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Understanding Australian and United States Engineering Education Research (EER) contexts through the eyes of early-career EER researchers

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ABSTRACT

CONTEXT

Core to a successful international collaboration is the consideration and understanding of cultural and contextual differences. Although previous research has identified a range of challenges stemming from these elements, Engineering Education Research (EER) specific recommendations tend to focus on European-U.S. contextual differences. As the Australian EER landscape continues to expand, particularly for early-career researchers, it is important to broaden comparative EER efforts, particularly because international collaborations are increasingly an important consideration for career promotion indicators.

PURPOSE

This research focuses on how engineering education researchers familiar with both the Australian and U.S. contexts experience and undertake EER in both contexts. This research aims to provide greater insights into the similarity and differences of the systems EER operates within across the two countries.

METHODS

Semi-structured interviews were conducted with engineering education researchers at U.S. and Australian tertiary institutions to gather their perceptions of EER in both contexts. Interviewees were selected for having significant experience in both contexts and falling into early-career categories. An iterative process of thematic analysis was undertaken to analyse interview transcripts using open coding.

ACTUAL OR ANTICIPATED OUTCOMES

Interviews with early-career engineering education researchers illuminated the structural differences across contexts that ultimately impact and lead to differences in how EER functions in both contexts. These contextual differences are also impacted by sociocultural differences that influence how international collaboration does and does not work.

CONCLUSIONS/RECOMMENDATIONS/SUMMARY

This work contributes to the literature that explores what is different about EER across contexts by pointing to why we may see these differences. It is imperative that we consider organizational and sociocultural contexts when exploring differences across EER contexts and capacities for collaboration.

KEYWORDS

Engineering education research, international collaboration

Introduction

Engineering Education Research (EER) is a growing field that is becoming increasingly connected around the globe through international collaborations. The benefits of collaborations in EER are well reported and include, for example, improving diversity of thought on projects, reducing the risk of "reinventing the wheel" by leveraging regional developments, increasing research quality, and increasing funding opportunities (Borrego & Bernhard, 2011; Borrego & Newswander, 2008; Xian & Madhavan, 2012). Of particular note, as contextual and cultural differences are fundamentally important in much of EER because of its roots in the humanities and social sciences (Beddoes, Jesiek, & Borrego, 2011), international collaborations offer an opportunity to consider these contextual differences so that different systems of education may learn from one another. Similar to the benefits, the challenges that need to be navigated while undertaking international research collaborations are also well reported in literature including factors like differences in disciplinary paradigm, language, reward structures, and cultures (Borrego & Bernhard, 2011; Hakala, 1998).

Familiarity and understanding of the contexts involved in an international collaboration has been suggested as key to success (Lucena et. al., 2008) with Borrego and Bernhard (2011) suggesting a need for EER practice, perspectives, and values to be bridged between international contexts. Previous research has suggested that scholars can gain this knowledge through implicit cues like reading literature situated in the chosen context or participating in domestic and international conferences likely to draw attendees from both contexts (Beddoes, Jesiek & Borrego, 2011). However, the former does not necessarily ensure contextual understanding can be achieved beyond basic awareness, and the latter is reliant on privileges not necessarily afforded to all researchers. Drawing on peer experiences may assist with understanding contexts and cultures; however, again may be limited to a privileged few when it comes to international research collaborations in EER.

There is a noticeable lack of specific manuscripts in the current literature discussing contextual and cultural factors of different EER contexts. Most papers reporting on EER contexts have historically focused on classifying and describing EER. These prior studies include descriptions of the research areas, research strategies and funding sources (Borrego & Bernhard, 2011; Berhnhard, 2018; Jesiek et al, 2008; Jesiek et al, 2009; Osorio, 2005; Wankat, 2011; Xian & Madhavan, 2014) as well as methodologies, methods, and contributions (Borrego, 2007). These descriptions typically have arisen from a form of documentary analysis of publications from key conferences and journals (e.g., American Society for Engineering Education Annual Conference and Journal of Engineering Education, respectively) (Borrego, 2007; Jesiek et al, 2008; Jesiek et al, 2009; Xian & Madhavan, 2014), and have also included conceptual papers (Berhnhard, 2018; Borrego & Bernhard, 2011). The perspectives of researchers themselves with respect to how they experience and understand different EER contexts are lacking in the current literature. This lens is significant as it provides insights of the experiential difference between contexts in a practical sense that can be useful in understanding factors important to consider in successful collaborations. Regionality has been acknowledged in literature in comparisons of the United Kingdom, Australia, and India (Jesiek et al, 2009), the United States and Europe (Borrego & Bernhard, 2011) as well as globally (Jesiek et al, 2008). To the extent of the authors' knowledge, no research compares Australian and United States contexts for EER, despite studies noting Australia has a strong tradition of publishing EER internationally (Jesiek et al, 2008; Jesiek et al, 2009) and the engineering education systems being noted as sharing many similarities (Borrego and Bernhard, 2011; Grenquist & Hadgraft, 2013; Patil and Codner, 2007; Prados, Peterson and Lattuca 2005) that potentially sets the stage nicely for opportunities for potential collaborations.

