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Becoming an engineering education researcher through a kaleidoscope of practice theory perspectives

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Abstract:	<p>There is a considerable body of literature on the challenges that are encountered in the transition from technical engineering research to engineering education research. These challenges include conceptual difficulties, shifts in identities and in paradigms, and changes of cultural and social capital. Many of the studies in this area emphasise the importance of having a network of engineering education researchers, but there is little research on what such a network would look like. Our research builds on this by investigating how the Centre for Research in Engineering & IT Education (CREITE) has established conditions which enable the development of engineering education research capabilities across several universities in NSW.</p> <p>Our novel research approach views six case studies of CREITE members through the lens of three practice theories: community of practice (Lave & Wenger, 1991); Bourdieu's theory of practice (1986); and the theory of practice architectures (Kemmis et al., 2014). The findings reveal a kaleidoscopic understanding of what constrains and enables engineering educators to engage with the field of EER, and the pivotal role played by a research group such as CREITE.</p>

Becoming an engineering education researcher through a kaleidoscope of practice theory perspectives

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Abstract

There is a considerable body of literature on the challenges that are encountered in the transition from technical engineering research to engineering education research. These challenges include conceptual difficulties, shifts in identities and in paradigms, and changes of cultural and social capital. Many of the studies in this area emphasise the importance of having a network of engineering education researchers, but there is little research on what such a network would look like. Our research builds on this by investigating how the Centre for Research in Engineering & IT Education (CREITE) has established conditions which enable the development of engineering education research capabilities across several universities in NSW.

Our novel research approach views six case studies of CREITE members through the lens of three practice theories: community of practice (Lave & Wenger, 1991); Bourdieu's theory of practice (1986); and the theory of practice architecture (Kemmis et al., 2014). The findings reveal a kaleidoscopic understanding of what constrains and enables engineering educators to engage with the field of EER, and the pivotal role played by a research group such as CREITE.

1 Introduction

The journey into engineering education research has been researched from several perspectives, in part at least because it involves a significant shift in research paradigms (Borrego, 2007), identity development (Gardner & Willey, 2018), community (Mann & Chang, 2012), boundary crossing (Rodrigues, Paul, & Cicek, 2021) and habitus, field and capital (Dart, Trad, & Blackmore, 2021). However, there has been less exploration of the conditions that enable or constrain such shifts, and the practices that allow engineering education research capabilities to flourish. In this paper, we take a novel approach by considering these conditions and practices through a kaleidoscopic lens of three separate but complementary practice theory perspectives: Bourdieu's theory of practice; Kemmis and colleagues' theory of practice architectures; and Lave and Wenger's community of practice. In particular, we consider the affordances of a collaborative, multi-institutional research group to enable and sustain engineering education research practices. To investigate this phenomenon, we have invited six participant co-researchers to share their stories of how they came to be involved in engineering education research, and in the Centre for Research in Engineering and IT Education (CREITE). We analyse the stories through the prisms of the three practice theory

1 perspectives, to provide an understanding of the appeal of engineering education research and an
2 introduction to working with practice theories.

3 *Engineering education research journeys*

4 There is no defined path into engineering education research (EER); however, the literature does
5 highlight some common threads amongst a variety of journeys and experiences. Those open to
6 multiple perspectives tend to be drawn into EER (Allendoerfer, Adams, Bell, Fleming, & Leifer, 2007)
7 and many researchers move from their discipline-based technical engineering research (TER) into
8 EER out of a desire to improve engineering teaching practice (Dart et al., 2021; Rodrigues et al.,
9 2021; Williams & Figueiredo, 2012).

10 This move can be particularly challenging due to the shift from quantitative to qualitative data
11 analysis and the different approach to viewing research design and validity, as well as the lower
12 value often ascribed to EER than TER (Dart et al., 2021). Borrego (2007) highlights the need for
13 engineering educators to make an epistemological paradigm shift from positivist to interpretivist if
14 they wish to undertake EER and the perception that qualitative research methods associated with
15 EER are less rigorous than those of TER. She also points out the perceived importance of rigour for
16 engineering educators, implying that if EER is not made explicitly rigorous, it will be devalued or
17 dismissed by engineering educators, especially those engaged in TER. Interestingly, TER does not
18 apparently need to establish its rigorous practices – they are taken as given. The relatively low status
19 of educational research in engineering faculties is noted by Gardner and Willey (2018) as a key driver
20 of factors such as senior (faculty) management support and funding for TER over EER, as well as for
21 greater promotion opportunities for those involved in TER.

22 Furthermore, there is also difficulty in navigating the shift from being an expert in a technical
23 discipline to a relative novice in engineering education (Gardner & Willey, 2018). To alleviate
24 unfamiliarity with education theories, Borrego (2007) proposes that engineering educators
25 collaborate with researchers outside the field of engineering; however, Wankat, Felder, Smith, and
26 Oreovicz (2002, p. 234) highlight the difficulties faced when EER involves “...collaborations...
27 between engineers and social scientists, who frequently have different vocabularies, priorities, and
28 conceptions of research”. These tensions may partly explain the tendency for those more
29 comfortable with multiple perspectives to engage with EER.

30 Entry into EER is often driven by academics needing to meet institutional research requirements,
31 particularly where funding is limited and EER is seen as a low-cost approach to meeting these
32 requirements (Williams & Figueiredo, 2012). Furthermore, EER networks are a common entry point
33 for emerging researchers into EER, despite local and institutional support often being lacking or
34 inconsistent (Allendoerfer et al., 2007; Gardner & Willey, 2018; Williams & Figueiredo, 2012).
35 Rodrigues et al. (2021) agree with the need for a network to facilitate connections with other
36 engineering education researchers, and emphasise the critical role performed by mentors and role
37 models in bringing people into EER and supporting them in the early stages. Allendoerfer et al.
38 (2007) and Rodrigues et al. (2021) also highlight the role of luck (which they refer to as “intentional
39 serendipity” and “happenstance” respectively). A number of engineering education researchers
40 believe this luck plays a significant role in guiding them into EER; however, there is often evidence of
41 intent alongside this luck, such as taking steps to meet key colleagues or being open to new ideas
42 (Allendoerfer et al., 2007).

