- ***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 Research Briefs Dr. Nicki Sochacka, the Associate Director for Research Initiation and Enablement in the Engineering Education Transformations Institute (EETI) in the College of Engineering at the University of Georgia.

  Nicki's research is innovative and highly interdisciplinary. Today, I've asked her to tell us about some new research that delves into how stories shape and reflect engineering cultures and norms and values.

  Nicki, welcome to Research Briefs. I'm so happy to have you here today.

- **Dr. Sochacka: Thank you, Ruth, I'm so happy to be here.**

- ***To start off, can you tell us about your own story, your pathway into engineering education research?***

- **Yes, sure. Well if you told me 25 years ago when I was studying to be an environmental engineer that in 2018, I'd be in the United States studying engineering education research I would certainly have never believed you. So, when I was studying to be an environmental engineer the concept of graduate studies had never occurred to me. And, you know, because I was really passionate about environmental issues, and I wanted to get out there and work, and I wanted to change the world, and so that's what I did. Or, at least I did the working thing.**

  So, I went out and I worked for an international consulting firm called URS, started off in Brisbane and then went to Sweden and worked for about two years and I really loved it; it was really exciting. I got to work on a whole bunch of different projects and meet lots of different people.

  But as I kept working two things happened. The first was that all of the travel and all of the new projects all the time started to get a little bit old. And I started feeling like I wanted to really sink my teeth into something; just sort of moving from one project to the other every time something got interesting, I felt like I had to move on. And then the other thing that happened is that, I noticed that I felt really prepared for the technical side of my job but there were a lot of social things happening that I felt like I just didn't have frameworks to understand.

  So, the work that I did was a lot in soil and groundwater management. And so, I was taking a lot of soil samples, drilling a lot of wells, and so many social factors went into how many wells we drilled, and how many soil

samples we took, and there was so much sort of legislation, past history of companies. And then the degree to which the companies we were working for, how sustainable they wanted to be was also related to their motivation, beliefs, values, all these sorts of things. And so, I felt like I wanted to do something social and learn more about social theories. But I still didn't consider a Ph.D.

And then one day when I was working on a site at Uppsala, which is a bit north of the capital of Sweden, Stockholm, I was really cold, and I think I was complaining about my work and one of my colleagues said to me, she was actually American and we were working for an American company, and so she had come over and she said to me, "You're so smart, you should do graduate studies." And I just remember thinking, "Huh, okay, that's a thing? Well maybe I should consider graduate studies," and that really planted a seed. And so, I ended up quitting my job and going back to Australia and investigating this whole Ph.D. thing.

And then one thing led to another and I found myself working with Drs. Lydia Kavanagh and Lesley Jolly and my Ph.D. topic still had nothing to do with engineering education; it was about the sociotechnical response to a drought that we were having in southeast Queensland which is where I was living at the time. And I did that Ph.D. as part of a research center called the Catalyst Research Center that was headed up at the time by David Radcliffe. And I was working with a whole bunch of other students, and the thing that we all had in common is that we had all studied engineering as undergraduate degrees and we were all using some kind of method of social

inquiry to look at some aspect of engineering practice or engineering education. And these methods of social inquiry really resonated with me. I felt like they filled that gap that I felt when I was working, you know, that lack of social frameworks. And so, with my topic of looking at the drought, these social theories really helped me think about how sociotechnical systems work and how to change them.

And then partway through my Ph.D., sort of life and love took over and suddenly I found myself in the United States, here at the University of Georgia, where I finished my Ph.D. and then slowly realized that it rains quite a lot in Georgia. In fact, it's raining right now, has rained for the entire last week, and so I thought maybe this is not the best place to continue my research on drought and water management. But my methods of social inquiry that I had learned during my Ph.D., they were really transferable to engineering education and I started also to get really excited about the possibility of working in education as a way to achieve the kinds of sort of changes to environmental systems, social systems that I wanted to achieve. And the engineering education community was really welcoming and so I gradually made the transition and I guess here I am.

