**Understanding Australian and United States Engineering Education Research (EER) Contexts**

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**ABSTRACT**

Engineering education research (EER) is a growing and increasingly globally connected field. Understanding cultural and contextual factors is fundamental to EER and further is critical to enabling fruitful international collaborations. The purpose of this research is to understand how engineering education researchers experience and understand EER in Australia and the United States to better facilitate future international collaborations. This research draws on eight interviews conducted with participants who had significant experience carrying out EER in both the United States and Australia and ranged in their career status. Two key domains of comparison emerged from the data: 1) The landscape: Structure and resources of EER in each context, and 2) How the landscape plays out: Implications on EER studies and collaborations. Our analysis finds extremely different research environments for EER in Australia and the United States, the implications of which can be explained in part by resource dependency theory and institutional isomorphism. Our results can inform and enhance future collaborations across these national contexts and help researchers identify opportunities for symbiotic research relationships.

**KEYWORDS**

**INTRODUCTION**

The environments wherein we work and conduct research are made up of and defined by cultural and contextual factors. These cultural and contextual factors are fundamental to much of the work undertaken in Engineering Education Research (EER) as they inform the subject being studied and the nature of the field's development (Beddoes et al., 2011). Borrego and Bernhard (2011) identified a need to bridge gaps in EER practice, perspective, and values between international contexts; implicit to this statement is a need to understand the contextual and cultural factors that EER is situated within in each context, which we take on specifically in this manuscript in our comparison of EER contexts between Australia and the United States. Familiarity and understanding of contextual and cultural factors has also been suggested as key to success in international transferability of research and international collaborations (Borrego & Bernhard, 2011; Lucena et al., 2008). Understanding the contextual and cultural factors at play allows research to transcend a single country's educational context. International collaborations are particularly important for improving research quality by increasing the diversity of thought on projects and learning from the work in other contexts to avoid repeating the same mistakes

(Borrego & Bernhard, 2011; Borrego & Newswander, 2008; Xian & Madhavan, 2012). EER is a growing field that is increasingly connected globally. As such, there is a growing opportunity for international collaborations and work across contexts. Understanding cultural and contextual factors affecting research activities within each context is key to the success of these endeavors.

EER's regionality has been acknowledged previously (Jesiek et al., 2008), with regional specific comparisons of Australia and New Zealand (Godfrey & Hadgraft, 2009), the United States and Europe (Borrego & Bernhard, 2011), and the United Kingdom, Australia, and India (Jesiek et al., 2009). These works and others describing the field of EER have primarily focused on outlining and comparing research areas, research strategies and funding sources (Bernhard, 2018; Borrego & Bernhard, 2011; Jesiek et al., 2008, 2009; Osorio, 2005; Wankat, 2011; Xian & Madhavan, 2012), as well as methodologies, methods, and contributions (Borrego, 2007). Studies in the Australian context have focused on the research activities undertaken by EER community members (Dart, Trad, & Blackmore, 2021; Godfrey & Hadgraft, 2009), however, little previous work has investigated how differences across these national contexts influence the research activities of community members. Where EER is discussed in those prior studies, voice is also seldom given to the researchers themselves as noted by Dart, Trad, & Blackmore (2021). Prior studies tend to focus primarily on documentary analysis of key conference and journal publications (Borrego, 2007; Jesiek et al., 2008, 2009; Xian & Madhavan, 2012), with a select few generating conceptual papers (Bernhard, 2018; Borrego & Bernhard, 2011). The perspectives of the researchers themselves with respect to how they experience, understand, and navigate their contexts can also provide insight into the experiential difference between contexts in a practical sense. Thus, investigating how national contexts influence EER from the perspective of researchers themselves is a promising and needed area of inquiry, which we take up in this paper.

