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The development of engineering education research: a UK based case study

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ABSTRACT

This work adopts a case study approach to examine the emergence of engineering education research (EER) within the UK. First, a summary of the contextual factors influencing UK EER activity are presented. This section includes information pertaining to higher education (HE) policy, networks, and funding. Semi structured interviews are used to investigate who identifies as an engineering education researcher; how they define engineering education as a field of research; who they consider their audience to be; and the factors that inform their research questions, methodologies, collaborators and where they disseminate their work. The findings are discussed in relation to the social, political, and economic systems in which engineering education exists. The study reveals a landscape in which EER research is largely unfunded, and is primarily conducted by intrinsically motivated academics who concentrate on topics of personal interest or local context, and who do not usually collaborate or publish within journals.

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Engineering education research; UK; scholarship; researcher identity

1. Introduction

In the last few decades EER activity has grown to include large-scale research projects; the formation of research networks; the rebranding of journals which focus on rigorous research; and the establishment of research departments, graduate programmes and new conference series (Beddoes 2012). As a result, there have been several research articles which focus on the status and development of engineering education research as a distinct field or discipline (Borrego and Bernhard 2011; Jesiek, Newswander, and Borrego 2009). Several pieces of research have focused on the development of EER within different contexts including: the U.S.A. (Froyd and Lohmann 2014); Portugal (Sorby et al. 2014; van Hattum-Janssen, Williams, and Nunes de Oliveira 2015); Ireland (Sorby et al. 2014); Australia and New Zealand (Godfrey and Hadgraft 2009); Europe (Bernhard 2018); as well as within three Nordic Countries (Edström et al. 2016). Elsewhere, work has considered EER within the global context (Jesiek, Borrego, and Beddoes 2010a, 2010b; Streveler and Smith 2010).

The Journal of Engineering Education (JEE) have produced two strategic plans which include strategies to overcome challenges to advancement in the ‘international capacity for rigorous scholarship in engineering education’ (JEE 2005, 2011). Such work, which focuses on the globalisation of research, highlights the difficulties encountered when considering the approaches taken by researchers in different geographical locations. For example, Borrego and Bernhard (2011) compared approaches to EER in the US and Northern and Central European. They concluded that the growth of

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EER depends upon understanding the perspectives of researchers within other contexts, as well as valuing varying views on what constitutes quality. In a different piece of work Edström et al. (2016) claim that, in comparison to the USA where the National Science Foundation (NSF) has invested heavily in ERR, it is networks and communities that have played an important role within development of EER within Europe. This, they believe, has resulted in a fragmented and 'bottom-up' approach to research, and a diverse range of funding opportunities.

Such work acts to demonstrate the importance of understanding the historical and contextual factors which influence the role and scope of EER. In this work we focus on the development of EER within the UK. In so doing, we make reference to similarities and differences to its status within other global contexts including the USA, Australia, and the rest of Europe.

1.1. Engineering Education Research (EER) within the UK

Engineering Education Research (EER) in the UK stretches back to the end of WWII (Bosworth 1963, 1966; Heywood 1969, 1970; Heywood and Monk 1977; Ministry of Education 1945, 1956). Despite this long history, there are few studies which pay attention to recent developments. Data from a survey commissioned by the Higher Education Academy (HEA) in 2013 found that in the UK, EER is generally conducted by academics or teaching staff who dedicate small amounts of time to it. The low levels of engagement with EER were attributed to a lack of recognition of EER by academic institutions and the engineering community, a lack of resources and financial support, and a lack of staff time (Clark 2009; Shawcross and Ridgman 2013). Low levels of publication, especially within peer reviewed journals, was also attributed to a lack of information about both appropriate journals to target and to the selection criteria of these journals (Shawcross and Ridgman 2013). A later study, which focused on research published by UK authors in the Journal of Engineering Education (JEE), the International Journal of Engineering Education (IJEE) and the European Journal of Engineering Education (EJEE) between 2000 and 2017, showed low levels of engagement compared to countries such as the USA and Australia, and that most published research was single authored, or from single institutions (Nyamapfene and Williams 2017). A lack of consistency in research questions was also highlighted. This work also found that UK authors were less likely to publish research within the Journal of Engineering Education (JEE) compared to EJEE and IJEE, this raising questions as to how researchers select journals to submit their research to. The authors did not identify any trends in the topics addressed, something which points at a lack of focus, for example on national objectives (Nyamapfene and Williams 2017).