43 *A short history of CREITE*

44 The Centre for Research in Engineering and Information Technology Education (CREITE) has its
45 origins from 2016 as fairly informal meetings of like-minded engineering academics at the University
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1 of Technology Sydney (UTS) interspersed with events hosted at the University of Sydney. Despite
2 having *Centre* in its title, CREITE does not have official status as a 'research centre', as that would
3 necessitate meeting key performance indicators in research income that are not achievable in the
4 Australian funding landscape for discipline-based education research. Instead, its status is as a
5 departmental research group.
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7 The original co-ordinator was Anne Gardner, with other members providing coordination duties as
8 required. CREITE membership is now approaching seventy members. These range from PhD students
9 to full Professors and, although being primarily drawn from the founding universities UTS and the
10 University of Sydney, the Centre boasts members from across the Sydney region and beyond,
11 including from the University of New South Wales, University of Newcastle, and Charles Sturt
12 University. Despite COVID restrictions now having been largely lifted, most meetings have remained
13 online to facilitate the continued engagement of the dispersed membership.
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16 CREITE hosts monthly meetings with activities including, e.g. guest speakers discussing EER
17 methodologies or research projects; peer feedback sessions on draft abstracts or conference
18 presentations; interactive sessions on different skills and approaches in EER (e.g. reviewing journal
19 manuscripts). Attendance ranges from 10 to 20 participants, with a small group that attends almost
20 every session and a larger membership that attends depending upon schedule and interest.
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23 *Practice theory perspectives*

24 Practice theory has emerged from several different theorists: e.g., Bourdieu, Kemmis and Schatzki,
25 underpinned by the thinking of Heidegger and Wittgenstein (Schatzki, 2012, p. 13). The term
26 'practice theory perspectives' is used to acknowledge that there are various approaches taken to
27 theorise practice which have emerged from different research streams. There are thus distinct
28 differences with each practice-based approach having "its own history, vocabulary, and set of basic
29 assumptions" (Nicolini, 2012, p. 9); however, are similar in that they work to uncover "[d]eeply
30 embedded beliefs and taken-for-granted discourses" (Salamon, Sumsion, Press, & Harrison, 2016, p.
31 1) which underlie many practices. Uncovering these practices and making them more visible can
32 provide opportunities to challenge or rethink practices that are unhelpful or damaging.
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37 The emphasis on practices rather than on practitioners can allow a new way of looking at the
38 elements of a practice, and can shift the focus away from individual practitioners while still
39 acknowledging their agency. Having practice as the unit of analysis acknowledges the situatedness of
40 practices – that they belong to a particular place and time, and unfold in ways that are shaped by
41 specific conditions (Kemmis et al., 2014) or arrangements (Schatzki, 2012). As noted by Boud and
42 Brew (2017, p. 81), practice is co-constructed and thus "[d]iscussion of practice in isolation from
43 practitioners or sites of practice is to misunderstand the nature of practice". Thus, focusing on the
44 practice allows researchers to consider the interactions of objects, organisations, people, processes,
45 relationships, rules and specific situations when developing an understanding of dynamic practices.
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51 The following paragraphs provide a snapshot of the three perspectives; we then outline our
52 approach to the current study and provide an analysis of our data through the lens of each
53 perspective.
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55 *Community of Practice*

56 Lave & Wenger were instrumental in developing the theories underpinning community of practice
57 (CoP), and predicate communities of practice on the principle of situated learning, where: "agent,
58 activity and the world mutually constitute each other" (1991, p. 33). They developed the notion of
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1 communities of practice in concert with their work on legitimate peripheral participation (LPP),
2 which explores the social aspects of learning as a wider understanding of 'apprenticeship'.
3 Legitimate peripheral participation explains the idea of novices being on the periphery of a practice,
4 and gradually being inducted into fuller forms of participation as they acquire greater skills and
5 knowledge of those practices. Learning is central to the theory of LPP, but it is 'situated learning' –
6 the learning of the activities that are part of the practices. As Nicolini points out: "With LPP theory,
7 the analytical focus shifts from learning as an activity performed by the individual to learning as a
8 mode of participation in the social world" (2012, p. 82).
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11 A CoP comprises the *domain*, the *community* and the *practice*. The *domain* is the realm or site of
12 practices, such as becoming butchers in supermarkets (Lave & Wenger, 1991) or becoming
13 researchers in EER. The *community* are the people who are connected by their interest in the
14 domain. Within a CoP, members learn through the process of sharing of knowledge - novices learn
15 from more experienced members, whilst also allowing the more experienced members to learn
16 through consolidation of their knowledge. The *practice* in a CoP is the shared focus of the
17 community, which develops over time and through sustained interaction of its members – it includes
18 the shared resources, interactions and language of that community: "a shared repertoire for their
19 practice" (Wenger, 2006, p. 2). Although a CoP is situated in a shared social and cultural context, the
20 communities of practice lens asserts that it is only through the interactions between members that
21 practice is shaped. As a result, it has been suggested that communities of practice may be better
22 suited to environments that allow autonomy, have a practitioner orientation, are informal and allow
23 crossing of boundaries (Wenger, 2006).
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28 *Bourdieu's Theory of Practice*

