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Early Career Academics Transition into Engineering Education Research: AAEE Winter School Case Study

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ABSTRACT

CONTEXT:
Learning to become an engineering education researcher can be a difficult process to navigate. Training programs such as the Australasian Association of Engineering Education Winter School (AAEE WS) and others recognise this and thus prepare engineering researchers for transitioning into engineering education research (EER). EER covers all the diverse disciplines of engineering, which vary widely from the traditional engineering disciplines (e.g., civil, chemical, and mechanical engineering) to newer, emerging disciplines (e.g., biomedical, nuclear, and mechatronics engineering). This paper looks into the transition of early career researchers (ECRs) into EER through a case study that explores the experiences of three participants in the 2022 AAEE WS.

AIM:
The aim of the paper is for the authors to share their reflections on their experience and benefits of attending the 2022 AAEE WS and to investigate whether their experiences align with their background and engineering disciplines. We hope to inform other researchers thinking of attending the same program in the future and to provide recommendations to those considering organising similar intensive training and professional development programs.

METHODOLOGY:
In this study, we, as the participants, explored the 2022 AAEE WS as a case study. We used purposeful sampling as the participant selection method to enable diversity within the dataset without sampling the full cohort of attendees. The sampling of the authors allowed three distinct engineering disciplines, experiences, and locations to be explored. We reflected on our experience attending the WS, and then conducted a thematic analysis of the reflections to develop a means to help us understand the experiences ECRs go through to transition into EER.

OUTCOMES:
The three main themes identified through the thematic analysis were Knowledge, Growth, and Relationships, which aligned closely with Vygotsky's Scaffolding Theory. All three authors found great personal/professional benefits from attending the WS which facilitated their transitions into EER. Given the diversity of authors, we believe our findings would apply to anyone interested in entering the field of EER regardless of background. This collaborative paper has also achieved the AAEE WS's overarching outcome of fostering ECRs to perform independent EER.

CONCLUSIONS AND RECOMMENDATIONS:
The authors believe that attendance at the AAEE WS offers a myriad of benefits to participants, and that it has greatly aided them in achieving their personal and professional goals. The authors agree that the program has helped them achieve growth and confidence in becoming independent engineering education researchers, expand the boundaries of their knowledge, and foster new and meaningful relationships with the wider EER community. However, the authors recommend leveraging the collective experience of the participants in a more applied manner in the training sessions. We also suggest other EER centres put forward expressions of interest to organise/facilitate future WS programs; hence contributing collectively to more scholarship while gaining more experience in establishing such training programs.

KEYWORDS
engineering education, thematic analysis, self-reflection, professional development, training.

Introduction

Academics are busy individuals who must balance day-to-day responsibilities while they strive for productivity in their teaching, research, and service. They are also under immense pressure to achieve certain goals based on agreed-upon performance indicators, among which is developing and disseminating impactful research outputs. For early career researchers (ECRs), which include those who intend to develop skills in a new area of research such as engineering education research (EER), there is an immediate need for support, training, and professional development opportunities (Dart et al., 2021). Since EER is relatively new to many Australasian institutions (and other parts of the globe to a varied extent; Dart et al., 2021), support and training opportunities would help ECRs familiarise themselves with new expectations and ways of conducting research (Dart et al., 2019). The field of EER is concerned with better understanding and improving the process of knowledge formation in engineering. It encompasses not only how specific engineering concepts should best be taught, but also the design of learning environments and underlying curricula within which the teaching is embedded (Bernhard, 2015). These considerations extend across a broad range of engineering disciplines, from those considered more traditional (e.g., civil, chemical and mechanical engineering) to newer, emerging disciplines (e.g., biomedical, nuclear and mechatronics engineering).