Others have focused on the tensions that exist as a result of the dual responsibility that academics have for teaching and research (Alpay and Jones 2012; Alpay and Verschoor 2014). For example, results from Alpay and Verschoor's (2014) survey of UK faculty attitude towards research and teaching roles showed that relatively low value is placed upon teaching achievements. A different piece of work highlighted the need to raise the relevance and value of scholarly activity within engineering education (Alpay and Jones 2012).

However, these pieces of work are limited by a lack of qualitative information pertaining to engineering education researcher identity, and the factors that inform their research. This gap in the research is of particular interest when considering the implications that the state of a research field has for the identity of those involved. As Gardner and Willey (2016) point out, the field of research that an individual chooses to participate in both shapes, and is an expression of, their identity. It is therefore important to understand the experience of those involved in EER so that we can make suggestions regarding the emergence of EER.

Focusing on the UK, we take a case study approach to investigate the experience of those involved in UK EER, and the way in which their experience is shaped by the context in which they conduct their work. The study follows the approach taken by Borrego and Bernhard (2011), which focuses on answering the w-questions (what, why, to what end, where and who) of education. In so doing, semi-structured interviews are used to investigate who identifies as an engineering

education researcher or is involved in EER; how they define engineering education as a field of research; who they consider their audience to be; and the factors that inform their research questions, methodologies, whom they choose to collaborate with and where they choose to disseminate their work.

In light of the 'persistent state of déjà vu' (Wisnioski 2015, 244) experienced by engineering educators, this study highlights the challenges and issues faced by EER researchers in the UK, and in so doing, it is hoped that this will help reveal factors needed to support the development of UK EER. It is believed that by understanding the way in which contextual factors influence EER within the UK, readers may be able to recognise similarities and differences within their own context. Throughout the discussion sections, the authors have sought to draw comparisons with research findings from the USA, Australia, the three Nordic countries (Finland, Sweden and Denmark), Ireland and Portugal.

1.2. Context

As Cheville (2014) clearly demonstrates, engineering education is shaped by the complex system in which it exists, and is therefore influenced by social, political, and economic factors which define the educational approaches taken and valued. As such, EER is influenced by the governance of higher education, funding priorities and the availability of research infrastructure within the context it takes place. This section presents aspects which are considered to influence EER within the UK and is split into the following parts: UK HE; teaching as a profession; networks; funding; and research assessment and benchmarking exercises.

1.2.1. UK Higher Education (UK HE)

Marketisation of higher education (HE) within the UK began in the 1980s, at which point subsidies for the fees of international students were removed, the funding of research and teaching was separated, and research became selectively funded (Brown 2015).

In 2006 'variable' student fees of £3,000 were introduced and by 2012 the maximum full-time undergraduate tuition fee was increased to £9,000 (Brown 2015). By 2015, block grants, which were provided to cover teaching costs were only awarded to a small group of subjects. In the same year, the deregulation of funded fulltime undergraduate places meant that there were no longer caps on student places (Brown 2015).

Such changes have implications for the way in which universities operate, not least the establishment of UK HE as a competitive marketplace in which universities compete on quality, something which is, in part, facilitated by the introduction of the Research Excellence Framework (REF), an exercise that determines the allocation of 'quality-related' government research funding, as well as the National Student Survey (NSS), and the Teaching Excellence Framework (TEF).

