, the first step is when individuals decide to live, and he calls it, "divided no more." When they say, "This is important to me, I'm going to do this." And, I think that happened to me with that experience in that Ed Psych course.**

  And another piece I forgot to mention, someone whom I owe a great debt of gratitude, was the research director of this lab where I worked at that time, Ken Reid, he was quite supportive. He said, "Well, this is different but it's really important and I support you." So, I got support for conferences and other things so that made being divided no more a little easier.

  And then, as you were just mentioning, Ruth, at conferences and other settings I found others; other likeminded people, or people who had been through similar experiences and we came together, we found one another, and I think, and that's the second step in Parker's movement approach. And that also, I think, made it easier to take the third step to which is going public; to talk about it with others, present it more broadly. I was doing some of those more out of step because I went public early on before I had a really strong supportive community. But, I think finding others made it easier to then go further and do even more.

- ***So, would you say then that having that strength of the community really gave you the courage to go public? I think that's a very scary step.***

❖ **I think so, yep.**

- ***And, what advice would you have for people who are trying to push the boundaries of the engineering education research community and know they're going to be doing different things, maybe using different methods or different theories, and now they're beginning to face that step of going public with it? What advice would you have for them?***

❖ **You know me, Ruth, and my favorite answer, it depends. So, it depends on the context. If you're in a context where there isn't a lot of support start small, do little things, look for others, look for more a more senior person who you might get interested maybe in your department maybe in another department, watch out for yourself. So, start small, start early. There are things that most of us can do in our classes, little things, that help us build up experience and confidence and then find others. And that might mean finding others at a distance. Hopefully though everyone can find someone nearby to share successes with, to problem solve, struggles or failures. It just makes it so much easier too. And, I had David and Roger Johnson who were just superb mentors.**

- ***Do you want to say a little bit more about them because I know in some circles they are incredibly famous, but other people might not know them?***

- **They developed the conceptual cooperative learning model based on the work of Morton Deutsch, a social interdependence theory in the '70s. I think their first paper on cooperative learning was probably '74 or '75; it was primarily K-12. Cooperative learning had gotten its start in higher education. Morton Deutsch was at Columbia and did the first systematic study of cooperative learning in engineering education at MIT. It was published in 1948. And then one of Bill McKeachie's students, Haynes did a systematic study of cooperative learning at Michigan in the '50s.**

  But David and Roger I think saw that there was so much need and a lot of interest and support in K-12 that they just ignored higher ed; they had to make choices I think about where to allocate their resources.

  - ***And they were at the University of Minnesota, and still are right?***

- **They were at the University of Minnesota together. They're both retired but they still travel internationally. And, two of the prompting events that got more and more schools interested in cooperative learning was one court-based desegregation and then the mainstreaming law, Public Law 94-142 which says all students have a right to access to the broader peer group. And so, how do you bring people who are different together in meaningful ways? And just putting them together in close proximity without changing the way that they meet and interact doesn't help. And so, cooperative learning was really instrumental in helping with creating supportive learning environments with the mainstreaming law and in desegregated schools.**

  And so, then when I came along I was interested in higher ed; I'd worked a

little bit with high school teachers, but I don't have skills with working with elementary or middle school students. I'd worked with teachers, but I was most interested in higher ed. So, I kind of re-sparked their interest in higher ed and in '91 we did a research monograph and the first practitioner guide for cooperative learning in higher ed.

And, they still do some higher ed things, they did an ERM Distinguished Lecture a few years ago, but their emphasis is more K-12. And now there's a broader group of people internationally who work in higher ed with cooperative learning.

- ***So, they were kind enough to take you under their wings.***

❖ **They adopted me essentially. So, I did lots and lots of workshops with them and they would identify opportunities when I would get invited so that was another thing that opened up pathways. Somebody who would contact them and say, "We want a workshop for our faculty at such-and-such community college," and Roger would call me and say, "We're not available, could you do this?" So, that's another way I wound up doing more workshops.**

- ***So, one of the things that Parker Palmer's model would predict, after people have determined kind of their true self, they found others, they've gotten support, they've gone public, then they work to change the system. And, do you see that happening with regards to cooperative learning in engineering education that people are working to change the system; in other words, make it more acceptable, make it more common,***

make it more usual?

- **Yes. I mean there are several initiatives. The big one was the National Academy study Discipline-Based Education Research, and then the Practitioner Guide, really were looking at effective practices with high standards of evidence and then advocating for them with the practitioner book "Reaching Students." And the national academies have a lot of credibility, so I think that helps. Folks like Carl Wieman in the Physics Ed group, they have helped to have a Nobel laureate saying, "We really need to change these practices.**

  One of the most active groups right now is called the Accelerating Systemic Change in STEM Undergraduate Education; it's really about systemic change or institutional transformation and their centerpiece is research-based instructional practices of which cooperative learning is one. And so, they're really focused on understanding how do we transform institutions to get more of these evidence-based, or research-based, instructional strategies.

  The National Science Foundation Innovation Corps for Learning is another program for really trying to sustain and scale research-based educational practices.

  So, there's a bunch of things going on; it's not easy. Faculty in engineering, like faculty in most STEM disciplines have been through many, many years of traditional practice; lecture, recitation, homework, exams. And, when you spend many, many years being socialized in a particular practice and maybe occasionally, or rarely, seeing some other practice, it's quite hard to

change if that's the majority of what you've experienced. I mean that's the core of your experience, it's what you know, it's what you've succeeded at. And, I think that's part of the reason why it's really hard to change.

And some of these practices, the really, really effective ones, like cooperative problem-based learning were not easy to implement. I shouldn't say that. They're easy to implement poorly.

- ***But they're hard to do well.***

- **They're difficult to do well. And, I think there just hasn't been the, as Sheri Sheppard would say, "The will to do this," on the part of institutions there are a lot of individual faculty who care a great deal about their students learning and want to use the most effective practices but may or may not be in a context that makes that easy to do. And so, I'm eternally optimistic, some would say naïvely so, but I think with the emergence of engineering education as a discipline where we actually have more and more people who not only are familiar with the evidence but have gathered some of the evidence, who have experienced more research-based instructional practices that over time the practices will change.**

It essentially follows Arnold Arans' argument, "You want to change education start with graduate programs." If you change the experience in graduate programs, graduate students go off and teach in all kinds of institutions; the kinds that prepare teachers, the kinds that work with all kinds of students. And, if they learn to do something different in graduate

school and then go and practice it, it will change the world.

- ***Well I think that's a perfect way to end. I know your life has inspired me, Karl, and I hope that our listeners are inspired as well and have the courage to be divided no more, and to follow their heart and find others and change the world.***

  So, thank you very much.

❖ **Thank you, Ruth.**

- ***Research Briefs is produced by the School of Engineering Education at Purdue.***

- ***Thank you to Patrick Vogt for composing our theme music. The transcript of this podcast can by Googling "Purdue Engineering Education Podcast." And please check out my blog, RuthStreveler.Wordpress.com.***