The Australasian Association for Engineering Education (AAEE) is a professional association affiliated with Engineers Australia that unites and supports various stakeholders that share a passion for fostering excellence and innovation in engineering education. This is done through various events and programs, including the AAEE Academy of Early Career Engineering Educators (AECEE), the annual AAEE Conference, grants and awards, as well as the Australasian Journal of Engineering Education (AJEE). AAEE is the Australasian counterpart to engineering education-focused professional bodies found in other parts of the world, such as SEFI (Société Européenne pour la Formation des Ingénieurs) and ASEE (Society for Engineering Education).

AAEE has recognised that learning to become an engineering education researcher can be a difficult process to navigate in Australasia. One factor contributing to this is the relative youth of the field – engineering education has only just recently been assigned a formal Field of Research code by the Australian government (ABS, 2020). Another factor is the challenge of transitioning from a highly quantitative field to one that is more qualitative in nature (Dart et al., 2021). To help the field grow, AAEE conducts an annual week-long Winter School (WS) to introduce common approaches in EER. These more formalised professional development and training programs are “immersive experiences that bring together engineering educators and researchers wanting to enter into EER (and those who want a refresher) to learn about designing and undertaking effective education research projects, evaluating teaching and curriculum and positioning evaluation and research activities in light of current trends” (AAEE, 2022). Unlike SEFI’s (2021) similar Summer School, participation in the AAEE WS is not restricted only to PhD candidates. It is open to academics of all levels with an interest in pursuing EER.

This paper grew organically from a fortuitous meeting of its three authors after the 2022 AAEE WS. This program has been run by the University of Technology Sydney (UTS) since 2016 (Willey et al., 2022). Participants in the AAEE WS typically come from a diverse range of backgrounds and engineering disciplines, including PhD candidates and university lecturers with or without PhDs. These sub-cohorts bring their own personal and professional experiences to the WS and are strongly encouraged to share and learn from each other in a very welcoming and friendly (though professional) environment that fosters the participants’ development of EER skills. As such, the organisers of the WS face the ongoing challenge of curating content and activities that benefit the majority of the attendees, and providing the best platform to assist them in carrying out EER, related to their respective engineering disciplines. In the 2022 WS, there were a total of 17 participants who completed 17 sessions involving a range of presentations, group, pair and individual activities, and out-of-class exercises.

There exists a body of recent research on the benefits of professional development training (Kim et al., 2021; Hammack et al., 2020; Lamanauskas et al., 2020; Mesutoglu & Baran, 2021),

summer/winter schools (Bacharova et al., 2014; Dart et al., 2019; Dart et al., 2021; De la Fuente et al., 2020; Matemba et al., 2018), and conferences/workshops (Borrego & Bernhard, 2011; Johar et al., 2021; Tiwari et al., 2020; Tormey et al., 2020), on boosting the development rate of skills over a short, intense period. However, there is insufficient evidence on the broader outcomes of such training exercises (Collins et al, 2022) to judge and distinguish the most efficient type of program for a particular end goal (Kim et al., 2021). What is evident, however, is that the focus of such training programs has been shifting from teaching theoretical skills towards "facilitated learning by doing" approaches (Tormey et al., 2020), considering that there are greater benefits in enterprising learning modes compared to didactic/mechanistic approaches to teaching (Gibb, 1993). These new approaches include more flexible, informal learning environments, collaborative learning through debate and/or exchange of ideas, and applied problem-solving. As such, intensive training programs, such as the AAEE WS, theoretically provide excellent learning experiences and invaluable opportunities for participants to enhance their skills over a short, intense period. To determine alignment with the literature, we investigated the personal and professional benefits of attending the 2022 AAEE WS for three authors from diverse backgrounds, to answer to the research questions outlined below.

Aims/Research Questions

The authors' aims in this paper were to reflect on their experiences attending the 2022 AAEE WS, and to apply their learnings to relate any similarities/differences to their identities as engineering educators from different backgrounds and engineering disciplines. In doing so, the following research questions were considered:

1. What are the benefits of attending the AAEE WS in the context of working towards one's personal and professional goals?
2. Are there specific aspects of the AAEE WS that might better suit particular sub-cohorts of participants or ECRs?