Another outcome of marketisation is an increase in rationalisation, whereby specialist departments (often arts and humanities departments) are lost as part of a general reduction in diversity and consumer choice. This has resulted in competition, not only from other institutions, but also internally between departments, something which is believed to stifle collaboration across disciplines (Brown 2015), for example between engineers and education researchers.

1.2.2. Teaching as a profession

The Dearing Committee met at a time when there was a focus on maximisation of returns from HE (Pollitt 1993). The Dearing report (1997) made several recommendations that focused on establishing quality in teaching, the first of which being the formation of a professional body for Lecturers, the Institute for Learning and Teaching in Higher Education (ILTHe) that was tasked with defining standards and accrediting programmes aimed at the training of university teachers. Whereas traditionally, university lecturers had not needed formal qualifications in teaching, the report suggested that all new lecturers should achieve associate membership of the ILTHE.

In 2003, a single central body responsible for standards of teaching in HE was formed, this being named the Higher Education Academy (HEA). The UK Professional Standards Framework (PSF), introduced in 2006, was intended to acknowledge the development of skills and knowledge of education (HESA 2021).

Today the HEA (now referred to as AdvanceHE) offers four levels of Fellowship. They also manage and lead the development of the UK Professional Standards Framework (PSF), a globally recognised framework for benchmarking success within HE teaching and learning support. Postgraduate Certificates in Higher Education are offered in some universities, something which is generally required of new staff on a part time 2-year basis, culminating in the award of Fellow of the HEA (accredited by HEA). Whilst this is not compulsory, many institutions require a certain number of staff to be qualified in each department and in some cases new staff are expected to gain HEA Fellowship during their probationary period (Thornton 2014).

Many engineering educators do not tend to consider teaching as a professional activity and show allegiance to the engineering profession and bodies associated with their technical research discipline. Their teaching is not commonly informed by knowledge from the discipline of education (Heywood 2018) and although the HEA used to include 'subject centres', which acted to share best practices in specific disciplines (including engineering), these closed in 2012.

UK HEIs have employed a variety of strategies to address the increasing pressures to engage in 'quality' teaching, for example by changing internal structures for academic career progression. The approach taken varies significantly across institutions and although some institutions have not separated the research and teaching element involved in the role of an academic, it is commonplace to have three pathways with staff employed on either research and teaching contracts, teaching and scholarship contracts or research and innovation contracts (Advance HE 2018). (Note: the term used to describe academics on teaching and scholarship contracts varies across institutions and can include teaching fellow, lecturer (education and scholarship) and teaching specialist. In this paper, we typically refer to those on a teaching and scholarship contract as 'teaching specialists'.)

There has subsequently been an increase in the appointment of teaching focused academics, with 66% of institutions claiming to have a teaching-focused career progression pathway (UCEA 2019). In 2019/20, 32% of UK academic staff were employed on teaching only contracts compared to 26% in 2015/16 (HESA 2021). The appointment of lecturers who have worked in industry has also become more widespread (GuildHE 2018).

The increase in such roles, alongside an increase in the number of teaching excellence awards (Skelton 2005) and the TEF, are believed to have raised the status of teaching and reprioritized teaching development. However, reward and recognition within UK HE is still predominantly focused on research performance (Blackmore 2017; McAleese 2013). In many cases the attitude of management is considered to have reduced the impact of such teaching development initiatives (Floyd and Platt 2013; Platt and Floyd 2015), this sometimes being linked to a prestige culture that inhabits universities, and which is associated with world-leading research. The progression of individuals on education focused career tracks commonly relies on them providing evidence of scholarship. However, varying opinions about the differences between scholarship and pedagogical research, as well as expectations of impact on HE, has meant that promotion can be challenging (Smith and Walker 2021). Unlike research, there is no equivalent external calibration that can be applied to teaching (Blackmore 2017; Fairweather 2005; Kreber 2003; Ramsden and Martin 1996) and views about what constitutes teaching excellence can vary across contexts (Abbas et al. 2016). It is perhaps for this reason that many staff continue to consider research success as critical to long-term job security and career progression (Cashmore et al. 2013).