29 Bourdieu's theory of practice has been used extensively as a way of understanding social life through
30 a practice lens. Bourdieu viewed social life as unfolding in "*cultural and symbolic, economic and*
31 *social fields and capitals*" (Kemmis, 2022, p. 75, emphasis in the original). Power and contestation
32 are central to his work: the study of practice reveals sites of contestation and ongoing struggles for
33 domination. The three key elements of his theory are: Field, Habitus and Capital, and these combine
34 to form practice. According to Bourdieu, (Habitus X Capital) + Field = Practice (Bourdieu, 1984, p.
35 101, in Nicolini, 2012, p. 59); thus, all three elements need to be analysed in concert with one
36 another to have a full understanding of practices, and of social life.
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40 Habitus as explored by Bourdieu is a concept that is widely applied in several disciplines, although it
41 is notoriously difficult to define. It is variously described as a form of knowing in practice, the feel for
42 the game, "a way of being in the world" (Nicolini, 2012, p. 56). We acquire habitus mostly through
43 our upbringing, but also through other forms of socialisation (e.g. the habitus we acquire at
44 university or in the workplace). Habitus is a group or a class phenomenon (Nicolini, 2012, p. 60) so a
45 person is always sharing habitus with other group members (class, family, club membership), and as
46 habitus is shaped by field, it also reproduces the field. All capital is seen by Bourdieu as being
47 symbolic, and, in the case of academia, comes in the form of academic, scientific and intellectual
48 capital within disciplines. Academic capital refers to "control over academic resources", which could
49 include access to sites of research; scientific capital relates to "research reputation", and intellectual
50 capital is seen to be generated by scientific capital, as it refers to "the ability to influence public
51 opinion" (Bourdieu, 1996, as quoted in Mendoza, Kuntz, & Berger, 2012, p. 561). Field is a structured
52 social space, containing social agents who dominate or who are dominated, and where there is
53 constant contestation to preserve or to transform the field (Bourdieu & Wacquant, 1992). In our
54 study, the field is engineering within universities. The struggles of agents to make their respective
55 forms of capital more highly regarded allow an understanding of why there is frequently such
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1 tension between TER and EER. Through a Bourdieusian lens, it is not only that EER is
2 paradigmatically different from TER; it is in competition with TER to be seen as “the dominant
3 measure of achievement” (Maton, 2005, p. 690).

4 *Theory of Practice Architectures*

5 The theory of practice architectures (TPA) shifts away from the individual practitioner and towards
6 understanding a practice in the specific site where practitioners encounter each other in their
7 practice. The practice can be understood through the practice architecture, comprised of
8 interconnected environmental factors that are the cultural-discursive (language), material-economic
9 (work) and social-political (power) arrangements which are found in or brought to the site (Schatzki,
10 2002). Gardner, Goldsmith, and Vessalas (2016) propose considering the practice architecture as a
11 system and the arrangements as elements of the system—and so TPA can therefore be considered
12 as the application of systems thinking to practice.
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16 These arrangements shape practice through enabling or constraining practice, namely what can be
17 said (sayings), what can be done (doings) and how to relate to others and the world (relatings)
18 respectively. These sayings, doings and relatings are, however, not only influenced by the site
19 arrangements but also, in turn, influence the nature of the site arrangements. The
20 interconnectedness of the different components of practice (namely the site, its arrangements, as
21 well as its allowances and constraints) echoes Senge’s (1990, p. 68) description of systems thinking
22 as “a framework for seeing interrelationships rather than things”. These interrelationships
23 necessitate focusing the lens of theory of practice architecture on how a specific combination of
24 arrangements contribute to shaping how practice occurs in a particular site (Schatzki, 2010), and it is
25 only through the focus on the nuances of a specific site that specific sources of influence can be
26 identified and their significance analysed and understood. In this approach, TPA makes practices
27 visible to illustrate what makes them possible, to support the adaptation and improvement of
28 practices (Kemmis & Edwards-Groves, 2018). Furthermore, TPA highlights that sustainable
29 transformation of practice requires effecting change in not only the practice, but also the
30 arrangements that enable or constrain the practice (Kemmis et al., 2014).
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37 *A brief comparison of the practice theory perspectives*

38 All three practice theory perspectives provide ways of understanding the world through analysing
39 practices rather than individual behaviours, and put practice at the centre. However, while the
40 communities of practice lens focuses on the internal workings of a group and relationships between
41 its practitioners, Bourdieu’s theory of practice lens and TPA lens recognise the effect of external
42 structures upon practice. These are respectively the field in Bourdieu’s theory of practice and
43 practice architectures in TPA (Fig. 1). These external structures can overlap; for example, power and
44 resources play a role in both the field and arrangements. However, whereas power is central to
45 Bourdieu’s theory of practice and intrinsically associated with competition, power is present in only
46 one of the arrangements of TPA (social-political), acting as both an enablement and a constraint on
47 practices. Similarly, resources in the form of capital are a source of competition in Bourdieu’s theory
48 of practice, whereas resources are one part of the material-economic arrangements, and can enable
49 some practices while constraining others. For instance, the scarce resource of time in one’s research
50 allocation may enable practices that constrain the collection and analysis of qualitative data while
51 enabling the collection and analysis of quantitative data.
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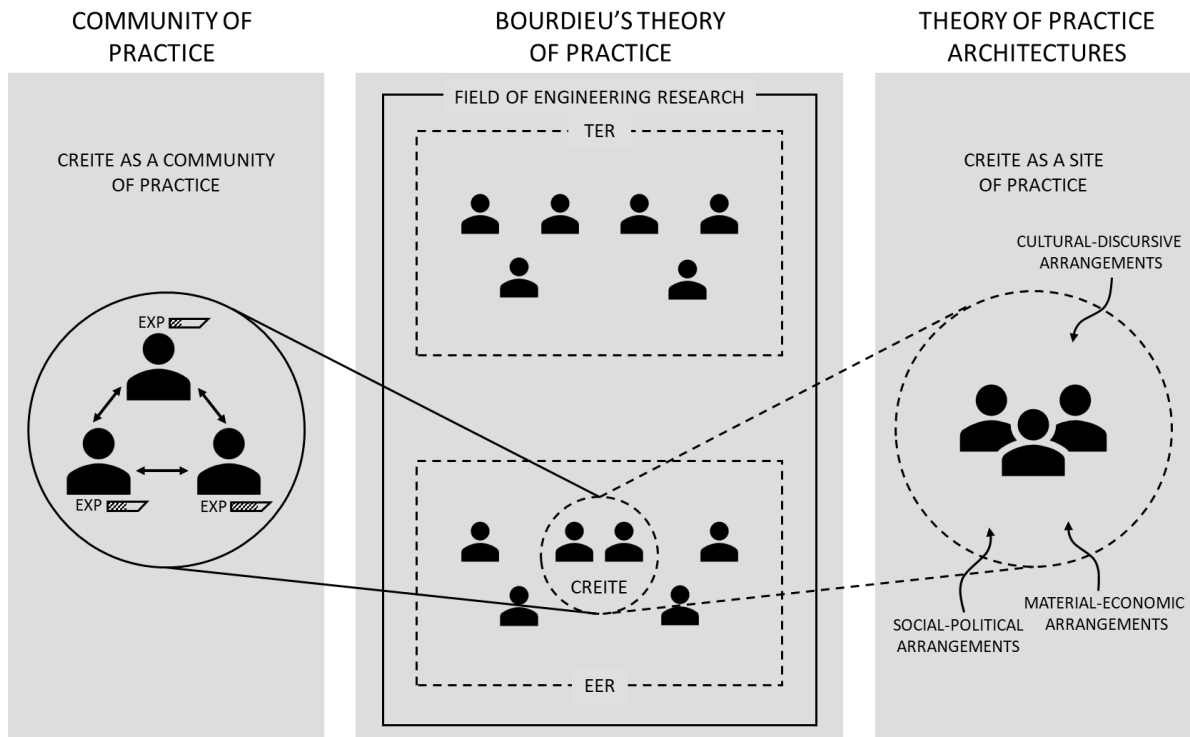