Purpose and Research Questions

The perspectives of engineering education researchers on how they experience and understand an EER context different to the one in which they are trained is currently missing from the literature. There is also a current gap in literature comparing the United States and Australia EER contexts from the perspectives of researchers in the field. Our research explores engineering education researchers' comparative understanding and experiences of the U.S. and Australian EER contexts. To that end we ask the research questions:

1. How do early-career researchers, who had significant research experiences in Australia and the United States, perceive differences in EER between Australia and the United States?
2. What are the opportunities and challenges of collaborating in EER across Australia and the United States?

Methods

We conducted semi-structured interviews with three early-career engineering education researchers who have experience conducting EER in both Australia and the United States. Qualitative research methods, such as interviews in the case of our study, allow for the exploration of social phenomena from the perspective of those who experience them (Miles, Huberman, and Saldana, 2014).

Sample

The data discussed in this paper are from a subset of a larger qualitative study. The larger study includes interviews with participants at a variety of levels along the professional pathway (i.e., early-career professionals as well as those who have received academic promotions within the field). This paper discusses findings from three early-career participants. We selected early-career participants because of a commonality of the external influences that early-career academics face, such as key performance indicators and success metrics associated with gaining tenure and rank based promotions. Future publications will analyse data from professionals further along in their careers.

To meet selection criteria, participants must have had significant experience conducting EER in the United States and Australia. Given the unique requirements for participants, we implemented purposive and snowball sampling to identify participants. Because of the small sample size and the small nature of the communities under investigation, we do not offer pseudonyms or participant IDs to protect participant anonymity and instead offer the following collective positionality of our participants.

At the time interviews were conducted the three participants in this study were early career professionals. Each participant received formal training in a traditional engineering discipline, both inside and outside of the United States (but not in Australia), prior to receiving formal training in engineering education in the United States. During each participant’s training they experienced EER in Australia. Participants have had a variety of experiences in the Australian context including conducting research, attending conferences, working, and living in Australia.

Data Analysis

We used thematic analysis to synthesize and interpret data, a method for systematically identifying themes across a set of data (Braun and Clarke, 2012). We followed Braun and Clarke’s (2012) six-phase approach to thematic analysis. In Phase 1 we familiarised ourselves with the data by reading through transcripts. In Phase 2, we identified an initial set of codes. Open coding allowed for the data to drive our analysis as opposed to imposing a framework or theory onto our data. Initial codes were then reviewed and revised in an iterative process. Phases 3 and 4 involved identifying and reviewing patterns or themes

across the codes we identified. Phase 5 brought about the finalizing of our identified themes. Lastly, Braun and Clarke (2012) advise that phase 6 include producing a report, such as this one, where we address our research questions and order the themes in a way that connects logically and meaningfully.

Positionality

The research team for this study consists of four scholars, three of whom are from the United States and one from Australia. Two authors are Ph.D. candidates in Engineering Education at a U.S. institution where they are receiving formal training within the engineering education field, one is a PhD candidate in Engineering at an Australian institution working on an engineering education dissertation and receiving training in social sciences and humanities, and one is an Associate Professor in Engineering Education at a U.S. institution who earlier in his career worked at an Australian university. Particularly relevant to this paper, three of the authors are early-career researchers who have been navigating international collaboration. The senior academic on the team helped ensure interpretations summarised in this paper were based on collected data instead of the team's own experiences navigating early career research collaborations. This research was enabled by a grant from the U.S.-based National Science Foundation that allowed researchers to compare EER and systems of education between the U.S. and Australian contexts.

Limitations

The interviews in this study were conducted by U.S.-based researchers, meaning that no one with an Australian perspective conducted interviews. Further, the snowball sampling approach taken in this study can lead to a biased sample. Finally, this paper only represents pilot work with a limited sample size, so theoretical saturation was not reached. Future work will include a larger sample size.

Results and Discussion

The major influences on EER in both the United States and Australia, as illuminated by our research, are university structures as well as funding sources. These structural components impacted and informed the function of EER in both contexts. We also found that the structural components interplay with the cultural dynamics within each context to inform different functions within the EER environment, such as collaborations. Although opportunities to collaborate between contexts exist, they do not come without challenges.