The relative decline in the number of 'traditional' academics (here meaning one that focuses on research and teaches) has also been attributed to institutional strategies to reduce the number of staff eligible for the Research Excellence Framework (REF) (Locke et al. 2016), which will be discussed further in the next section.

1.2.3. Research assessment and benchmarking exercises

The Research Excellence Framework (REF) is a research funding system which aims to assess the quality of research produced by HEIs within the UK. It is claimed to be one of the most highly developed performance assessment mechanisms in the world (Pinar and Unlu 2020; Torrance 2020). It focuses on the assessment of three areas (1) research outputs, (2) impact of research beyond academia (e.g. economic, social, and cultural impact) and (3) the research environment, and the results are used to allocate mainstream quality related (QR) funding directly to institutions. Submissions from 34 subject based units of assessment (UoA) are graded across four categories (4*, 3*, 2*, 1*) with 4* submission obtaining three times the amount of funding as 3*, and 2* and 1* submissions not generating any funding. The QR funding is then distributed across the UoAs, with some subjects having cost weightings due to the relative expense associated with research in the area.

Performance within the REF exercise influences not only funding, but also university rankings and thus plays a role in informing potential students and staff. The REF therefore affects other activities within HEIs (Pinar and Unlu 2020) and there is a pressure to align research with processes outlined by research assessment (Cotton, Miller, and Kneale 2018). The high stakes associated with the exercise is believed to have resulted in a 'risk-averse' approach which 'risks stifling creativity and diversity' (Higgins 2020), and can act to discourage the development of interdisciplinary and emerging research disciplines.

Previously, institutes did not have to return submissions in fields where there was limited or low-quality research activity. This led to the identification of 'REF-returnable' researchers (Torrance 2020) whose work constituted the majority of submissions. Inclusion in the REF was therefore deemed to have significant influence on career progression (Torrance 2020).

However, in the latest iteration the rules changed meaning that 'all staff with significant responsibility for research' must be returned (REF 2019a, 13) and each UoA must submit 2.5 outputs for each eligible individual. Each institution must write a code of practice which sets out how they identify staff with significant responsibility for research (REF 2019a, 33). Furthermore, staff cannot be shared across UoAs, for example, an individual cannot be returned in the engineering and education submission (REF 2019a, 30).

In many institutions, those on teaching and scholarship contracts are not included in the return (Chalmers 2011), and in some cases, individuals who have not produced the required number of REF outputs have been moved into teaching and scholarship-focused roles, leading to the view that changing pathway is a form of punishment (Bennett et al. 2018). Such actions are thought to strengthen differences between pedagogy and other research, a narrative which is 'increasingly embedded into institutional structures' (Cotton, Miller, and Kneale 2018, 1633). Not being returned in the REF is therefore believed to lower the status of teaching-focused academics (Tierney 2020).

REF guidance stipulates that 'Research on pedagogy and educational issues within higher education that relate to the disciplines covered by Main Panel B (within which Engineering falls) may be submitted in the UOA to which it relates rather than to UOA 23 (Education)' (REF 2019b, 31). This would mean that EER would be submitted in the UoA 12 (Engineering) and be assessed by an engineering panel, although it is possible that panel membership is increased according to 'main and sub-panel chairs' recommendations' if there is 'a clear gap in the expertise of a sub-panel required to assess either outputs or impact' (REF 2019b, 6). Consequently, although pedagogical research can be considered within the REF, it remains marginal and is considered as neither 'real' nor 'equal' to disciplinary research (Chalmers 2011).

In a more general sense, the REF has been claimed to have several consequences which have influenced the field of education. For example, it is thought that many education researchers do not have a background in the social sciences, which has affected the quality of outputs (Torrance 2020) and led to a reduction in the number of research active education staff with successive REF

exercises (Torrance 2020). The impact of education research is also believed to be ‘small scale’ and ‘close to practice’ as opposed to ‘world leading’ (Torrance 2020, 774).

