Supporting the Transition to Engineering Education Research: growing the community through the AAEE Winter School

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ABSTRACT

CONTEXT

There is an increasing amount of research into the experiences of engineering academics making the transition from technical engineering research (TER) to engineering education research (EER). The literature is almost unanimous in agreeing that formal and informal networks are critical in enabling this transition. One such network is the AAEE Winter School, which since 2011 has been running intensive one-week workshops to induct academics into engineering education research methodologies. Over the years it has inducted many people into EER, but the impact of these experiences has been under-researched.

PURPOSE OR GOAL

This paper investigates what engineering academics are seeking when they enrol in the AAEE Winter School. It explores engineering academics' motivation to become involved in EER, and the key benefits that they identify through participating in the Winter School.

APPROACH OR METHODOLOGY/METHODS

The 2022 AAEE Winter School was held at the University of Technology Sydney. A survey incorporating a range of Likert scale (four point), pick group & rank, multiple-choice, hybrid and free response answers was sent to participants. Nine of the 14 participants who attended the majority of winter school sessions completed all questions in the survey. A spreadsheet was used to analyse the quantitative data and a thematic analysis was conducted for the free response answers.

ACTUAL OR ANTICIPATED OUTCOMES

Despite the struggle for EER to be recognised as a legitimate area of research in engineering (e.g. Dart et al., 2019; Gardner & Willey, 2018), the results of the data analysis reveal that most of the participants see EER as part of the engineering discipline. However, this view does not appear to be shared by the majority of the participants' engineering faculties. Furthermore, many of the participants reported a significant skills gap in transitioning to EER. Key benefits of attending the Winter School included meeting like-minded researchers and developing an understanding of what is involved in educational research.

CONCLUSIONS/RECOMMENDATIONS/SUMMARY

It is important for researchers to have social connectivity through a combination of networking, collaboration, role models and mentors in order to successfully transition from TER to EER. The AAEE Winter School provides emerging EER researchers with the foundations for both social connectivity and an opportunity to learn about EER research methodologies to support their research journey.

KEYWORDS

Engineering education research; research methodologies; networks; Self Determination Theory.

Introduction

The journey into engineering education research for engineering academics has been explored from several perspectives in recent years. The theories of community of practice (e.g. Mann & Chang, 2011), Bourdieu's theory of practice (e.g. Dart, Trad & Blackmore, 2021), identity development (Gardner and Willey, 2018), and grounded theory approaches (e.g. Rodrigues, Paul & Seniuk Cicek, 2021) have all been applied to investigate this phenomenon, and a range of understandings have emerged from these studies. For example, researchers have identified the need for an epistemological paradigm shift (e.g. Borrego, 2007; Dart, Trad & Blackmore, 2021) to accommodate qualitative research methodologies and education-based theories of learning. Other insights, such as the importance of the role of mentors (Dart et al., 2021; Mann & Chang, 2012), the desire to improve learning outcomes for engineering students (e.g. Gardner & Willey, 2018; Rodrigues et al., 2021) and the significance of belonging to a supportive community (e.g. Allendoerfer, Adams, Bell, Fleming, & Leifer, 2007; Siddiqui, Allendoefer, Adams & Williams, 2021) have been noted by several researchers.

Why are there so many studies? What is it that occasions such interest? There are several reasons for this interest, and many of them relate to the observations that have surfaced in the engineering education research literature. One major reason is the substantial and significant differences between technical engineering research (TER) and engineering education research (EER), as has been remarked on by researchers for at least two decades (Borrego, 2007; Dart et al., 2021; Gardner & Willey, 2018; Wankat, Felder, Smith & Oreovicz, 2002). The widely different approaches between these two fields of research are evident not only in the types of research but in what are seen to be valid forms of research and what are regarded as valid or invalid types of research questions - in other words, significant differences in epistemologies and in methodologies. As already noted, those who choose to enter the field of EER from a technical research background often need to recalibrate their world view (their ontology) to match with the qualitatively (no pun intended) different approaches that underpin educational research.