Structure and Function of EER

Structurally, participants noted the influence of funding and university structures on their research. Participants noted differences in the institutional roles that engineering education researchers hold in each context. In the U.S. context, engineering education departments or centers were commonly mentioned as a collective base for engineering education researchers. Participants also noted engineering education specific graduate training programs in the U.S. context as an entry point into EER. On the other hand, participants noted that established academics in the Australian context come to EER out of interest from a technical engineering discipline, often concurrently undertaking research in said technical discipline. One participant noted awareness of a PhD student undertaking an engineering education project in the Australian context noting the difference to the U.S. context:

> *We did have one PhD that graduated but she was a civil engineer and her dissertation was in engineering education. So, she basically says that she has a PhD in engineering education because there [in Australia], your PhD is your dissertation. But in order for a model like ours to be successful there, we need to have the resources and we need to have ... You need to be recognized as a field… I think for them, the model of having one expert in a traditional department works very well.*

Participants spoke of engineering education researchers being housed in technical engineering departments in the Australian context and the challenges of lacking a community of support:

> *I do think that engineering education can be successful in a distributed model. I think it would be helpful, though. So, my experience in Australia as being the only engineering education researcher that I knew at the university was pretty lonely … But I don't think that being the only one at [Australian University] is sustainable, because after a certain point, I was like, "No one here understands what I'm doing. I can't connect with the grad students because they're all civil engineers, and they're not interested in my research. I don't have any research community."*

In summary, participants noted that EER was structured and housed within engineering schools differently between contexts. In the United States, EER was described as its own department with dedicated graduate programs and academics whose research portfolio focused on EER. Comparatively, in Australia, EER was described as undertaken from within technical engineering departments, typically by academics trained in a technical field that maintain concurrent research in their technical field of interest. Participants also discussed possibilities of undertaking graduate research in EER in Australia. While these experiences parallel the authors' observations, continued research is needed to further understand these realities.

One participant speculated that the propensity for EER departments in the U.S. context may be driven by the availability of EER research funding:

> *I think it would be hard to support a department if there's not research funding, like a research-based department, if there's not research money available. So, I think that's a huge contributing factor, not just in Australia, but in most other countries outside the U.S. Because from what I can tell, most places don't have anywhere near the amount of funding that we have in the U.S., so I think that's why we haven't seen a lot of engineering ed departments showing up at other places. Some places have the centers which are often supported by the university, but I don't know of a lot of other engineering education specific departments elsewhere.*

Further, participants contrasted the recent challenges in obtaining research funding in the Australian context with the relative availability of funding in the U.S. context. Having consistent funding sources via the U.S.-based National Science Foundation is a fundamental differentiator between the two research communities.

> *When I went for my postdoc [in Australia], they had that Office of Learning and Teaching, OLT.... But now that that funding isn't available anymore, in my last position, it was hard to identify where to get funding, how to get funding, because it wasn't like the [NSF] equivalent in the Engineering education sense. They did have the CSRO grants, that's [a] different type of thread of research, engineering research.*

> *I think it comes down to the resources that maintain the system. I think our [U.S.] model works very well for many reasons. One is obviously money. We receive funding from NSF or all other places. So we can have a department that can offer scholarships, we can afford grad students and the grad students have the main resource that we have and that they are the ones that keep these department going and our research on top of things. That's the true. I think that will be very difficult to implement in Australia.*

Participants observed that the differences in structure informed the function of EER in their environment by encouraging them to focus more on teaching related research topics.

> *But I think being in a traditional engineering department [in the Australian context as opposed to a stand-alone Engineering Education department in the US context] did force me to focus more on the, how do we actually teach and learn engineering a little bit more and think about what is necessary as an instructor, what type of things would an actual instructor of these traditional engineering courses wants to know, and what would they be willing to try?*

This primary focus on teaching related EER in the Australian context, unlike the U.S. context, was also evident in participants' reflections on structural incentives for undertaking research.

Participants reflected on being able to connect EER activities to improving teaching and learning practice as being more important in the Australian context than more traditional research metrics for academic career progression, such as number of research publications. Thus, the structural incentives to publish and obtain funding for EER are different in each context:

> *There is not that pressure around getting money or even publishing [in Australia]. I think it's more important for you to do important things and meaningful things that you can translate back into a classroom. I think that's a huge deal.*

Participants also noted differences in the logistics of the university environment between the two contexts. For example, one participant noted the challenges in learning "the infrastructure of the institution," including "basics" like ethics approval processes.