- ***It is amazing, isn't it, how when we look back there can be these times when we've said, "I would never, ever, in a million years imagine that I'd be here right now." It makes you wonder about the future and what can we imagine our 25-years-from-now future, right?***

- **Yeah, absolutely. I mean, like I said both graduate studies and the United States, neither of those things had ever entered my mind. So, isn't that crazy that I'm here now?**

  - ***Yeah, well we're glad you are.***

- **Thank you.**

  - ***So, when I introduced you, I mentioned that your research looks at how stories both reflect and shape engineering culture. Can you tell us how you came to do this particular kind of research?***

- **So, this research project has really been many years in the making, and I really loved it because it's such a nice example of how research projects develop and emerge. I guess when you read research studies in journal articles, they all come really nicely packaged. And so, maybe I'll tell you more the emergent development story.**

  - ***Yeah, 'cause it's never that neat is it?***

- **No, not at all. Although, I hope it sounds "neat" in the paper.**

Yeah, so I guess like most research this project started with an idea, sort of a sense of maybe better described as a sense of discomfort or a sense of dissonance and that was in response to when I first read the *National Academy of Engineering's report, "Changing the Conversation,"* I think it

must have been back in 2010. I was looking over those messages that they were suggesting as a way to change the conversation about engineering and attract more and more diverse people in the field. And when I was reading those messages, I thought they were really great and aspirational, but they didn't reflect my experiences of being an engineering student and then, at the time, teaching engineers and being in a College of Engineering, I guess in an engineering education culture.

And so, I became really interested in this idea that, you know, if there's an underlying assumption by the *National Academy of Engineering* that these messages can change people's decisions, I started to wonder, "Okay, well what messages are actually out there in the world, in the public discourse, and what are the implications of those current messages for people making decisions about coming into engineering or not?"

And then, later on as the project developed, we folded in that culture piece. So, if we can know what messages or stories are actually told about engineering, how do those messages shape and reflect our culture?

- ***So, there's a point, I know you're going to bring out at some point, of both reflecting and shaping at the same time. Do you want to say that here or do you want to leave that for later?***

❖ **Maybe I'll leave that for later. Maybe I'll speak a little bit more about where we went from there and then that can come in later.**

So, the way that we started looking at how engineering's portrayed in the public discourse was by looking at the *American Society for Engineering Education's* First Bell newsletter. Do you get those?

- ***I know people do; I myself do not, but I know a lot of people do.***

- **They seemed at the time to be a really great source, a pre-sorted source, of articles that discussed engineering and STEM fields in the mass media. So, we looked at a year's worth of those and initially we used grounded theory as a method to look at them. And we did that because we didn't really know what we were going to find and so we wanted to let the data really speak to us.**

And as we were doing this analysis, we saw some really interesting things. And one was, there was some sort of conflicts in what we were reading about how engineering is portrayed. So, a lot of the articles spoke about engineering being really math and science-based, which was interesting because that was one of the recommendations that the *National Academy of Engineering* made about something not to emphasize. And then there were some articles, but really very few, but some articles were certainly saying that engineering is more than math and science-based.

And then there were these other tensions. A lot of the articles were speaking about engineering being a profession in crisis and not enough people are coming to the field. And then there were these other articles that were talking about how people with engineering degrees were having

difficulties getting a job. And, in fact, the undergraduate student that we were working with at the time, she was about to graduate, and she was having difficulties getting a job. So, here she was reading all these articles about how everyone should come to engineering 'cause it's a profession in crisis, and here she was with her peers having difficulties getting a job.

- ***What year was this, Nicki, just to have people be able to put it in a kind of an economic framework with the different recessions and things? What year did you collect the data?***

❖ **That's a good question. So, we collected it from the middle of 2011 until the middle of 2012. So, there were certainly some echoes left from the Great Recession. Yeah, and I think that certainly did factor in somewhat into the articles.**

- ***But still not at the very depth of all of it.***

❖ **Yes, I think if we had looked a few years earlier there would've been a lot of more mention of recession; at this time it was more, you know, as we worked through the recovery was certainly mentioned.**

So, at this point we had these really detailed, hierarchical trees with codes and sub-codes and just in the same way that in Alice Pawley's work she has spoken about her coming to narrative methods because she realized, or noticed, that breaking things down into codes took away some of the coherency, some of the meaning of what she was doing. We noticed that as

well, or it more came out that when we started looking across the various branches of the trees and tying some of the categories together, we felt like we had more coherence in the data. And so that took us away from looking for messages that were comparable to the *National Academy of Engineering's* messages and prompted us to start looking for, okay well what are stories with beginnings, middles, problems, characters, challenges, solutions, and endings? And so, we started to look at the data through that lens.