We focus on understanding the influence of national context on EER from the perspective of researchers who have worked in both Australia and the United States. It is regularly noted that Australian and U.S. undergraduate engineering education share many organizational and institutional features (Borrego & Bernhard, 2011; Brown & Knight, 2014; Grenquist & Hadgraft, 2013; Patil & Codner, 2007; Prados et al., 2005). In both contexts, students can undertake a Bachelor of Engineering program specializing in a sub-discipline of engineering to enter practice as a professional engineer. In both Australia and the United States, undergraduate engineering programs are voluntarily accredited through external peer review by a professional body, Engineers Australia (EA) and Accreditation Board for Engineering and Technology (ABET), respectively. As both EA and ABET are signatories of the International Engineering Alliance's Washington Accord, there is an equivalence to the minimum standard of professional engineering graduates between the countries. In both contexts there is a synergistic relationship between tertiary institutions, industry and professional bodies creating a feedback loop. Given the vast similarities between contexts, prior work comparing these two contexts has included

descriptions of the environment that influences engineering teaching activities (Brown & Knight, 2014; Carberry & Baker, 2018). Brown & Knight (2014) found differences between Australian and U.S. contexts with respect to teaching activities. To the extent of our knowledge, limited works (Deters et al., 2022) have looked at understanding the differences between contexts with respect to research culture and environment for the EER community. As such, it is likely that differences in socio-cultural experiences with regards to EER exist and should be further investigated because of the potential for collaborations on teaching-focused projects stemming from the high degree of similarity between the teaching contexts.

## *Purpose and Research Questions*

This research explores that current gap in the literature of a comparative understanding of how engineering education researchers experience and understand EER in Australia and the United States, including the differences experienced between contexts. It asks the following research questions:

1) How do engineering education researchers with significant research experience in Australia and the United States experience the different research contexts?
2) What are the researchers' perceived differences in engineering education research contexts between Australia and the United States?
3) What are the opportunities and challenges of collaboration in engineering education between Australia and the United States?

Although we did not approach data collection and analysis with a pre-determined theoretical interpretation in place, we observed following our thematic analysis the ways in which organizational theories could be useful for helping explain differences in participants' EER experiences between Australia and the United States. We thus conclude our manuscript by interpreting some of the main findings using ideas from resource dependency theory (Pfeffer and Salancik, 1978), which explains interdependencies between different actors, and institutional isomorphism (DiMaggio & Powell, 1983), which explains similarities in patterns and behaviors in prestige-seeking organizations.

## METHOD

As the research questions work to explore how people experience and perceive a social phenomenon (i.e., EER contexts in this case), interviews were deemed to be an appropriate method for data collection (Miles et al., 2014). We conducted semi-structured interviews with eight engineering education researchers who have experience conducting EER in both Australia and the United States. Ethics approval was received from the researchers' institution prior to data collection (IRB # 17-238). The relevant questions from the interview protocol are shown in Table 1.

Table 1: Interview Protocol

1. Can you tell me about your journey to becoming an engineering education researcher?
2. Can you tell me about your experience being an engineering education researcher:
    a. In the U.S.?
    b. In Australia?
3. What projects are you currently working on?
4. How would you describe / categorize your work?
5. What similarities did you notice between the US and Australian contexts when conducting engineering education research?
    a. Differences?
    b. Why do you think those differences exist?
6. There are a few (and growing) departments that bring together engineering education researchers. What do you think of that model versus a model where engineering education researchers are embedded within disciplines?
    a. Could either model be successful in both national contexts?
7. What challenges did you face in transitioning from one context to the other?
8. What opportunities do you see to collaborate with researchers from the other context?

*Sample*

This study sought participants who had significant experience conducting EER in both the United States and Australia and ranged in their career status (i.e., early-career, mid-career, late-career). Here, significant research experience was defined as conducting at least one EER study in each context and having knowledge of how EER operates in each context.

As it was predicted that the number of potential participants that meet the inclusion criteria would be relatively small, purposive and snowball sampling was used to identify and recruit participants (Miles et al., 2014). Additionally, because the number of potential participants is so small, we took extra lengths to ensure that participants are not identifiable, including reporting demographics in aggregate and not individually.