Borrego's seminal paper (2007) on the emerging field of engineering education research highlights the 'conceptual difficulties' that can arise because of the differences in the theoretical frameworks and methodologies of TER and EER respectively. Engineering educators in Borrego's study were likely to be unfamiliar with education theories, and several had the perception that qualitative research methods associated with education research were less rigorous than those of engineering research. To alleviate unfamiliarity with education theories, Borrego proposed that engineering educators collaborate with researchers outside the field of engineering, such as colleagues from the field of education or psychology. However, Wankat and colleagues highlight the difficulties faced when EER involves "…collaborations… between engineers and social scientists, who frequently have different vocabularies, priorities, and conceptions of research" (Wankat et al., 2002, p.234).

Moreover, Borrego highlights the perceived importance of rigour for engineering educators through her repeated use of the term: 'rigorous engineering education research(ers)', and by the definition she includes:

> *one who is successful at attracting research-focused external funding and publishing in archived research journals such as Journal of Engineering Education, since both of these employ peer review to enforce rigorous standards* (2007, p.91).

Given these and other differences between the two domains of research, it is clear that the path to EER for engineers with a background in TER is often neither smooth nor easy. This is frequently acknowledged in the literature, and several studies refer both to the difficulties of crossing boundaries and the need for a supportive community to enable or facilitate boundary crossing (e.g. Gardner & Willey, 2018; Mann & Chang, 2012). Rodrigues and colleagues conclude that: "finding a new domain with a supporting community – a home – was crucial for their [scholars'] continuation and success in EER (2021, p.14).

This leads us to explore what resources are available to enable such recalibrations, and to ask the question: what do novice EE researchers need? Again, the literature provides a range of responses to this question, but there is agreement on the following forms of support: formal networks, informal networks, and formal instruction in qualitative research methods.

Formal networks: several authors have identified formal networks as being important for people to pursue EER (e.g. Borrego & Bernhard, 2011; Dart et al., 2021). Formal networks provide a means of making connections with other researchers, expanding their knowledge of the field, and as a way of accumulating capital (in the Bourdieusian sense), as explored by Dart and colleagues.

Informal networks: these networks play diverse roles in supporting novice researchers in EER. They can range from invitations to attend conferences, co-author papers, or meet with likeminded colleagues, to corridor conversations which facilitate and maintain interest in the field (e.g. Mann & Chang, 2011). These encounters are termed "intentional serendipity" (Allendoefer et al., 2007) or "happenstance" (Rodrigues et al., 2021), and illustrate the importance of relationality in EER: that people engaged in this field of research seek connections and collaborations with others.

Formal instruction in qualitative research methods plays a key role in the induction into EER, as evidenced in several studies. For example, Benson and colleagues (Benson, Becker, Cooper, Haden Griffin & Smith, 2010) profile engineering education departments in the US, emphasising the important role of formal instruction in education research methods. Borrego and colleagues have conducted several studies that investigate the need for engineering faculty staff to receive formal instruction in education research methods in order to undertake EER (e.g. Borrego, 2007; Borrego, Douglas, & Amelink, 2013). Nagabhushan and Sohoni (2020) report on the effectiveness of providing an online 12-month course on EER for engineering faculty staff in India, and noted several benefits, including that of better quality EER research and reporting.

The Australasian Association of Engineering Education has been running Winter School intensive workshops in education research methods since 2011. The format of the Winter School has changed over time, from week-long off-campus retreats, to week-long campus-based workshops, to two-week part-time online programs under COVID. Nevertheless, the purpose and focus of the Winter School have remained generally the same - to:

- improve practice through workshops with experts identified by the participants and AAEE,
- share research methodologies and data analysis techniques,
- provide an opportunity for peer review of work…build community and a reference group for students and academics whose interests are often unique in their home departments (Matemba, Parker & Jolly, 2018, pp.15-16).

However, whether the purpose and focus of the Winter School have been understood by its participants, and the extent to which the Winter School has been meeting the needs of its participants, have been under-investigated.

Therefore, we conducted a survey of the participants in the AAEE 2022 Winter School on research methods, which was held in person at the University of Technology Sydney from 18-24 July, 2022. We sought to investigate, amongst other questions, what motivated the participants' interest in EER and why they chose to attend the Winter School.

The following paragraphs present the survey design, approach, analysis and preliminary results.

Methodology and Methods

While there were 17 participants who enrolled in the 2022 Winter School, due to illness several were unable to attend the majority of sessions. The 14 participants who attended the majority of sessions were invited to complete the survey.