The authors were intrinsically motivated and did not consider the intensity of the program a barrier to their success (White & Crowley, 2015). By sharing their reflections and findings, they hope to inform other researchers considering attending similar programs in the future and to provide recommendations to those considering organising similar intensive training and professional development programs.

Positionality Statements

The positionality statements for the three authors involved in the reflection and thematic analysis process are provided below, revealing their lenses and purposes for participating in the program.

Tina Baradaran is a PhD candidate in Nuclear Engineering Education Research (NEER) at the University of New South Wales. With a background in medical physics and science education, she identifies as a non-engineer and appreciates the differences between fields as she immerses herself in both science and humanities. Tina's prior research was in examining the radiation dose to the sensitive cells of the eye lens for patients undergoing external beam radiotherapy and the implications of the radiation. This work aligned with the positivist research paradigm. Tina soon found out that she was drawn to education and pursued a teaching career. She has previously taught physics to students at the secondary up to the tertiary level. She worked in the nuclear industry at the Australian Nuclear Science and Technology Organisation as an educator for three years before pursuing her NEER career. Tina is interested in innovation of education, particularly in the nuclear engineering discipline. She prefers to work with qualitative research methodologies and her research paradigm is transitioning to be aligned closely with the interpretivism paradigm.

Lionel Lam is a Lecturer/Teaching Fellow within the Department of Biomedical Engineering at the University of Melbourne. In comparison with traditional Teaching and Research positions, this role has a heavier teaching load but a dialled-back research component that revolves around EER. Prior to starting this role, Lionel completed his PhD in Chemical Engineering, focusing on the development and application of ex vivo single-cell assays to better understand differential responses to specific immunotherapies. This work fell under the positivist research paradigm, with an emphasis on the

scientific method and associated quantitative analysis approaches. While most of Lionel's experience has been in academia, he has about two years of industry experience as a research consultant in food science, pharmaceutics, and wastewater treatment. While he has published some studies into transdisciplinary curriculum design, he is still navigating his transition into EER, primarily by familiarising himself with the interpretivist research paradigm more common in EER, along with its bevy of accompanying qualitative methodologies.

Saeed Shaeri worked in the industry as a coastal/water engineer for about 16 years before starting his teaching career. He is a civil engineering lecturer at Charles Sturt University – a regional university with campuses across different states, and currently works as a learning and teaching quality Academic Lead. Saeed is interested and inclined to conduct research with a mixed method as he believes there is always important quantitative information that could assist in interpreting the qualitative evidence and vice versa. Hence, Saeed finds himself to be following a pragmatism research paradigm. While he has published a few EER conference papers, he considers himself an ECR in completely transitioning into EER. Saeed's research interests/topics are authentic assessment, methods/tools to enhance students' motivation and engagement, and learning analytics. Saeed is a Fellow of the Higher Education Academy (FHEA), and serves as a peer reviewer for a number of higher education journals.

Methodology and Theory

This paper looks into the transition of ECRs into EER through a case study that explores the experiences of three participants of the 2022 AAEE WS. Case studies have had a long and effective history in many fields such as education, business, law, and medicine (Davis and Yadav, 2015), and it has remained popular since it directly relates to the real world and engages in solving authentic problems. In the case study for this paper, purposeful sampling was used as the participant selection method to enable diversity within the dataset without sampling the full cohort of the WS. This purposeful sampling explored the authors' three distinct engineering disciplines, experiences, and locations, as outlined in their positionality statements in the preceding section.

After an initial conversation around the idea behind this research paper, each author reflected individually on their experience of the WS. These reflections (between about 870 to 1200 words) were left open to cover any topics and to ensure that responses were unconstrained and authentic. However, the reflections were later considered final, without being influenced or changed by subsequent conversations/discussions around the research questions and the thematic analysis process outlined by Braun and Clarke (2006). Each author read and familiarised themselves with the other two reflections before administering coding and conducting thematic analysis. This process allowed the identification of overarching patterns within the datasets, which helped to pinpoint codes/themes in response to the research questions.