Recruited participants that comprise the sample were all either trained as engineering education researchers or had transitioned to EER and had experience conducting systematic EER studies. Participants included both early-career researchers (e.g., PhD candidates, post-doctoral, assistant professor) and those who received academic promotions (e.g., associate professor, professor); when the interviews were conducted, participants were working at a public institution in either the Australia or the United States, with prior work experience in the other national context previously. A pilot study featuring results from three early-career participants has been

previously published ([Removed for Review], 2021). The present paper presents results from the broader study and includes participants across career stages. Table 2 characterizes the sample.

Table 2: National context of Significant EER Experiences for Participants (N=8)

|  | **Australia** | **United States** | **Other National Context[1]** |
|---|---|---|---|
| Education (PhD) | 3 | 5 | 0 |
| Postdoc or Additional Research Experience | 4 | 1 | 3 |
| Professional Appointment at time of Interview | 3 | 5 | 0 |

[1] We note "other national context" to characterize the sample of participants but only focused the data collection on the Australia and United States EER comparison.

*Data Analysis*
Thematic analysis was employed to identify themes systematically across the data set (Braun & Clarke, 2012). This analysis involved six phases where the researchers first familiarized themselves with the data by reading the interview transcripts (phase 1). Initial codes were subsequently identified using inductive or open coding (phase 2) such that the data drives the later stages of analysis. Patterns or themes were then identified across the codes and reviewed (phases 3 and 4) before being finalized (phase 5). Finally, themes were organized in a way that connects them logically and meaningfully based on the data set and presented (phase 6).

All authors coded at least 2 transcripts (phase 2) and contributed to the discussions of identifying and finalizing themes across codes (phases 3, 4, and 5). Transcripts were coded by a single researcher, and that initial coding was reviewed by a second researcher as a mechanism for ensuring consistent approaches to coding across our team. Researchers identified initial codes by noting elements of EER that participants highlighted as they reflected on their experiences as engineering education researchers in both Australia and the United States. Researchers then used tables to identify patterns across codes and identify candidate themes. Quotes were then reviewed within each candidate theme, and themes were further refined and defined. Where discrepancies emerged in interpretation of themes based on coded elements, they were noted and then discussed to consensus.

Differences and similarities in the structural components and resource allocation in EER across both contexts were identified as predominant themes. Additionally, the configuration of these structures and resources were revealed to impact the function of EER across context. The analysis of themes are presented in the Results and Concluding Discussion sections of this paper.

*Positionality*

The research team for this study consists of four scholars, three of whom are from the United States and one from Australia. The project advisor was an Associate Professor in Engineering Education at a U.S. public institution who earlier in their career worked at an Australian public university. Two researchers were PhD candidates in Engineering Education at the same U.S. public institution at the time the research was conducted where they received formal training in the engineering education field. One researcher was a PhD candidate in Engineering at an Australian public university working on an engineering education dissertation having received training in social sciences and humanities.

*Limitations*

This study has limitations that inform the transferability of its findings. First, all interviews were conducted by U.S. based researchers, so there was a lack of an Australian EER perspective during the interview stage of the study. As a result, any follow up questions that the Australian researcher may have had were not able to be clarified with the participants directly, thus relying on interpretation by U.S.-based researchers for specific terms. Second, because of the nature of snowball sampling, this study may have missed certain perspectives. Largely, the participants in this study have knowledge of EER at large, public universities in the United States and Australia. Although in both contexts there is a rich diversity to how engineering education programs are delivered, there is a much smaller number of universities that offer engineering in Australia relative to the United States. Participants primarily had experience with large research-intensive universities in the United States. There was a greater diversity in the type of university participants experienced in the Australian sector. Accordingly, perspectives of EER at different institution types within both contexts may not be fully represented in this study.

## RESULTS

To address the research questions posed by this study, we divide our results into two key sections: 1) The landscape: Structure and resources of EER in each context, and 2) How the landscape plays out: Implications on EER studies and collaborations. These differences in the EER landscapes in each country were described by participants as having implications on what is studied in each country, and consequently, on the potential collaborations between these countries. Within the first section, the landscape, brief statements of the implications for EER are made, which will be elaborated on and synthesized within the second section, how the landscape plays out.