Figure 1: Diagram of the three practice theories as applied to CREITE (where dashed lines indicate exposure to external influences)

Communities of practice explores practice as the sustained focus of a group of practitioners, with individual practice shaping and being shaped by other practitioners within the community. Whilst issues of power may arise, they are only interpreted at the level of interpersonal interactions. The concept of LPP is that of the process of absorbing and being absorbed into a practice: how participation in a practice, from the periphery to full participation enables the learner to acquire expertise. Thus, it sees learning as more a process of socialisation than a cognitive process (Lave & Wenger, 1991; Nicolini, 2012).

Similarly, Bourdieu's theory of practice explores the experience of social agents but, in bringing their dispositions through the concept of habitus, moves away from concentrating on only their interactions within a group of practitioners. Bourdieu's theory of practice also acknowledges the effect of context on practice through the field and capital that influence the behaviours and practices of these individuals. In contrast to CoP and TPA, contestation for power underpins this theory, as is reflected in the language used to describe it: the social arena, the feel for the game, the competition for capital.

As with Bourdieu's theory of practice, TPA explores the context and conditions that shape the practice. However, in contrast to both communities of practice and Bourdieu's theory of practice, which are interested in the experiences of individual practitioners, TPA focuses on the extra-individual, investigating the intersection of multiple practitioners and the landscape that shapes their shared practice. TPA understands the site-specific nature of practices and the arrangements that shape and are shaped by them.

As a result, each lens highlights different aspects of practice; for example, communities of practice as a lens facilitates analysis of the persistence of current practice, while the TPA lens facilitates analysis of the potential for change from current practice. Bourdieu's theory of practice lens enables an understanding of power in practices. Furthermore, TPA provides not only a theoretical lens (as in

1 communities of practice and Bourdieu's theory of practice), it also guides the exploration of
2 connections between practice and arrangements and hence provides a methodological approach to
3 analyse sites of practice.

4 Utilising these three perspectives as theoretical lenses, we have explored the following research
5 question:
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7 *How does the use of three complementary practice theory perspectives (Bourdieu's theory of practice, the*
8 *theory of community of practice, and the theory of practice architectures) generate novel insights about*
9 *the journey to EER and CREITE?*
10

11 **2 Positionality**

12 Many scholars have argued for the importance of researcher reflexivity when conducting qualitative
13 research, such as our study as motivated by the above research question. For example, Hampton,
14 Reeping, and Ozkan (2021, p. 127) warn that "not considering how one's position influences a
15 research design can become a threat to the result's credibility". This need is often operationalised
16 with the inclusion of positionality statements in research publications, where positionality has been
17 defined as "the stance or positioning of the researcher in relation to the social and political context
18 of the study (the community, the organization, or the participant group)" (p. 126). It is important to
19 be transparent about researcher positionality because it "affects every phase of the research
20 process, from the way the question or problem is initially constructed, designed, and conducted to
21 how others are invited to participate, the ways in which knowledge is constructed and acted on and,
22 finally, the ways in which outcomes are disseminated and published" (Rowe, 2014, p. 678).
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28 **Our Positionality**

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30 In one sense, given that the data for our study is solely comprised of retellings of our own
31 experiences and perspectives on the transition into EER (i.e. how we relate to the phenomenon), it
32 can be considered as an analysis and synthesis of our positionality statements. To pre-empt that
33 level of detail, Table 1 gives an introductory overview of our involvement with EER and our
34 relationship with CREITE.
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37 *Table 1. Positionality of the authors*

38 Author	39 Relevant training/qualifications	40 Connection to CREITE	41 Involvement with engineering education community	42 Current role & institution
43 Rosalie	44 BA (Hons) English; Grad. Dip. Ed. ESL/English; MA Applied Linguistics; MA International Development; PhD Engineering Education	45 Current coordinator	46 14 years	47 Senior Lecturer, Academic Language & Learning, University of Technology Sydney
48 Guien	49 Bachelor of Engineering (Civil)/Arts PhD in Civil Engineering Graduate Certificate in Educational Studies (Higher Education)	50 Current coordinator	51 5 years	52 Learning Designer, University of Technology Sydney
53 Scott	54 BSc(Hons) physics, BA maths, GradDipEd maths and science, GradDipSciComm, PhD engineering education, GradCertT&L	55 Current coordinator	56 10 years	57 Senior Lecturer, Humanitarian engineering. University of Technology Sydney
58 Anne	59 BE(Civil)(Hons), MEngStudies, PhD engineering education	60 Previous coordinator	61 17 years	62 ADTL faculty of Engineering & IT, University of Technology Sydney