And at this point another thing that we did, so before we got to that insight about looking for, not just messages, stories, we didn't have any theories in this study or any other methodology other than grounded theory which we knew would just be exploratory. And so, at this point we started to bring in some theories that we thought would be helpful. And so, because we were looking at the media, we looked into media studies and found these really interesting theories around agenda-setting. So, this idea of what does the public discourse, or the mass media, choose to talk about? And how that can have an impact on peoples' opinions. And also framing, so not just what mass media talks about but also how they talk about it.

And so, we took those two theories and that helped us decide, "Okay, well maybe there are some stories that are being agenda-set or being emphasized more than others." And there certainly seemed to be some sort of problem definitions and sort of moral spins and solutions that were being emphasized more than others. And so, that's when I read this really great and very interesting paper that used a methodology that we ended up using

in our study which was called "Narrative Policy Analysis." And so, we started to tease that. I feel like I've been talking a lot maybe this should be your chance to say something.

- ***No, no, I really want you to talk about the narrative policy analysis because I had not heard about that before until I was looking at your papers and it's just a really fascinating idea. I'd like you to tell people a little bit about what it is.***

- **So, narrative policy analysis is a really fascinating research methodology and basically the core of it is this idea that with really complex, uncertain, and polarized problems or policy issues it's really hard to find hard sets of facts and evidence that can guide policy. And so, the idea is that with these kinds of complex, uncertain, polarized policy issues it can be really helpful to find the stories that we tell ourselves about our problems because it's actually more than the facts and the hard evidence, it's the stories that inform how we go about trying to solve these issues.**

- ***And the stories really start to kind of work into our brains. And our beliefs, I think, often are shaped by these stories, don't you think?***

- **Yeah, definitely. I mean there are a lot of researchers who work with stories, or work with narratives who emphasize this idea that we engage with the world and naturally make sense of the world through stories. And so, yeah, when someone tells us a story that resonates with our own beliefs, we're more likely to accept that and act on that than someone throwing a**

whole bunch of facts at us, or a whole bunch of evidence, or counter-evidence. And, like you said, these stories are sometimes are so implicit that we don't even notice that our actions are based on them, or that we can be influenced by them.

And so, we thought that if we could identify these stories then we could really hold them up and as a community we would have a chance to look at them and say, "Hmm, we like these stories or we agree with these stories or we don't," because if we can't see them really clearly then it's hard to change, make any changes.

So, the person who developed this research approach, narrative policy analysis, Emery Roe, he talks about three kinds of stories. So, the first type of story is, Dominant Stories. And they're the stories that he says they function to reduce the complexity, uncertainty, and polarization. So, they're the ones that policy responses, solutions, are designed according to.

And then he talks about Non-Stories, which I think are totally fascinating. So, the dominant stories are stories in the sense that they have a beginning, a middle, and an end. So, they offer a coherent narrative explanation of whatever problem we're talking about. And then non-stories he describes as critiques of dominant stories. And he says that non-stories are really interesting because if you critique a dominant story, so if you try to throw some facts at it, he says that because non-stories aren't full stories in and of themselves, so they don't have beginnings, middles, and ends, they don't offer a coherent story that people can sort of sign up to and then develop an

alternative set of solutions according to them. So, instead, he says that when you critique a dominant story what you're actually doing is strengthening the dominant story because you're increasing the complexity, increasing the uncertainty, and so people latch onto them even more.

- ***Intriguing.***

❖ **Isn't that crazy?**

- ***Yes.***

❖ **And so, instead, he suggests that if you want to change how people solve, or approach problems then what you need to do is develop counter-stories. So, these are full alternative, compelling explanations that are different from the dominant stories and that point to different ways of moving forward.**

- ***Do you have, kind of at the tip of your tongue, one example of a dominant story, and a non-story, and a counter-story that you've found that you could share?***

❖ **Yes. So, we identified five dominant stories and we defined them as having a beginning, a middle, and an end. And the really interesting thing that we observed is that all of the dominant stories had the same beginning; so, they had the same call to action, the same problem definition. And that was this idea that there's a chronic shortage of engineers, and that this chronic**

shortage of engineers really threatens the United States' ability to compete with China, to compete with India, and it really puts them at risk of their survival in the world. So, it's this really sort of very dramatic story around a lack of people coming and how that can have international implications.