1.2.4. Networks and research groups

The main network for engineering educators and researchers in the UK is the UK & Ireland Engineering Education Research Network (EERN), which was founded in 2009, and which describes itself as a ‘Professional Forum’. Its remit is to ‘promote engineering education scholarship across the UK HE sector, with an additional remit of critically examining how engineering might be better represented within the pre-university teaching environment’ (NREEN 2021). Their underpinning ethos is ‘that engineering education research should be conducted in such a way so as to make a positive difference to engineering education at all levels, improving the quality, context and content of the student experience.’ The network is not funded, but previous events have been financially supported by host universities and organisations such as the Engineering Professors Council (EPC), the Royal Academy of Engineering, and the HEA. The EERN also has a subdivision for newer researchers.

Some UK institutions are home to their own EER groups, with the most prominent being the UCL Centre for Engineering Education (CEE) which offers an MSc in Engineering and Education and which provides teaching and learning support. The CEE also provides support for EER at the Faculty level, in addition to that offered by discipline-specific educational research groups at the departmental level (Graham 2018).

1.2.5. Research funding

UK Research and Innovation (UKRI) is responsible for directing research and innovation funding provided by the governmental science budget. UKRI is composed of seven research councils, including Engineering and Physical Sciences Research Council (EPSRC), and Economic and Social Research Council (ESRC), the latter being responsible for funding education research. UKRI have developed a The Cross-Council Remit Agreement that governs how they manage research proposals that cross two or more council remit domains. This agreement governs how interdisciplinary research, such as engineering education, may be assessed and requires each council involved to agree the extent (as a percentage) to which the grant falls within their remit. The lead council must agree that 51% falls within their remit and are responsible for ensuring that peer reviewers have experience across a number of research domains.

Organisations such as the Royal Academy of Engineering (RAE) and the EPC (the representative body for engineering academics in higher education) have been known to support engineering education research (for example by commissioning reports or supporting EERN events).

2. Methodology

This research adopts a case study approach, this being suited to the detailed and complex analysis necessary to answer how questions (e.g. *how* engineering education researchers experience UK EER and *how* their experience is shaped by the UK context) about contemporary phenomena within real-life contexts (Yin 2014). We define our case as the UK organisational field of EER which includes EER units within universities as well as national organisations that support, fund, and disseminate EER such as research networks.

We have chosen to make use of semi-structured interviews for data collection. We recognise that we are unable to provide a complete and unbiased picture, something which will be discussed further in *Limitations*. Inferred by the chosen methodology, the aim of this work is not the acquisition of transferable findings. Despite this, there is some attempt to make causal inferences pertaining to the way in which contextual factors influence the experience of UK based researchers when conducting EER. Such inferences are discussed in relation to findings regarding EER within other contexts (primarily the USA and Australia).

Ethical approval was obtained from Swansea University College of Engineering Ethics Committee.

2.1 Semi-structured interviews

The nature of the research questions necessitated the use of a purposeful sampling approach. A call for participants was distributed via the UK & Ireland Engineering Education Research Network (as well as by the subgroup, the Newer Researcher Engineering Education Network) mailing list, which was considered to include the majority of those peripherally or directly involved in UK EER. The authors also sent emails to colleagues within their own institutions. Recipients of the email were asked to self-identify as ‘an engineering education researcher or (be) involved in engineering education research’ to participate. This wording was chosen to accommodate for the ‘overall lack of clarity and continued sense of ambiguity about the identity and status of engineering education research’ (Jesiek, Newswander, and Borrego 2009). This method of self-selection allowed the authors to understand the ways in which those who identify as EER researchers within the UK define EER (discussed further in section 3.1.1.).