A 21 question survey incorporating a range of Likert scale (four point), pick group & rank, multiple

choice, hybrid and free response answers was developed. The survey was tested through a number of iterations by the Winter School facilitators for validity and the wording was refined to minimise any ambiguity. Consideration was also given to the type, format and order of the questions. Similarly themed questions were grouped together to reduce survey fatigue and promote more reflective answers from respondents.

The questions prompted a mixture of phenomenological (in what way did participants respond to different activities), evaluative (what worked for whom under what circumstances), causal (why did that happen) and exploratory (what are the significant factors that occurred) data.

Nine participants completed all questions in the survey, representing a 65% response rate from the 14 invited participants. A spreadsheet was used to analyse the quantitative data, while a basic thematic analysis was conducted for the free response answers. A preliminary analysis of the results is presented here.

Results

While eight of the nine respondents agreed they regarded EER to be part of the engineering discipline, only three felt that their university's engineering faculty considers it to be so. Despite this, six of the nine respondents reported they felt supported to undertake EER at their university. The most common reasons for feeling supported included encouragement and leadership from senior staff, and observing the success and recognition of more senior EER colleagues within their institution, as expressed by the following responses:

> *Several more senior colleagues undertake research in EER have been successful within the institution.*

> *Excellent leadership. A critical mass of passionate educators. A growing community of practice internally*.

This suggests that networking, role models, and observing the recognition and success of more senior EER colleagues contribute to developing new and emerging EER researchers' identity as EER researchers. It would be reasonable to expect that continued growth in their network through conference attendance, EER events and other related activities, will also be of importance for their transition to identifying as established EER researchers (Gardner and Willey, 2018).

The three respondents who felt unsupported to undertake EER held the perception that within their institutions the majority of faculty staff, who were technical researchers, did not regard EER as 'proper' research. They also noted that there was no support from their line manager, supervisor or executive for undertaking EER.

Hence those who felt supported had both personal and institutionally visible EER role models available to support their transition and develop their network. This supports earlier findings that formal and informal networks are critical in enabling a transition from TER to EER (Borrego & Bernhard, 2011, Dart et al, 2021, Rodrigues et al, 2021).

Self-determination theory (SDT) provides another lens with which to view the key role played by social relatedness in the journey to EER. The theory provides further support for the importance of social relatedness facilitated through networking, collaborations, mentors and role models. Relatedness, together with competence and autonomy, are postulated by SDT to be "three innate psychological needs …. which when satisfied yield enhanced self-motivation and mental health and when thwarted lead to diminished motivation and wellbeing". (Ryan and Deci, 2000).

Motivation

So if a transition to EER is not an attractive, nor supported option within many institutions, what motivates academics and researchers to undertake this transition? The respondents were asked to pick, group and rank a number of statements in regard to how much each statement contributed to their motivation for becoming involved with EER (the three groupings were highly motivating, somewhat motivating or little/no motivation).

Perhaps not surprisingly, the statements most frequently rated as highly motivating were:

- Personal interest in teaching and learning, and
- Desire to positively impact students' educational experience in the engineering profession.

In common with the motivation and anecdotal experience of many in the AAEE community, a personal interest in teaching and learning and a desire to improve educational outcomes were highly motivating factors for participants beginning their EER journey. This finding is supported in the literature; for example, Rodrigues and colleagues identified the desire to "right pedagogical wrongs" and improve student learning as key motivating factors for people entering EER (Rodrigues et al. 2021).

The most frequent statement that was grouped as 'somewhat motivating' was "An invitation to join a research project". This points to the importance of collaboration in providing opportunities for interested researchers to transition to or begin their research journey in EER and highlights the value of establishing networks to facilitate these collaborations.

The statements most often grouped as providing 'little or no motivation' for their transition to EER were:

- Opportunity to access research funding, and
- A way of generating research without needing a budget.

In the Australasian context this result is not surprising, given that research funding and financial support for EER is scarce. This motivation may differ in contexts where such financial support is available to emerging EE researchers.

Most educators who have a passion for teaching and learning and improving the student experience are not typically motivated by financial gain. This is demonstrated by the regularity of how often they work well above and beyond the hours for which they are paid and/or initially self-fund their own teaching and learning initiatives. It is little wonder, then, that the same passionate educators are motivated to transition to EER to improve their practice and not to access research funding.