*The landscape: Structure and resources*

When participants described their varied experiences in each context, they did so within the context of the structure of EER in each country. Within this category, four key structural differences emerged: 1) departmental and university configurations, 2) EER qualifications and training, 3) industry connections, and 4) culture.

*Structural Landscape*
First, participants noted differences in departmental and university configurations – namely the kinds of roles that engineering education researchers held within departments and universities. For example, in the U.S. context, participants mostly spoke of experiences involving departments of engineering education that conduct externally funded research, teach, and house graduate programs of engineering education. Comparatively, in the Australian context participants spoke of engineering education researchers being "embedded in engineering disciplines" or "home departments where they teach." These researchers may also have "research groups" or be aligned to "research centers" that, as one participant described, "allow those individuals in those different departments or schools to align together their research activities." Some participants also pointed to "teaching and learning committees" in the Australian context as being a structural entity through which researchers could find community or organize. One participant noted that certain U.S. institutions also have a distributed model that embeds EER individuals within engineering disciplinary units, which is a structure more like that seen in the Australian context. The implications here for EER is that a collectivized model provides a landscape ripe for community, collaborators and support, whereas a distributive model relies on additional groups to exist or be created for this purpose.

Second, participants noted differences in EER qualifications and training between countries. Participants noted that in the United States it is common to hold and work with individuals who hold a PhD in EER specifically, whereas in Australia, it was common that individuals working in EER were academics who were trained in a technical engineering discipline but interested in EER. As an example, one participant noted:

> One thing is I don't feel like, when you're in engineering education in Australia, I don't feel that's the main thing that people do. So, it's usually you are in civil engineering and you do engineer education, you are in chemical engineering and you are doing engineering education.

In addition, participants noted differences between the nature of graduate programs between the two countries:

> There's quite a distinct difference between the ways that PhDs are undertaken in the States versus in Australia. So, in Australia, we have no coursework. It's purely just the dissertation, you do the dissertation for three to four years. And so, part of that is then

finding supervisors and finding other opportunities to learn the context, to learn the methodologies, to learn those kinds of broader philosophical discussions going on in the landscape. Because you don't take classes in them before you pick a dissertation.

As another participant similarly noted, "In Australia, it's great because you're more independent, but you also don't get to work with experts in the field who can put together a beautiful course slate. You come in with all of this learning. And so that's a big difference." Yet another participant characterized how different approaches to PhD training ultimately influenced the kinds of knowledge within EER that individuals gain across the two contexts:

When I went over [to Australia] as a postdoc, and even just talking to grad students, they knew more, broader stuff than I did around engineering education. They'd read broader. I had a far deeper depth of knowledge in methodology and in my particular field, but they had read broader. And I think that part of the challenge of moving between those is just that difference in education. You know, if you think about a PhD process as an education.

One participant noted parallels between the current Australian graduate system and U.S. institutions that currently do not have formalized graduate programs. The participant describes how some U.S. institutions have or still mirror Australia's decentralized version of an EER PhD, wherein there is no formal EER department or degree program, but students are able to study under engineering education researchers and obtain a PhD in Engineering specialising in Engineering Education:

Because the Australian system is, you know, there are no courses, there's no approved PhD program. So, there's a lot more flexibility to be sort of entrepreneurial in that space. It feels like in the U.S., that existed at the time and still exists, that people in institutional locations that don't have programs are having engineering education graduate students.

The summative implication for EER from the participants' experiences is that there is a diversity in perspectives, knowledge and experiences that an individual commonly acquires as part of existing in a space. This diversity is particularly evident when comparing the experiences in Australian and U.S. EER contexts.