The authors then discussed their identified codes/themes, allowing a collective thematic analysis and consolidation of the major emergent themes to be achieved. This process was used to assure coding reliability by aligning identified codes with the major themes. While a limitation of thematic analysis is the possibility of excluding key themes due to limited occurrences in datasets with small sample sizes and different narrative approaches, this was considered carefully during the coding stage, as well as a 'critical friend' phase. Here, the identified codes/themes were shared with another WS participant to receive critical external feedback. Hence, the thematic analysis was an iterative and cyclic process that happened individually for the first iteration, collectively for the second iteration, checked against an external participant for the third iteration, and collectively again with all three authors for the fourth and final iteration.

Lastly, Braun and Clarke's (2006) thematic analysis method aligns with Vygotsky's Scaffolding Theory (VST). One major concept of VST is the idea that the potential for cognitive development depends upon the individual's 'zone of proximal development' (ZPD). That is, for a complete development of the ZPD, there needs to be social interaction. In this context, the whole week at WS was scaffolded where participants were able to build up a range of skills with instructor guidance and peer collaboration exceeding what could be attained alone (Fani and Ghaemi, 2011). Therefore,

adopting the VST and the concept of ZPD served as an important tool and framework to explore the study's research questions.

As this project used a dataset consisting of only its authors' contributions, this resolved the need for multi-institutional ethics approval, and mitigated the risk with power dynamics and privacy and confidentiality. Moreover, a discussion of informed consent was held throughout the process, ensuring all involved were comfortable with the research approach.

Results

The results of the thematic analysis are summarised in Table 1.

Table 1: Themes/Codes derived via thematic analysis of reflections.

Codes	Themes
Experience	**Knowledge**
Knowledge Consolidation	
Peer Sharing	
Emotion	**Growth**
Identity	
Transition	
Diversity	**Relationships**
Engagement	
Peer Understanding	

The most significant theme identified is 'Knowledge' which correctly represents the importance of knowledge and experience sharing in these types of training programs (as is also depicted in Dart et al., 2021), and their influences on the consolidation of knowledge. Considering the three codes in this theme, the sharing of ideas, methods, approaches, theories, models, and basic concepts proved to be an important factor in the authors' evaluation of the program's success:

> *I loved being able to network with engineering education researchers from other institutions, sharing and discussing ideas and seeding possible collaborations.*
>
> *Outside the speakers' sessions, we had time to take what had been shared and talk with our peers about it … to improve our work and better design our research … Together we worked to give each other feedback on our projects and what is important for us, what impacts us, why we care about this research and what we want to achieve.*

The reflections revealed that this collegial and collaborative attitude was present not only among the authors, but also in the program's facilitators/presenters who demonstrated generosity in the dissemination of information (Matemba et al., 2018):

> *So, over the breaks, I was not hesitant to approach them for a short chat ... Most of the presenters were established researchers with years of engineering education experience … there was always an aspect of their work that could help me answer my questions.*

By immersing themselves in the content and discussions, the authors were able to enhance their knowledge and consolidate fragmented concepts, providing more definition to the start of their journey into EER (Dart et al., 2019):

> *Many things stood out to me such as understanding methodology and the role of methodology in understanding your research.*
>
> *By discretising the steps of the research process in engineering education and dissecting each step in detail, it has allowed me to grasp the links between theory and methodology that I've always found nebulous prior to this.*
>
> *That has provided me with a great opportunity to understand what different types of work are done both at the teaching level and in the HDR space.*

The authors were also able to identify strategies to achieve even better outcomes with the training program. One such supporting excerpt reads:

I did feel that there should have been more of these discussion-based activities, especially ones centred on the participants' research questions...

'Growth' emerged as the second theme. Specifically, all three authors stressed aspects of the program relating to their 'Transition' to EER. This is in line with the objectives of the program to provide opportunities for networking and the exchange of ideas, and to empower its participants with familiarity with EER (AAEE, 2022):

I personally found it very reassuring to be able to hear from more experienced academics that the discomfort I've been feeling through this transition is valid and normal.