Participants pointed to direct differences in the way that EER is structured in both contexts and identified ways in which those structural differences result in differences in how EER functions in both contexts, and vice versa. Many of these structural and functional differences can also be linked to cultural differences and how that, in turn, impacts opportunities for collaboration across borders.

Culture and Collaborations

Participants discussed a number of cultural differences that they noticed as they moved between contexts, and we found that these cultural differences also interacted with the structure and function of EER and opportunities for collaboration across contexts. One participant noted the importance of inclusion and diversity to their work in the United States and reflected on cultural differences in how inclusion and diversity were treated in Australia:

> *The second challenge, changing context was that [in the U.S.] I really spend a lot of time educating myself about inclusion and diversity [..] [It is] part of my research, part of my identity. Arriving [in Australia] and seeing that they don't care about those things was really difficult. I even joined a committee for inclusion and diversity and the whole thing was like, how can we bring more women? Wait, what? And that was entire conversation. The first survey that I did, [...] they came back and say, no, no, no. You don't ask these questions [about race]. So that was a challenge because it was part of my research. I wanted to understand those things and it was really complicated. So that part was a challenge.*

Similarly, another participant noted that although both populations focus on student attendance, the root causes for the questions being asked are different between contexts:

> *We complain about attendance, but they have a completely different attendance questions because they have students who are trying to deal with public transportation and work. A lot of their students are working full-time or part-time far more than our students are, so it's just different contexts to figure out and then understand what are the important research questions in that context because they're not the same, necessarily, as the ones we focus on.*

Structural, functional, and cultural differences, including differences in terminology (e.g., "placements" in Australia versus "internships or co-op" in the United States, as noted by one participant) can make it a bit challenging for collaboration or finding common ground across contexts. For example, researchers in the U.S. and Australian contexts often have a different knowledge base and entry into engineering education, which can make it harder to find shared language. As one participant said:

> *I think the hardest thing was figuring out how to communicate with people who weren't engineering education people. And, honestly, that just involved becoming more confident in myself. I'm so used to having a discussion about, what research questions do we want to pursue, and I would ask, "So, what research questions are you interested in?" And they would just look at me like, "Well, you're supposed to tell us. You're the engineering education expert." So, yeah, there was a different expectation in terms of what my role was on a project.*

However, differences in funding structures or terminology do not mean collaboration is impossible. A number of opportunities for collaboration were identified by participants. First,

they found opportunities for improving teaching and learning noting that teaching interventions were easier to implement in the Australian context:

> *I think there are opportunities for collaboration that we need to take advantage of in terms of teaching intervention because of the flexibility that we have to implement things really fast. It's really easy to revamp an entire course and it is really easy to implement whatever you think would be effective.*

Leveraging topics with structures in place to support related efforts is one way that participants thought to make collaboration feasible. Next, participants also saw opportunities to collect data across countries to conduct research on more diverse data sets:

> *Well, I think the biggest thing would be to be able to collect data on a big scale for multiple countries. Right? So, the problem with a lot of our research is that it is all U.S. based, and like I said, our universities are structured differently. Our curriculum looks different because we have more liberal arts stuff built in, even though we all complain about how we're cutting liberal arts stuff, Australia has even less, and other places are similar. Some places are similar to Australia, some places are maybe more similar to us, but I think they can't just take everything that we find in our studies if we do them all in the U.S. and apply them in Australia or other contexts where their system just looks very different.*

Here the participant points out the value of collecting data across borders to not only garner more information between contexts but also further validate findings.

While the cultural differences identified are interesting to note, further research is necessary to understand the root causes of these differences and how they have manifested within the structure and function of EER. For example, researchers can explore the process of legitimization of EER between both contexts (i.e., what is the legitimacy in facilitating EER or what is considered legitimate EER).

Conclusion and Implications

Our results indicate the importance of considering organizational and sociocultural contexts when exploring and making meaning of differences in national EER environments. Existing work often focuses on differences in research methods and topics between national contexts, but because EER is an applied field embedded within organizations and a larger sociocultural context, these critical contextual factors cannot be ignored. Contextual factors can significantly influence what is considered valid work, how researchers go about doing that work, and with whom. This study aims to add to prior research which has answered *what* is different about EER by context by illuminating some of the fundamental reasons *why* we may see differences in topics and methods.

This work points to the need to think more about context. Beyond understanding why EER varies by context, considering organizational and sociocultural context in other aspects of EER may help us understand why we have not seen the change that we have sought in engineering education. Further, this work speaks to the importance of funding international opportunities for engineering education researchers, which can build collaboration capacity and prompt researchers to recognize how organizations and sociocultural contexts influence all aspects of their work.

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