Paul	BE(Mech), Grad Cert in Educational Studies (Higher Education)	Member	7 years	Lecturer Mechanical Engineering, University of Sydney
Hua	Bachelor of Engineering (Electrical), Master of Philosophy (Electrical Engineering), PhD candidate	Member	2 years	PhD student, UNSW

During discussion between the author team, we reflected on how our engineering bias towards outcomes and expedience led us to adopting practice theories. Practice theories are less epistemologically driven, less focused on how we come to know things about EER, and more ontologically-focused, about helping us understand how our practices are shaped by our contexts, which aligns with our pragmatic interests in the topic. This is explained further by Wilkinson: "Practice architectures theory, like other theories in the family of practice approaches, employs an ontological lens to its study of practice. That is, its "main concern is with what practices are, how practices happen; how they are shaped, constrained and enabled; and what practices do. These are ontological questions" (Mahon et al., 2017 in Wilkinson, 2021, p. 130). In the context of our study, we were exploring what conditions enabled and constrained our practices of engineering education research, and how the practice landscape, or field, in which we practise, shaped and continues to shape our practices.

This focus on reflecting collectively on our individual experiences of transitioning into EER led us towards the methodological approach of collaborative autoethnography, which is discussed further in the following section. Collaborative autoethnography "enables each team member to occupy both researcher and participant perspectives simultaneously" (Chang, Ngunjiri, & Hernandez, 2016, p. 23), which accurately describes our reflexive approach.

3 Method

In this study, we have used collaborative autoethnography (CAE) as a way of exploring the stories of the co-authors in their diverse journeys into EER. CAE is "a qualitative research method that is simultaneously collaborative, autobiographical, and ethnographic" (Chang et al., 2016, p. 17). It provides an opportunity for the reader to hear several different voices exploring and analysing their own stories in order to find commonalities and differences in their social context.

This approach aligns with our focus on the conditions and practices that shape the different transitional experiences of engineering educators, which necessitates exploration of personal context, experiences and prior knowledge. It also aligns with how we as co-researchers collaborated with one another. As Allen-Collinson (2013, p. 291) points out, "collaborative autoethnographers adopt various models of collaboration, ranging from full involvement at all stages of the research process to collaboration at a specific point or points during the research". In our study, all co-researchers initially responded in the same way (a written narrative) to the same prompt questions (see below), and then the first three co-researchers conducted the analysis of the narratives. The draft manuscript was sent to all co-researchers for comment and feedback before initial submission and then after revisions.

Given the different foci of the three practice theories (local conditions vs the broader landscape), it was important to gather details on journeys not only towards CREITE, but also into EER (the wider landscape within which CREITE lies). As a result, participants were asked to respond the following questions:

- How did you become involved in engineering education research (EER)?
- How did you become involved in CREITE?

- What keeps you involved in engineering education research and CREITE?

The answers were in the form of a written narrative which was emailed to the first three co-authors.

The collection of stories as collaborative ethnographic data allows us to explore similarities and differences between each researcher's experience to build a broader understanding of the diversity of journeys into engineering education. In addition, this reveals the varied roles that a research community such as CREITE plays in supporting engineering educators in their journeys. We have applied the lens of the three practice theory perspectives to the stories to see what can be illuminated with each lens, both in terms of the journey to EER and the role of CREITE in supporting EER and facilitating the learning of EER practitioners.

The co-authors' stories were analysed using thematic analysis to identify key terms, key themes, and dominant practices (Braun & Clarke, 2006). This involved one researcher, who had a background in applied linguistics and in text analysis, reading through all the case studies to identify key terms, and to start to group these terms into potential themes with associated quotes from the case studies. From this analysis emergent themes began to appear. Two other researchers then read through the case studies and noted emergent themes, linking them to relevant quotes. These were added to the list of potential themes identified by the first researcher. The three researchers critically compared and discussed the themes, combining some and removing others that were deemed not to be significant, until agreement on the themes was reached. The process was then to identify which elements of the three practice theories could be seen to speak to the themes, and vice versa.

The final list of themes was compiled, with their associated extracts from the narratives and their connection to the three complementary practice theory lenses. The three researchers then applied an inductive approach, iteratively working from the themes to the practice theories and back again, starting to form insights about what could be revealed through the different lenses. These are reported on in the following paragraphs. Key themes were:

- **Unplanned journeys into EER**
- **Collegial contacts & relationships in EER**
- **'Dangers' of EER – impact on engineering research career**
- **TER – differences between TER and EER**
- **Appeal of EER – intellectual and educational interest, as well as emotional connections**
- **Impetus for change – what drives the shift in research focus to EER**
- **Belonging to community: EER**
- **Belonging to community: CREITE**
- **Collaborating with people**

4 Findings from different lenses

Community of Practice

Through the CoP lens, it can be seen that invitations to the EER community act as a catalyst to legitimate peripheral participation in the community. These invitations lead to novice practitioners attending a wide range of EER events, including the Conference of the Australasian Association for Engineering Education (AAEE), the premier EER event in Australia, which attracts several hundred attendees (from first-timers to experienced international researchers) annually. Other events include an annual 2-day Symposium for PhD students in EER, a week-long research training intensive called the AAEE Winter School (each of which can be considered their own CoP), as well as regular monthly CREITE meetings. In these communities of practice, novice practitioners undertake

1 peripheral tasks, such as interacting and building relationships with EER colleagues as in the theme
2 **Collegial contacts & relationships in EER** -

3 *“The more I talked with kindred spirits the more I learned about scholarship and research in
4 engineering education. This led to me undertaking my PhD in academic identity development
5 for engineering academics who transition into engineering education research”* [AG];

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7 Through the process of undertaking these social tasks, they become more connected to the CoP as in
8 the theme **Belonging to community: EER**, e.g.