… there were also a number of (semi) free conversation times … very useful in helping me reshape my identity as an engineering education researcher, regain my confidence that I could … and re-adjust my direction moving forward.

After spending some time with the Engineer Education focused academics … I went away with way more to think about to craft a strong research focus … It gave me a whole different 'lens' to approach EER.

There were also elements of identity development and overcoming uncertainty/unhelpful emotions (Gardner & Willey, 2018):

I initially found it challenging as I attended without any particular project in hand. However, I was able to develop a few ideas, and based on certain activities, narrow down or polish my scope to make it more realistic and plausible.

…. I realised that there are aspects that I was not aware of; but I knew that I was eager to know about them more… I am very pleased that I was able to attend this winter school program, and … to get exposure to the resources and tools that I need, as well as other like-minded people.

The final identified theme was 'Relationships'. Within this theme, 'Engagement' stood out more than the other codes, once again aligning well with both the learning outcomes of the program and its underlying pedagogical approach (AAEE, 2022; Dart et al., 2021):

I found the first two days especially helpful … [covering] the stages of engineering education research, outlining the expectations and considerations of each stage … the two main research paradigms … the icebreaker activities on the first day … rich discussions of research interests.

A structured cloud-based databank was shared with the participants, containing all the required material for each day and session. These include relevant journal papers, reports, etc. as well as the presentation slides (which were mostly rich with hyperlinks and references).

… in almost all the cases, the facilitators/presenters encouraged participants to move around, find new people, and join new groups. That was an effective strategy that helped me to know most of the participants in a faster way …

'Diversity' amongst the participants as well as the program's facilitators/presenters was also identified as a key feature (as it was also noted in Dart et al., 2019):

I got to know participants who were teaching in various engineering disciplines, with or without engineering degrees. Some of the participants have a strong, long-standing industry experience … Some others were PhD candidates ... This group was also able to bring an interesting lens to many of the discussions …

What can be said is that overall, the authors' reflections portray the success of the program and its importance for ECRs entering and transitioning into the field of EER:

I'd highly recommend AAEE Winter School for anyone involved in engineering education practice and research to attend at least once in their career.

In conclusion, participating in the … Winter School … has been a great experience … has given me more confidence in my abilities to navigate the transition from technical to qualitative research.

Discussion

The three themes identified through the thematic analysis process can be understood in the context of VST and the concept of ZPD (Fani and Ghaemi, 2011). Here, the growth experienced by all three authors was facilitated by 'more knowledgeable others' targeting their ZPDs. This was evident in the references to 'established researchers with years of engineering education experience', as well as the repeated mentions of growing more comfortable with new ideas (e.g., qualitative methodologies and new research paradigms) through reflection, sharing, and discussion. Here, this growth was not catalysed just via interactions with the program's facilitators/presenters but via interactions with fellow participants, all of whom hailed from different backgrounds and engineering disciplines, and each of whom had a passion and/or depth of knowledge in a specific area of EER. These were useful in helping the authors process their emotions in the challenging transition in identities from technical to engineering education researchers (Gardner & Willey, 2018). All three authors alluded to having a boost in confidence after being able to observe and learn from more experienced academics who were clearly thriving in EER.

The 'Knowledge' theme also clearly aligns with the scaffolding theory. Where 'Growth' theme can be understood more as personal or professional growth, in the sense of growing to become more confident and adept engineering education researchers, the theme of 'Knowledge' encapsulates the more theoretical and defined body of knowledge surrounding EER (Dart et al., 2021). This includes, but is not limited to, familiarity with the research pipeline in EER, theories, methodologies, and research instruments. Again, the authors' reflections reveal that much of this knowledge was transmitted through meaningful interactions with 'more knowledgeable others', either with the program's facilitators/presenters or with other participants (Dart et al., 2019; Matemba et al., 2018).