The third way participants noted differences in structures pertained to the role that industry plays in engineering education and EER in each context. Participants noted increased involvement of industry in engineering curriculum design and implementation in Australia:

Most schools have an industrial advisory board. And I was very impressed by how seriously industry representatives took that role. Like they were involved in curriculum design, they were involved in reviewing grades at the end of one semester. They were

involved in understanding what was happening with the students. They even were conducting focus groups and things like that. So, they'd really care. And when I asked them, what's your motivation? They say, well, I know in the long-term if we are involved, we will get better engineers, which makes a lot of sense.

Another participant described additional involvement of industry individuals in the classroom:

> … and I feel like industry there [in Australia] is more involved in the education. Most of the projects they do are directly related to industry. And they have real projects coming from industry… like core classes, the course has a budget to bring people from industry. So, you can pay people from industry to spend the semester coming and joining your class and you're sitting there and answering questions. And they will get paid for that. So, it's very common to have, especially in the design classes, two or three guys from industry or girls from industry sitting there and hanging out with the students.

Lastly, participants described differences related to culture that impacted the landscape of EER in both contexts. Participants noted that they felt that university types varied within each context, which had a large impact on how EER was structured. One participant noted that in Australia:

> I think the [Australian University A] and the [Australian University D] experience, it's way different from [Australian University B] and [Australian University C]. It was crazy how different it was […] from that side the new engineering upper side versus the more traditional.

Along with learning different university types and institutional cultures came learning the new infrastructure and terminology of a new university. One participant highlighted the terminology shift:

> Some of the differences, just the terminology is a little bit different, so getting used to the terminology, like what is a placement versus a co-op for student internship, what is a course, versus a unit, versus a program, versus a subject, versus a class?

The implication for EER is the importance of establishing terminology and sufficient detail of the specific university context, within a much larger context of postsecondary education, when preparing or reporting on EER studies.

Next, one participant who is not originally from the U.S. or Australia felt that they were welcomed as an international person in the United States but felt unwelcome in Australian universities. The participant said:

> [When] I was in any city, people, in general, they are very open to international people and they treat you really well and ... But then you go into the university and it's the

opposite. It's the other bowl where they really don't care about you. If you're an international person coming from a third world country, they only care about you if you are an international person coming from England or the US so it was really hard to show your value. People were harsh in general. So [it] was more difficult and it required more proving before people took you seriously.

Moreover, participants noticed that the scope of conversations about diversity and inclusion in Australia were narrower than those in the United States. One participant, who "spent a lot of time educating [themself] about inclusion and diversity" and had made it "part of [their] research" and "part of their identity" noticed stark differences in how diversity and inclusion were approached and discussed. The participant recalled:

Arriving there 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 meeting 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 said, no, no, no. You don't ask these questions. I start asking them about race and needs and things like that . . . What are you doing? No, you don't ask? So that was a challenge because it was part of my research. I wanted to understand those things and it was really complicated.

It should be noted here that Australian higher education data only presents data on race for Aboriginal and Torres Strait Islander peoples (Australian Government Department of Education, 2022). The lack of nuance to diversity and inclusion work in Australian engineering education beyond recruitment of women experienced by this participant has been previously noted as a criticism of Australian EER diversity and inclusion work published in literature (Brown, Pearson and Rosenqvist, 2020). In this case, the cultural differences between the two contexts and what was deemed valuable from a research topic perspective influenced this scholar's research agenda. The implication for EER from these participants' experiences is a need to recognize that there exists important variation in how different research topics are prioritized and operationalised when working across or between the Australian and U.S. contexts.

*Resource Landscape*

In addition to noticing structural differences, participants also discussed differences in available resources to support EER in each context. These differences were often informed by structural factors. Three key resource differences were raised across the interviews: 1) recognition as a field, 2) funding, and 3) research labor.

First, participants discussed the different ways EER was recognized as a field between the two contexts in their experiences. Participants noted the interrelationship with departmental

configurations meaning that in the United States, EER was more respected and established as a field when compared to Australia. As one participant described:

> …schools and departments [in the U.S.] have been instrumental in giving engineering education as a field, the heft and the respect that it has. I mean, without those schools and departments we wouldn't be in the position that we're in.