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11 *“One of the reasons for wanting to be involved in CREITE was to maintain connections with
12 the EER community, which I was starting to lose as my PhD research took me ... away from
13 EER per se”* [RG]

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15 and build legitimacy within the space. Over time, they transition to being experts within the space,
16 who then extend invitations to new novices at the periphery - e.g. AG has invited three of the co-
17 authors into the EER community.

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19 As a CoP, CREITE’s domain is a shared interest in engineering education research. The community
20 are the members of CREITE who are connected by their interest in engineering education research,
21 as in the theme **Belonging to community: CREITE**, such that

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24 *“CREITE is made up of a very eclectic group of people that have seemingly nothing in
25 common, but they do, a love of EER that keeps the faithful together”* [PB],

26
27 and are mostly based in NSW. Moreover, the practice consists of resources (such as a conference
28 calendar and presentation slides on various EER topics), as well as interactions between community
29 members. It aims to be

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32 *“a peer learning community allowing us to learn from each other and support the
33 participation of engineering academics in this emerging research field – especially HDRs and
34 ECRs”* [AG].

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36 This highlights the importance of legitimate peripheral participation of novice engineering educators
37 within the community, which is also reflected in activities under **Appeal of EER** such as practice
38 presentations, introduction to EER methods and methodologies, as well as discussing projects and
39 potential collaborations. During such activities, expert engineering educators play an important role
40 in bringing novices to full participation, e.g. in providing presentations as speakers, as well as
41 providing feedback on practice presentations.

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43 Although CREITE has leadership in the form of its coordinators, it is a largely non-hierarchical
44 community. It allows its members autonomy in how and how often they participate,

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48 *“I was also introduced to CREITE ... and attended sessions rarely. When I did attend, however,
49 everyone was welcoming and there was an unspoken understanding that it was okay to only
50 attend whenever it was possible”* [GM].

51
52 This is also reinforced by its informal approach to community membership and the importance of
53 informal social interactions even whilst there is a more formal research focus, as in the theme
54 **Belonging to community: CREITE**, e.g.

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57 *“Being a member of CREITE reminds me of the small conversations had over coffee, lunch or
58 dinner at AAEE. You always walk away slightly more charged up and enthusiastic.”* [PB].

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1 CREITE also has a practitioner focus, meeting the needs of its membership, such as maintaining
2 connections with EER, developing as an engineering education researcher and sharing one's research
3 with others.

4 Although CREITE is associated with UTS and engineering education research, it creates connections
5 amongst practitioners that cross institutions that are across a number of locations in NSW (including
6 the University of Sydney, the University of New South Wales, Western Sydney University, and the
7 University of Newcastle) and brings together educators from different backgrounds (e.g. physics
8 education [SD] and applied linguistics [RG]).
9

11 Bourdieu's Theory of Practice

12 Through the lens of Bourdieu's theory of practice, a key insight is the contestation between TER and
13 EER, revealed in the differences in habitus and fields of the two groups. This insight emerges from an
14 awareness of field-habitus match or clash. 'Field-habitus match' (Maton, 2014, pp. 57-59) is where
15 the habituses of people match with the field in which they find themselves, and in which they
16 flourish. They feel like "a fish in water" (Maton, 2014, p. 57). The capital that they acquire aligns well
17 with their habitus and disposition. There is also the phenomenon of 'field-habitus clash' (Maton,
18 2014, p. 59), which is where the opposite occurs; the field does not align with a person's habitus, so
19 they may feel ill at ease within the social arena – a "fish out of water" (Maton, 2014, p. 57). The
20 capital which is seen as desirable in the field may not be valued by this person. This field-habitus
21 match aligns with the desirability of the cultural and social capital in these fields: for example, the
22 cultural capital of being recognised as a researcher in the engineering education community:
23

24 *"As a research area, EER really suits my Education focused role" [PB]*

25 and the social capital of becoming a member of the EER community to help others learn (in line with
26 the theme **Appeal of EER**):

27 *"I like to work with students and understand what they need and how their competence can
28 be improved via educational research" [HC].*

29 Collaborative practices, emotional connections, support for one another's research and the
30 importance of student learning are seen as part of the fabric of the field, and of the expected
31 practices within that field.

32 *"I was intrigued by the sense of belonging with a group of researchers in the field of
33 engineering education. As a student with limited background knowledge in this field,
34 CREITE ... makes me feel supported to be part of the community when I connect with
35 members on a professional-personal level" [HC]*

36 This is seen in the themes of **collegial contacts in EER** and **the appeal of EER** (particularly the
37 emotional connections) and **the sense of belonging, both to EER and to CREITE**:

38 *"I found a small group of like-minded engineering educators at the university ... and found
39 myself increasingly involved in the engineering education research community through the
40 AAEE conferences and AAEE Early Career Academy (ECA). I was warned not to drink the cool-
41 aid of the engineering education researchers, but I found them too welcoming to turn down"
42 [GM]*

43 This contrasts with the focus on individual competition and striving for dominance that typifies TER.
44 The competition for cultural and social capital is the reason for much of the contestation between
45 TER and EER. This can be seen in the theme of **'dangers' of EER**:
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"It was quite common to hear terms such as 'career suicide' about focusing on one's teaching rather than on one's research; low student satisfaction scores received very little attention from the HoS or from the Dean; and engineering education was seen as the domain of losers who couldn't cut the mustard in technical research" [RG]

where engineering education researchers are 'warned off' EER by TER colleagues, particularly in a space where education is undervalued by leadership.