This point is significant in terms of the support that the AAEE Winter School provides. While Winter School is not able to supply avenues for funding, it does provide the informal networking and collaboration avenues that motivate new researchers. In addition, it provides formal instruction that supports research; this can then be directly applied to EE researchers' passion for improving engineering education for their own students and those in the wider community (see Dart et al.2021 for an extended discussion about building capital through involvement in EER).

The instruction and participatory activities at the Winter School also build participants' feelings of competence, through contributing to building their resilience and a belief that they can succeed in their transition to EER. As pointed out earlier, competence is postulated by SDT as one of three innate psychological needs required to enhance self-motivation and well-being (Ryan and Deci, 2000). The third need proposed by SDT is autonomy. In terms of intrinsic motivation, autonomy relates to a person experiencing their behaviour as being self-determined. Choice, acknowledgement of feelings and opportunities for self-direction have all been found to promote a feeling of autonomy (Deci & Ryan, 2000 & 1985). While there are some opportunities for autonomy in the current Winter School activities, it is less clear how to augment these opportunities in future offerings. On the other hand, it should not only be the responsibility of the Winter School to meet the innate psychological needs of researchers in their transition to EER. If the AAEE community is committed to assisting novice and transitioning EE researchers to be successful, the community needs to consider how to establish other avenues beyond Winter School to motivate and support these scholars.

Participants who transition from TER to EER

Respondents were asked to describe their main reasons for choosing to attend the AAEE Winter School, with the most frequent responses relating to beginning to build their EER research

capacity and expanding their network as reflected in the following comments:

> *I need to be spending 20% of my time researching. The AAEE Winter School was my introduction to research*

> *Personal and professional goals to develop skills in EER and expand my network*

> *To help with my transition into EER (learning how research is conducted in EER, and the associated terminology, theories, and methodologies).*

Winter School attracts participants at different stages in their EER careers (historically some participants have even returned to further develop their skills) and the formal instruction component endeavours to accommodate this range. The Winter School curriculum has evolved in response to the experiences from previous years. It focuses specifically on assisting participants to address the acknowledged gap in skills for engineering educators transitioning from TER to EER. However, the limitations of a one-week program to address an extensive field of literature and skills means that facilitators must select a subset of topics and skills.

In our survey, five respondents had conducted technical research before transitioning to EER (four had conducted technical research for at least four years while the fifth respondent had conducted technical research for three years prior to their transition). Of these five respondents, two reported they experienced a large skills gap in transitioning to EER, two reported a moderate skills gap and one reported only a minor skills gap.

Four of the five respondents who had conducted technical research before transitioning to EER reported that the skills they were in greatest need of developing to facilitate their transition were:

- Awareness of relevant theories, and
- Awareness of relevant methodologies

Other skills that were highly ranked as needing development included:

- Familiarity with educational literature, and
- Learning terminology and language associated with educational research

Not surprisingly, respondents reported the skills that needed the least or no development to facilitate participants' transition to EER were:

- Quantitative research approaches, and
- Statistics

Of all nine respondents (that is, including both those that had previously undertaken technical research and those who began their research careers in EER) the most common methods they had used to collect data in their EER so far were surveys, interviews and observations.

The skills and attributes identified as needing the most development are already included in the current Winter School curriculum. The methods used by the participants in their research are also discussed in participative sessions where the skills are developed further.

Those skills identified as needing the least development, were not addressed in detail at the 2022 Winter School but were touched on and contextualised to EER. For example, while quantitative research approaches are discussed, far more sessions focus on qualitative research. Similarly, statistics were only discussed in the context of exploring different data analysis methods and how they can be used, and are often misused in EER, in the context of analysing survey data.

Winter School Participation Outcome

When asked to describe the best parts of their AAEE Winter School experience, the most frequent responses related to forming "collaborative networks" and "meeting like-minded researchers" with the next most frequent responses being related to improving their capacity to undertake EER.

The survey results indicate that the Winter School is meeting the needs of our target audience in terms of their expectations for delivery of formal instruction. However, the informal networks formed during the Winter School were valued more by the respondents than the EER instruction and associated discussions, or the individual guidance and support provided by facilitators to develop their research.