Second, participants noted the large difference in funding structures between the United States and Australia. Namely, there were large amounts of funding available for studying EER in the United States, whereas funding sources were described as virtually non-existent in Australia. For example, a participant commented:

> I mean, one big difference is because the way in which the money flows differently. So, here in the U.S. the National Science Foundation, and KEEN and other sources fund engineering education research and have really started to give a lot of support to engineering education research over the last 20 years. And this has led to the establishment of schools, and departments, and full-time positions where faculty have time to develop really deep expertise and write really thoughtful papers on engineering education research. Whereas in Australia there are fewer grants, and so that power that comes with money hasn't really happened in Australia.

Another participant described how this funding difference appears to be widening:

> I think a large driver of that is different magnitudes of resources spent on engineering education. We in the U.S. have a very good funding stream through NSF. That funding stream in Australia was kind of on the tail end when I was there and it seems like it's gone away federally.

Participants noted having to get "creative" with funding in Australia, including seeking financial support provided from industry for teaching activities. One participant explicitly noted:

> Internally, we were taking advantage of the industry as well because they have very strong industry connections. So, we were like, "Oh, you're funding this civil engineering lab, can you give an extra $200,000 and we will give you the best engineers and things like that." But it was very tricky.

Third, the differences in availability and sources of research labor were discussed by participants. Themes included the difference in what counts as research between contexts, and availability of graduate students to support research. As one participant described:

You never have this 100% of your time doing engineering education. So, I think there's a huge difference where here we have an entire field community [in the U.S. context] only dedicated to that.

The metrics by which an individual's research labor is deemed "productive" varies between the two contexts. For example, one participant noted the following:

I think the main difference is that here [in the United States] the researcher is a person that has these areas of interest and wants to go deep in that space and become like an expert in that space. And your expertise is measured based on how much money you can get, how many articles you can publish, how many papers you can present, right? And then you go into the Australian context, and it's not like that at all. It's basically, being a researcher is exploring many different teams at the same time. Your specific expertise is not as important as becoming active in all these different spaces. And I'm talking from the engineering education perspective here, like if we do engineering research it's a different story, but engineering education, specifically, is not very common [to have a clear focus such] that [someone] will be the assessment person or the motivation person. No, it's more like that you are involved in several projects that relate to education, so that's very different. And then the productivity is also very different. There is not that pressure around getting money or even publishing. I think it's more important for you to be doing important things in meaningful things that you can translate back into a classroom. I think that's a huge deal.

In summary, participants repeatedly pointed to resource differences between the contexts in terms of recognition as a field, funding, and research labor. In all cases, Australia was described as having a deficit of material and physical resourcing to support EER compared to the U.S. context. This implication of how participants spoke about this deficit was that it constrained and influenced their research direction, strategies as well as the way in which they worked.

### How the landscape plays out: Implications on EER studies and collaborations

The participants described how the different structural and resource elements of the landscape intertwined to dictate the function and form of EER within each context. Although on some occasions participants explicitly described how the contextual differences influenced collaborations, often the impacts were inferred. These inferred impacts were briefly stated in the previous section and will be elaborated upon in this section as they were described by participants as relating to their experience of the Australian and U.S. EER contexts.

First, we found that the style of research conducted in each context was impacted by the structure of EER in each context as well as the available funding. Namely, in the United States,

researchers are incentivized to conduct large-scale studies that can garner support from national funding agencies and focus on theory forming EER. On the other hand, in Australia, researchers are incentivized to conduct small-scale scholarship of teaching and learning work that has direct implications for classroom-level improvement within their local teaching environments. One participant described how these differences in departmental and university configurations ultimately moderates the impact that engineering education research has, but for different reasons:

> Again, it's a cynical perspective, but I think it's also a realistic and pragmatic perspective. Across the globe and particularly in Australia and in the U.S. context, we're doing some really high-quality engineering education research, but for lots of different reasons, it's not framed in a way that is translatable to impact. It's not framed in a way that here is this really hard quality piece of research that we've done. And here is how we can now change the practice of engineering education to benefit from it . . . It seems to be more of an almost, a scientific approach on what's happening, rather than a developmental translational approach on how do we really deeply research this thing in order to understand the mechanisms and theories of what's going on in order to transform it for the better . . . So it's very easy to do study after study on what's happening. But it's very hard to do a study that starts to argue and implement what needs to change for a particular outcome.