Participants comment on the 'performance-driven' nature of TER, and its technological focus; however, the cultural capital of TER – technical knowledge and related technical research – is not seen as desirable by the participants:

"I came back to Australia to pursue a long-held ambition of studying a PhD in astrophysics. However, sitting in front of a computer writing code wasn't satisfying" [SD].

Nor is the social capital of TER appeal seen as desirable, with the membership of a TER research group and its associated scientific reputation seen as an uncomfortable place to be:

"Other research groups I have noted are tightly knitted and performance-driven which creates a tense 'do or die' atmosphere" [PB].

The literature on the journey to EER reveals a similar alignment of field and habitus with TER-focused academics (Gardner & Willey, 2018; Mann & Chang, 2012), and could go some way to explaining both the field-habitus match with the 'performance-driven' practices of TER and the field-habitus clash of EER academics when they are in the field of TER.

Theory of Practice Architectures

As part of CREITE's practice landscape, EER plays an important role in shaping the practice of CREITE. EER's cultural arrangements are inclusive of diverse backgrounds (as reflected in CREITE membership from technical engineering, engineering education and non-engineering backgrounds). This supports opportunities for 'intentional serendipity' that are often the catalyst for the move into EER (under the theme, **Unplanned journey into EER**):

"I had no idea what I walked into, I thought it had something to do with improving teaching!" [PB]

In contrast, the cultural and social-political arrangements - as reflected in advice from technical engineering colleagues - discourage staff from EER (under the theme, **'Dangers' of EER**), e.g.

"[i]t was quite common to hear terms such as 'career suicide' about focusing on one's teaching rather than on one's research" [RG]

In the theme **TER**, socio-political arrangements are also at play in the shift from technical research to engineering education research,

"I think EER is interesting as I can interact with different people rather than lab equipment and simulation software packages. It also provides the right amount of challenge" [HC];

which highlights that technical research facilitates technical interactions at the cost of constraining interpersonal interactions.

Nevertheless, the cultural and social-political arrangements of EER facilitate the inclusion of early-career engineering education researchers. This is clearly reflected in the importance of specific researchers (e.g. Keith Willey, Anne Gardner) and research events (such as the AAEE conference,

1 HDR Symposium, Winter School) in our journeys. CREITE’s openness to cross-institutional
2 membership (a cultural arrangement) produces material-economic arrangements that support
3 engineering education researchers who may not have their own local network (under the theme
4 **Collaborating with people**), e.g.

5 *“USYD does not provide such a resource and I am not really sure if under its current structure*
6 *it will ever be able to” [PB].*

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9 Furthermore, the cultural and social-political arrangements also allow members some autonomy in
10 how they interact with CREITE, as reflected in

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12 *“When CREITE was established by Anne Gardner, I was happy to come along and participate*
13 *where I could” [RG].*

14
15 Other arrangements that can affect the engagement with EER are the prestige associated with
16 research funding (socio-political arrangement) and the somewhat limited funding sources for
17 education research (material-economic arrangement). The material-economic arrangements do
18 facilitate engagement in EER in that the nature of the research

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21 *“does not need mega dollars to make an impact” [PB]*

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23 and there are also the more practical reasons of alignment between education-focused roles and
24 EER, which reflect material-economic arrangements that require research outputs from staff that
25 already have substantial teaching workloads. These material-economic arrangements constrain the
26 time that academics have to develop research skills and conduct research, e.g. paradoxically only
27 having time for research by leaving academia:

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30 *“When the pandemic hit, I took a redundancy and suddenly had a lot of time on my hands. I*
31 *part-timed as a project officer for an AAEE grant, joined the CREITE organising committee”*
32 *[GM].*

33 34 35 **5 Discussion**

36 What we can see through all three lenses is that EER colleagues and interpersonal interactions are
37 key to the continuing practice of CREITE, as well as practice in engineering education research.

38
39 The CoP lens emphasises the security in the assumed shared understanding of the community that
40 results from social interactions between practitioners of EER. This resonates with Mann et al.’s
41 (2011) finding that the success of an EER group lies in the support and encouragement of colleagues.
42 In contrast to Dart et al. (2021), however, we did find a distinct lack of TER communities being
43 mentioned within our case studies. This is perhaps due to CREITE having established itself as the
44 “local research group”, having displaced the TER research groups, in our co-authors’ minds.
45 Moreover, for some of our co-authors, there is little to no potential for legitimate peripheral
46 participation in a TER community. This may result from a lack of access to the TER communities of
47 practice due to gatekeeping of membership (as identified by Davies 2005) – e.g. in the case of a
48 linguist like RG attempting to join a TER community – or a lack of desire to join and participate in a
49 TER community, which (by definition) self-removes the individual from the community.

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51 Through Bourdieu’s theory of practice lens, we can see an alignment between the habitus of
52 engineering educators, which are socially shaped during the process of interpersonal interactions,
53 and the field of engineering education: the field-habitus match (Maton, 2014). This perhaps touches
54 on the idea that EER tends to draw in those open to multiple perspectives (Allendoerfer et al., 2007).
55 There appears to be an alignment between the dispositions of individual engineering education
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1 researchers, the habitus of engineering education researchers that accepts diverse backgrounds and
2 a field like EER that brings together multiple disciplines. Furthermore, as noted by Dart et al. (2021),
3 the social and cultural capital that is gained from interactions within the field of EER appears to
4 compensate most practitioners for the loss of capital in the TER field, highlighting the perceived
5 value of these interactions to engineering education researchers. For many engineering educators,
6 finding EER could be seen as a homecoming for the practitioner, after struggling in the alien
7 landscape of TER. Furthermore, a group like CREITE provides validation for the move to EER, and is
8 clearly a field where the cultural and social capital of researching ways of improving learning
9 outcomes for engineering students is valued by its members.