- ***I bet every one of our listeners is shaking their head saying, "I have heard that story a million times."***

❖ **Yes, I've heard that story, I've written that story.**

- ***Yes, it's the beginning of my grant proposal, it's the beginning of my paper. Yes.***

❖ **Yes. Very common but does not have to be that way. So, that was the beginning of the story. And then I'll just tell you, well the first story was I think listeners will also nod their heads at; this idea that there's a chronic shortage, we need to get more students excited about and proficient in math and science. And then if we do that then more students will want to become engineers because after all engineering is defined by math and science. And then the other full stories follow a similar sort of pattern of the second story and we need to expose more students to the hands-on side of engineering 'cause engineering is about building things. We need to get people to understand what engineers do because engineers are really important, they make the stuff that makes the world go around; that kind of thing. So, that's what some of the dominant stories look like that we identified.**

And I want to give you a sense of what it looks like in the data. So, this is one quote that illustrates the competitiveness. So, it says, this is in the context of an article. "So, it's really about global competitiveness but don't tell the students that. For them, "Panic at the Point", a week-long STEM camp is a fun way for them to learn and get career information about math and science in STEM fields." So, when I read that quote, you know, it's really about global competitiveness but we don't tell the students that, I just thought that was a good quotation.

- ***Because we want to make it fun.***

- **Yeah, we want to make if fun, but we all know what the real problem is. So, there were some examples of dominant stories. And we only identified one non-story, and that non-story was this idea that in fact there isn't a shortage of engineers. And we found quite a few articles that referenced all kinds of reports with a lot of data that made quite compelling arguments that there isn't a shortage of engineers, but, what do you do with that? Throw your hands up in the air and say, "Okay, we're good." It doesn't really help very much just that by itself; it doesn't make a story.**

But it was funny actually, I was at an ASEE conference a couple of years ago and listening to a keynote speaker. And as he was speaking, I was sort of ticking off in my mind the dominant stories as he hit on them. And then part-way through his presentation he said, "And you know what, some people, you know, they give me all these facts and all these figures, they do

all these reports, and they say that there are enough engineers, that we don't need anymore. But some engineers can't get a job. You know what I say, I say, 'I don't care,' the world will be better with more engineers." And I was thinking, "Wow, this is amazing."

And I did ask for the transcript for a few years afterwards of that keynote, but it never materialized. But yeah, that was such a perfect representation that as much as we as engineers think that we're about the science, we're about the objective, we are human, and stories are powerful.

- ***Yes, yes. Is there a counter-story you found too, any counter-story examples?***

❖ **So, one of the challenges with counter-stories is that quite often they're drowned out by dominant stories. And so, by their very nature, they're hard to find. And so, we found some bits and pieces that could be constructed into a counter-story and so there were a few articles that spoke about climate change, or spoke about social inequity, or ecological destruction, sort of framed the big problem that engineers face in different ways. But quite often even these stories existed alongside this push for economic growth and international competitiveness. So, it's almost as if they had to be validated by being part of that story.**

- ***Yes, yes.***

- **And in terms of what engineering is and therefore what we need to foster in students, there were a few stories that spoke about engineering being a profession where people work with others and that collaboration is important. But again, it almost without exception that was alongside something like, "And it's about math and science," so we rarely found that by itself. And then there were a few articles, particularly ones that spoke about how to attract more women to engineering, that spoke about the importance of caring for other people. And so, we think that, as a community, we could together construct other counter-stories that might point us to different solution paths to attracting different types of groups of people to engineering and, also getting back to your original question, work into this process of shaping and reflecting engineering cultures.**

  - ***So, what reaction has . . . I know this research is in its early phases and you've had some conference papers and just preparing a journal article now, but what kinds of reactions have you been getting?***

- **Lots of different types of reactions. So, a few years ago we were working with an undergraduate student, he was working with us on the data analysis and he is a first-generation college student who's followed a non-traditional pathway into engineering and his reaction to the study was, "Huh, I hear these stories all the time." And he was a freshman student at that stage of the project and so he conducted a study, an autoethnography, where he reflected on the kinds of stories that he was hearing.**

And one of those instances that he reflected on was when one faculty member from our college came to speak to his freshman class, and this faculty member is really passionate about social justice issues and environmental sustainability. And so, the student was really excited for this faculty member to come and speak to the class. But when this person came all they spoke about was data, and spreadsheets, and data analysis methods, and didn't mention any of that social or environmental passion that she clearly had. And Michael wrote about this in a conference article and then went and spoke to the professor. And the professor said, "You know, I was speaking to a class of freshmen engineers so of course I had to make it more about the math and science and the analysis." And our student was like, "Well, why?" And she said, "Well, I didn't want to put people off." And he said, "Well, you kind of missed an opportunity to excite *me* about these other sides of engineering."