The 'Relationships' theme can also be viewed through the lens of scaffolding theory. The three authors did not know each other before the 2022 AAEE WS, and this paper only came to fruition in no small part due to the efforts and guidance of the program's facilitators/presenters. Here, instead of simply assuming that participants would engage naturally in networking and collaboration, the program scaffolded the icebreaking process with interactive activities. These included activities where the participants had to rate themselves along a spectrum (e.g., quantitative vs. qualitative researchers), with follow-up and probing discussions, as well as activities, where participants were encouraged to simulate and reflect on the implementation of specific research instruments (e.g., surveys, observations, and interviews). One activity that stood out was when participants were tasked with first fleshing out their research question(s) on paper, before engaging in 'speed dating' with other participants (and the facilitators/presenters) and pitching their research. This activity aided in engagement and networking across the diverse WS cohort and allowed participants to gain a better understanding/acceptance of their peers' interests.

Addressing this paper's research questions, the authors feel that attendance at the AAEE WS offers a myriad of benefits to participants who go in with an open mind, and that it has greatly aided them in working towards achieving their personal and professional goals. The authors agree that the program has helped them achieve growth, expand the boundaries of their knowledge, and foster new and meaningful relationships with the wider EER community. The reflections did not reveal the program to be better suited for participants with a specific background/field of expertise. Instead, taken together, they suggest that the program would be useful for anyone (e.g., academics vs. those with extensive industry experience, PhD candidates vs. established academics) interested in becoming more adept at EER, with the benefits being discipline-independent. However, the authors acknowledge some limitations in their study. That is, the discussions and reflections are limited to the authors' views whom all acknowledged the benefits of the 2022 AAEE WS before attempting to write this paper. Hence, the results could be biased to some degree. The authors also do not regard themselves as typical or representative of the participants in the 2022 AAEE WS. Their shared agenda for this paper was to reflect on their experience with the program and to share this with a broader audience.

Conclusion and Recommendations

Thematic analysis of the authors' reflections on the 2022 AAEE WS revealed emergent themes of 'Knowledge', 'Growth', and 'Relationships'. These can be understood in the context of VST, where participants in the WS were guided by 'more knowledgeable others' to explore new ideas and possibilities by stepping into their ZPDs. The authors agreed that despite coming from varied backgrounds and engineering disciplines, the 2022 AAEE WS was very useful in helping them work towards their personal and professional goals, at least in the short term. Here, the diversity in participants was beneficial, as it provided opportunities for richer and more inclusive discussions and deliberations. The authors strongly believe that the benefits of attending the AAEE WS are independent of background and would be applicable to anyone interested in entering EER. For further research, other comparable training and professional development programs should be investigated to explore their participants' experiences with them. This paper was prepared shortly after the 2022 AAEE WS, and the authors acknowledge that their reflections on the program might change with time. It would be worth reviewing the long-term impacts of attending the AAEE WS on the authors' career trajectories in EER. In going through the reflections as part of the thematic analysis process, the authors identified particular excerpts that did not stand out as codes/themes, but as recommendations:

> *… it would have been good to perhaps leverage the experience of the participants present, for example getting someone with prior experience in surveys and interviews to discuss how they went about setting these up for one of their research projects.*
>
> *… while the program has been run well overall for many years, it might be a good idea to rotate the organising committee every year … to avoid stagnation and to give … other institutions the opportunity to experience the growth that comes with running a program such as this.*

The first excerpt suggests that much of the theoretical content covered in the middle of the program might be made more interactive in future iterations, delivered in more of a 'guide on the side' rather than a 'sage on the stage' manner. Here, the authors suggest that the collective experience of the participants would be leveraged to explore the content in a more applied manner, instead of the relatively one-way knowledge transmission mode that some of the sessions suffered from. The authors also suggest that other EER centres or communities in universities across Australasia consider expressing interest to organise/facilitate future WS programs. This would ensure that the ideas discussed remain current (as is desirable in all fields of research) and would allow for other institutions and upcoming early career engineering education researchers to gain experience in establishing similar training programs, and achieve higher impact scholarship.

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