12 TPA highlights the role of these interpersonal interactions in shaping an ecological niche and
13 conditions where EER practices can flourish. While there are arrangements that do constrain the
14 practice of CREITE, such as a lack of support from TER colleagues and a lack of time due to high
15 workloads, these impact engineering education researchers more broadly and are not specific to
16 CREITE. What *is* within our remit and control are the arrangements that support the practice of
17 CREITE and these have been clearly focused on inclusivity and collegiality: an acceptance of a range
18 of backgrounds and a range of institutions; the acknowledgement that TER and EER are equally
19 important amongst its membership; and a shared understanding of material-economic constraints
20 on participation. CREITE is a site of practice that is successful in supporting its membership by
21 enabling the collaborative and collegial practices of EER to flourish. At the same time, these
22 collaborative practices constrain the individualistic and competitive practices of TER.

27 '**The dangers of EER**' was a particularly intriguing theme to explore through the lenses of TPA and
28 Bourdieu's theory of practice, and brought to the surface much that had been hidden or taken for
29 granted in the practices of technical and educational research in engineering.

31 The following observations can be made using the TPA lens. The practices which constrain practices
32 of EER, such as: competitive funding (material-economic arrangements), individualistic approaches
33 to research (cultural-discursive arrangements), and the valorisation of TER (social-political
34 arrangements) are those which enable TER practices and allow them to flourish. The reverse is also
35 the case: practices of collaboration and collegiality, and of undertaking educational research without
36 funding, enable EER practices and constrain TER practices.

40 Through the lens of Bourdieu's theory of practice, the '**dangers of EER**' can be seen in the loss of
41 social capital of TER for people moving into EER. This situation poses the question: is the loss of
42 capital in TER compensated for by the gain of the social capital of EER, and the potential better
43 alignment of field and habitus? These risks are real, and not always recognised by people on the
44 beginning of their journey into EER. From the perspective of TER, the '**dangers of EER**' have already
45 been commented on in regard to the competition for social capital, and for scarce resources such as
46 research time and research dollars. We have also noted that EER is in competition with TER to be
47 seen as "the dominant measure of achievement" (Maton, 2005, p. 690).

51 The importance of EER colleagues and interpersonal interactions aligns with Gardner and Willey's
52 (2018) and Dart et al.'s (2021) identification of networking playing an important part in the identity
53 formation of engineering educators. They identify the importance of conferences (such as the
54 annual AEE conference) for engineering education researchers to build their identities through
55 forming interpersonal relationships with other researchers at the conference, whether to learn more
56 about doing EER or to communicate with peers and create teams for future research projects. In a
57 similar vein to the annual AEE conference, CREITE offers such opportunities to build identity
58 through engaging with EER colleagues, but on a more regular basis. Nevertheless, although identity
59 formation through engaging with EER colleagues, but on a more regular basis. Nevertheless, although identity
60 formation through engaging with EER colleagues, but on a more regular basis. Nevertheless, although identity

1 is shaped through participation in CREITE, what our findings highlight is that that pre-existing
2 dispositions and values that align with the cultural and socio-political arrangements of CREITE have a
3 strong influence on the choice to participate in EER and in CREITE. This pre-existing affinity with EER
4 drives the process of legitimate peripheral participation in spite of a lack of prestige and funding,
5 which can be seen as socio-political and material-economic arrangements that constrain
6 participation, or alternatively a loss of academic, scientific and intellectual capital from the
7 perspective of the TER community.
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9 Ultimately, the significance of interpersonal interactions within all three lenses and within existing
10 studies on engineering education researchers suggests that a key component of the ongoing success
11 of CREITE and EER will lie in maintaining the strength of relationships amongst the members of the
12 engineering education community and our continuing engagement with novices at the periphery.
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15 Although this study has focused on the experiences of members of one particular group in their
16 move towards EER, we contend that the insights are transferable to other contexts. This argument is
17 based in part on the diversity of the six authors' backgrounds coming in to EER, and more broadly on
18 the diversity of the CREITE membership, collectively representative of the wider EER community,
19 and is borne out by the alignment discussed above between our findings and the relevant research
20 literature (e.g. Dart et al., 2021; Mann et al., 2011; Rodrigues et al., 2021). In particular, investigating
21 local conditions is a key factor in theories of practice because it helps readers understand how
22 practices are specific to their contexts.
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26 **6 Conclusions**

27 The different lenses highlight different components of practice. Communities of practice highlights
28 that CREITE is a safe space where novice engineering educators can be inducted into full
29 participation in engineering education research. It is also clear that it functions well within the CoP
30 framework due to its non-hierarchical structure, where concerns around power structures and trust
31 between practitioners are less of a concern. Bourdieu's theory of practice highlights the field-habitus
32 match for those engineering educators who are drawn to the field of EER. It suggests that the
33 scientific capital lost by EER participants through relinquishing TER as their main research area is
34 compensated for by the scientific and cultural capital gained from establishing a reputation in EER,
35 and in participating in EER-related practices. TPA highlights the importance of the practice landscape
36 and site factors in shaping practice. TPA particularly highlights the strength of cultural-discursive and
37 social-political arrangements within the EER community, and specifically within CREITE, which acts to
38 mitigate material-economic arrangements that are often less than optimal. Nevertheless, all of the
39 lenses reveal the importance of interpersonal interactions and engineering educators in not only
40 supporting CREITE's practice, but also in supporting practice in engineering education research. This
41 suggests that a key focus of CREITE and the wider engineering education community should be to
42 maintain ongoing social interactions and the formation of relationships amongst its membership and
43 with emerging engineering education researchers.
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50 In this study, we have focused on identifying what factors support the current practice of a cross-
51 institutional EER group, CREITE. What we have not explored are the factors that supported CREITE's
52 formation and launch, nor have we considered those who have journeyed into EER & CREITE and
53 who have left the field/returned to TER. Further research is needed on this, which will provide
54 further insight into the dynamics of EER groups and the broader role they play in EER journeys.
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