The perceived impact of funding structures on the nature of the research in EER has not been previously described in literature to the extent of the authors' knowledge. This difference in focus derived from funding could be inferred to have implication on the topics primarily studied and research questions primarily asked in each context. For example, the topics in the U.S. context may be influenced by funding body direction, whereas research topics in Australia are influenced more heavily by the capacity to feed findings back into teaching. However, participants often noted that there were similarities in the topics being studied in each context, for example in lecture capture, skills shortages, attendance, and inclusion. Despite this similarity, participants often noted that although there were surface level similarities, there were differences that needed to be accounted for. For example, one participant noted that the broadening participation space was "virtually non-existent in Australia" and "a completely different scale than what we see in the U.S." Another participant noted when discussing a project on student attendance, "It's not the same at all. We complain about attendance, but they have a completely different attendance question." Important differences in the educational context drive the educational phenomena under investigation in very different ways. The implication for EER is that although at the surface level opportunities for collaboration or transferred learnings may arise, the specific contextual differences may be worlds apart, so there is need for sufficient depth to conversations and reporting to establish the context and problem fully.

Lastly, the differing goals as well as structural constraints were highlighted as being an inhibitor of collaboration between EER researchers in Australia and the United States. For example, one participant summarized this as follows:

> In the U.S., you do research in engineering education and you're embedded in a college of engineering that has the U.S. legacy of being driven by metrics, which is largely publications in highly ranked journals. *The goals are often different in Australian engineering education research.* Then combined with the lack of opportunity to have international components of NSF funding, because the National Science Foundation doesn't want any money to be spent elsewhere, which other funding agencies around the world have different policies about that as well. So even if I can get funded to kind of justify my time spent on a collaboration, that can't be a shared endeavor necessarily because someone in Australia can't receive any money or it's very hard from an NSF project. And in order for me to engage in a project that takes up a lot of my time and capacity, the system and the metrics and reward systems force me to only do this if I actually get funded and get publications out of it. So, that introduces, I think, some significant barriers to some more in-depth collaborations with Australian researchers.

Another participant proposed that the lack of the understanding of the differing landscapes is what can create obstacles to collaboration:

> Some U.S. people came in [to Australia], they gave their pitch, and they didn't consider the fact that the Australians don't have graduate teaching assistants. Everything that they pitched [in their presentation] hinged on that resource. I think we often think we have some silver bullet-ish answers from a U.S. perspective, and we should just go around and tell everybody, "Here's how you fix all your problems," and we don't consider that they actually might be more advanced than what we do in the U.S.

As this example illustrates, fundamentally misunderstanding contexts can be a barrier for collaboration across EER. Without taking the time to critically examine which elements of educational interventions can or cannot transcend contexts, sharing ideas–and the ways in which they are shared–can actually result in potential collaborators being less likely to want to collaborate in the future. These kinds of misunderstandings can range from the obvious one in the example regarding graduate teaching assistants to the less obvious, such as differing language and terminology between contexts. As one participant hypothesized, when EER field members work with people who weren't trained as "engineering education people," as is the norm in Australian contexts, there can be differences in assumptions, ways of thinking, definitions, and terminology that need to be overcome.