And so that was a really interesting reaction and I continued having conversations with this professor and then they wrote me an email a couple of months later and said, "Oh, I just gave another presentation and I was totally myself, I just let it all out there, it felt fantastic." And so, I guess the reaction of the student was initially one of resonance and of the professor this sense that maybe these stories were in some way shaping what she thought was suitable to share with an engineering class. So, there are two reactions.

And more recently, the project team is in the process of preparing a journal article and we shared it with our research group and this research group has

a graduate student and five or six undergraduate students and some other faculty members. And one of the students had a really strong reaction to the paper and said, "Well, you know, if you change the story then the students who are there for the math and science and do want to earn a good salary, you know, you could risk losing the people that you already have."

And we had a conversation about that and I said, "Oh well, I'm not suggesting that we ditch these other stories just that we pay attention to telling a broader range of stories." And he said, "Yeah, but you don't want to lose the people you have if there aren't enough people in engineering." And so, he really had a lot of his identity wrapped around that and felt quite protective over the stories.

And then we shared the paper with a colleague who's sort of more on the other side and would like to see a lot of more social justice in engineering education curricula and this person thought that the paper, our work, could be damaging because it reaffirms these dominant stories. So, it seems that I upset everyone. I upset the people who like the stories and the people who don't like the stories.

I mean I guess the purpose of the study, now that we're this far through it, is really to articulate these stories and articulate them in a rich way that's grounded in data. And then have an opportunity to look at them and almost once you see the stories it's hard to unknow them. I mean I can't count the amount of times where I've caught myself in class telling a story

and then going, "Oh, hold on a second, okay well it's not bad to tell this story but let's make sure that I tell other ones as well."

And so yeah, if we can see what these stories are, how they do shape our efforts to recruit and retain students, and that we told other stories that might point us to other ways that we can address this apparent problem of a lack of interest in engineering and the certain problem of underrepresentation in engineering and that would be great.

- ***Fascinating. Wow, now this is just so interesting. So, I ask all the podcast guests to end with this question because I'm hoping that as people learn about different ways of thinking about the research and different methods that they'll think about maybe doing some exploration themselves. So, what advice would you have for people thinking about venturing into new areas, or trying new methods? What might they learn from you?***

❖ **I think that one thing they might learn is that it's okay not to know exactly where you're going at the beginning. And that, sometimes in our research group, we joke about emergent research designs and say it's really that you just don't know what you're doing. But there's value in that. I mean sometimes you can't know what you're doing at the start. So, yeah, being willing to step into a space and ask a question without knowing what theories, or methodologies, or those other formal parts will eventually make their way in.**

And so, with that, I guess being attuned to how theory and methodology fits with the data that you have, fits with what you're looking at, and being willing to try on different theories and methodologies and then move on if they don't work. I think reading widely. So, I came across this narrative policy analysis approach, at the time I was teaching engineering economics, and this approach was used in an article on ecological economics. And so, I think that reading outside of engineering education is a really rich and rewarding experience that none of us have time to do, but yeah that's fun.

I guess I am someone who is fairly problem-led in my work, so I like trying new methodologies. But I think there's also value in sticking with one methodology and learning that really, really, really deeply. And so, I think maybe thinking about what kind of a researcher you are; if you're someone that wants to really dig deep into one methodology or be more problem-led, and if you know, that might help you decide which step to take.

- ***Right, right. Well I know I am going to read up on the narrative policy analysis definitely because it's really fascinating. And what I would like to do on the website where we have this linked and the transcript will be linked is also put the citation to the conference paper so that people can look at that as well. And we'll wait for your journal article and read that with interest.***

❖ **Well, thank you.**

- ***So, Nicki, any last thing that you would like to say?***

❖ **Well, I think it's great that you're doing these podcasts. I've really loved listening to the ones that you've done, and I can't wait to listen to the one that you did with James just recently. So, thank you for this service to the community.**

- ***Well thank you, I really enjoy it. I really enjoy it. And thank you so much, Nicki, again. I will be looking with interest for your journal article.***

❖ **Wonderful. Thank you.**

- ***Thanks, Nicki.***

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 be found by Googling "Purdue Engineering Education Podcast." And please check out my blog, RuthStreveler.Wordpress.com.***