In previous Winter Schools, collaborations between participants have resulted in publications and continued working relationships (Matemba, Parker & Jolly 2018, Dart, Blackmore, Willey, Gardner, Jose, Sharma, Sloan, Jolly, 2019, Dart, Trad & Blackmore, 2021). A number of the facilitators of the 2022 Winter School are previous participants. This is evidence of the networking and collaboration which can emerge from participating in the Winter School. The results of this survey indicate that the 2022 Winter School was seen as valuable for these reasons. The connections made in the 2022 Winter School, which arise from the collaborative activities and open sharing of experiences, enable participants to identify "like-minded researchers". In an environment where some researchers feel their EER is not supported by their institutions, this informal networking and exposure to role models is of crucial value in supporting their continued participation in EER.

Contributing to the Community of Practice (community responsibility)

If the social connectivity and research development provided by events such as AAEE Winter School and the annual AAEE conference play such an important role in building and enhancing our community, why is there not more enthusiasm to host these events? Is this because they are a time-consuming and sometimes thankless task for those involved?

Historically, conferences were often profitable and sometimes in part, chaired as a way of raising money for the facilitators to fund their research (Covid travel restrictions and a reduction in participants' available funding sources has changed this for the present). However, AAEE has never sought to make a profit from Winter School.

Over the 11 years in which the Winter School has been held, there have been a number of repeat facilitators who have contributed for a block of several years, with Dr Leslie Jolly being the champion. Hosting and/or facilitating the Winter School means giving up a week of semester break, preparing in the weeks beforehand, and recovering the week after while catching up on normal duties. The Winter School is currently undergoing renewal, with new facilitators volunteering this year to work with the more experienced team, learning the ropes to take it forward. This year we also tried a different approach with invited speakers, interleaved with sessions run by the facilitators. This provided a variety of presenters and topics and made it less fatiguing for the primary facilitators, but it also meant that the flexibility to change sessions on the fly to tailor them for the interests of the participants was not available. However, this approach seems to be a sustainable way forward.

It has always been the intention to move the Winter School location each year. However, despite holding a Summer School in Hamilton, New Zealand (Waikato and Wintec) in 2020 and a Winter School in Melbourne, Victoria (Swinburne) in 2018, in the absence of other institutions offering to host, the Winter School has been hosted at University of Technology Sydney since 2016.

Pleasingly, in recent years it has become increasingly competitive to be elected to the AAEE Executive and AAEE Journal editorial board (sadly we can't say the same for reviewing). While still requiring a significant contribution to the community, these positions, we speculate, are more attractive than facilitating Winter School as they have career capital and prestige.

As a community, we need to generate the same enthusiasm for contributing to and/or hosting the Winter School and annual conference, in order to continue EER's move from an emerging field to being an established research discipline. It is also important that EER be recognised in the wider research community.

In addition, we suggest that the AAEE community may find it informative to use SDT as a framework to assess whether its activities are providing the opportunity and support to motivate

and enable novice and emerging researchers on their journey to achieving the required outcomes, to become recognised as being established in EER.

Conclusions and Recommendations

Helping novice and emerging Engineering Education researchers to develop their relevant professional networks is arguably the most important objective in supporting their transition to EER. Building their network and developing their research skills were the most frequent reasons respondents gave for enrolling in the AAEE winter school. A personal interest in teaching and Learning, and a desire to positively impact their students' educational experience were the most highly motivating factors reported by respondents for them to become involved in EER.

Respondents reported that a lack of local institutional support and members in their EER network were factors that inhibited their transition to EER. Attendance at Winter School facilitated the establishment of networks of supportive academics, and was seen by most participants as the best aspect of their attendance. This is especially important for participants who would otherwise lack this support.

These preliminary results reveal the importance of networking in events such as Winter School, which suggests that future programs aimed at supporting the transition to EER should consider expanding this aim. This could involve follow-up networking opportunities, or formalised processes for supporting collaborations that emerge. In addition, to assessing social relatedness, activities should also assess if they are providing opportunities to build and promote feelings of competence and autonomy as described by SDT, to enhance the motivation required for a successful transition to EER.

Future work will include examining other similar international programs for EER support to learn from and inform practice. It is expected that regional differences (such as variations in funding opportunities) may change why and how participants engage in these programs.

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