**CONCLUDING DISCUSSION**

Participants pointed out many structural and resource differences between the Australian and U.S. EER contexts, which resulted in many different experiences for researchers, ways in which EER studies are framed, and opportunities for potential collaborations between researchers in each national context. To make sense of why these structural and resource differences could play such an important role in determining the nature of EER studies, we turn to two perspectives from the organizational theory literature. First, in their classic piece describing resource dependency theory, Pfeffer and Salancik (1978) argue that interdependencies between an entity (i.e., an organization, or, in this case, EER researchers) and its surroundings will drive behaviors (Pfeffer & Salancik, 1978). When that central entity depends upon any external unit for a large amount of its resources, it is likely to have to conform to that external unit's demands. In the case of Australian EER, much of the funding for research is controlled internally by teaching and learning committees within discipline-based schools or faculties; there is much less external funding as there is in the United States. Given this scenario, EER researchers tend to be beholden to the needs and interests of their internal constituents, and so the net result is research agendas that tend to focus on classroom- or program-level teaching and learning issues. The community tends to directly support the needs and interests of engineering academics who are responsible for delivering undergraduate courses, and so the net result is an EER community that tends to engage in a lot of scholarship of teaching and learning. Because EER budgets tend to only support a portion of the EER researchers' time, the EER researcher has comparatively less agency to craft a research agenda beyond the stakeholder-driven items. Within the United States EER context, however, many researchers in the field have successfully garnered support from the National Science Foundation, and from a resource dependency perspective are less beholden to the needs and interests of their surrounding institutional context. The national-scale funding source still drives researcher behaviors, but the scale and scope of research tends to focus on much broader issues and topics and often less directly connected to local contexts—EER researchers in the U.S. context tend to have more agency in determining their own research agenda because of this arrangement.

A second organizational theory—institutional isomorphism (DiMaggio & Powell, 1983) – also can help explain some of the other differences between contexts. Having the external large funding source is a key mechanism for supporting the development of EER as a field in the United States, and one of the noted structural differences between national contexts is the presence of departments and/or centers focused on engineering education research, some even with large numbers of academics and graduate student communities. As institutional isomorphism explains, organizations tend to become more similar over time as they seek legitimacy and prestige, and one mechanism by which this happens is through mimicking organizations that are deemed legitimate and prestigious (DiMaggio & Powell, 1983). The newly formed and forming EER structural entities have tended to mimic the behaviors of more established, discipline-based departmental structures, and so we see EER researchers in the

United States engage in behaviors that emphasize publications, graduate education, and continued external funding. These kinds of forces do not impinge on the Australian EER community, and so we tend not to see the same kinds of research behaviors, and thus the research processes and products look different between the two contexts.

In summary, we found that many of the different experiences cited by members of the EER community who have both worked in both the United States and Australian could be explained through these perspectives on organizations. Moving beyond prior work that has talked about some of the differences between contexts in topics or methods, our paper considers the experiences of the researchers themselves and illuminates how differences in the contextual elements of the research environments across national contexts are important for understanding research processes and products. Although undergraduate education may appear to be similar between the settings, our analysis shows an extremely different research environment for engineering education researchers.

When EER teams are seeking to collaborate across these national contexts, our results show how and why certain kinds of research areas might breed more fruitful partnerships. Classroom-level teaching and learning research could be an important avenue whereby mutually beneficial partnerships could take off. For example, the U.S. EER infrastructure could support U.S.-based research personnel on a multi-institutional teaching and learning study, and one of the sites could be an Australian university EER team given the advances made by the Australian EER community within this space. Such a partnership could take advantage of some of the strengths of each context while leveraging unique characteristics of each (i.e., funding and personnel within the U.S. and access to advanced learning environments within Australia) to produce a mutually beneficial project. In scoping the project, our paper identifies the different elements of contextual structures and resources to which teams should pay attention.

Future research could engage in similar analyses to help EER partners across other national settings identify symbiotic research relationships. National contexts for EER in the United Kingdom, South Africa, and Europe tend to be more like that of Australia, but future comparative research could focus on where contextual differences could be important for this community. The Chinese engineering education landscape appears to be following some similar approaches to the United States in terms of national funding support (Cao et al., 2021), and future research could explore the ways in which that agenda plays out in similar or different ways for the engineering education community in that context. As we have shown throughout this paper, the context within which engineering education research takes place has important implications for engineering education research processes, outcomes, foci, and potential to collaborate globally.

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