Eleven individuals initially consented to participate. Through a snowball sampling approach, a further three participants were recruited, giving a total of fourteen. Participants came from eleven different universities with nine having previously worked in industry. Ten were in roles focusing primarily on teaching (teaching specialists). This includes participants with role designation as teaching fellows or teaching/education and scholarship academics. Three other participants were in research and teaching (traditional academic) roles, and one was doing a PhD in Engineering Education. Further participant information is given in Table 1.

Table 1. Interview participant information.

Participant Number	Disciplinary background	Career Stage	Institution Type	Job role	Experience in Industry
1	STEM	Early	Plate glass/Russell Group	Teaching Fellow	Yes
Russell Group	Teaching Fellow	Yes			
2	STEM	Late	Unique	Research Professor	No
3	STEM	Mid	Russell Group	Education and Scholarship	Yes
4	STEM	Mid	Civic/ Red Brick	Teaching and Research/ Scholarship	Yes
5	STEM	Late	Post 92	Research and Teaching (traditional academic)	Yes
6	STEM	Early	Russell group	Teaching Fellow	No
7	STEM	Mid	Plate Glass	Senior Teaching Fellow	Yes
8	STEM	Mid	Civic/Red brick?	Teaching and Research (Scholarship)	Yes
9	STEM/ Engineering Education	Early	Plate glass	Teaching Fellow	No
10	STEM	Mid	Plate glass	Teaching Fellow	Yes
11	AHSS	Mid	Russell Group/ Red Brick	Teaching	No
12	STEM	Late	Red brick	Research Professor	No
13	STEM	Mid	Russell Group/ Red Brick	Teaching?	Yes
14	STEM	Late	Russell Group	PhD (Engineering Education)	Yes

Note: Early career refers to those who have been in their current academic role for less than five years, having either come from industry or progressed from academic studies/postdoctoral research careers.

Late career refers to academics who have progressed to leadership and management roles.

Mid-career is used for participants that fall between the two prior categories.

Within the UK there are over 160 HEIs, all of which can be categorised in several different ways.

The Russell Group: a group of the top 24 British research universities.

Red brick/Civic Universities: Established in mid-19th century, commonly formed by local industrialists, to meet growing demands for higher education and promote social mobility.

Plate glass universities: Formed between 1963 and 1992 as part of government recommendations to increase the number of HEIs. Generally considered as progressive.

Post 92 universities: Typically consist of polytechnics that were given university status in 1992 to remove the distinction between universities and polytechnic colleges.

Unique institutes: institutions which do not naturally fit into a typology, for example, private, self-governing institutions, or those offering online courses or specialising in postgraduate study.

A semi-structured interview protocol was developed to encourage a conversation about the ways in which the individuals were involved with EER. Among topics discussed were participants' career path, job role and motivations; the factors that informed their choice of research questions, methodologies and collaborators; research dissemination; recognition and reward; EER conferences, networking and professional development opportunities.

Interviews lasted between 45 and 60 min and were conducted, recorded, and transcribed by the authors. The authors met following their initial interviews and adjusted the interview protocol. The transcripts were sent to participants for approval before analysis to enhance credibility of the findings (Guba and Lincoln 1994). A thematic analysis (Braun and Clarke 2006) was undertaken with an initially inductive and semantic approach taken to identify themes. The researchers coded the data independently to increase dependability (Guba and Lincoln 1994). For each transcript, each coder collated a list of quote/construct pairs and combined the constructs into themes. They then compared themes and sub-themes. The transcripts were re-read and re-coded following agreed theme identification. For each transcript, the researchers evaluated how each quote represented the constructs, first with their own quotes and then with the quotes the other had selected. In the case of a disagreement, the researchers referred to the original transcript and discussed the meaning of the responses until they agreed. They then summarised the quotes for each theme, re-assigning quotes into other constructs as necessary. Both authors agreed that data obtained during the final interviews did not lead to identification of any significant new themes.

2.3. Reflexivity

Prior to conducting interviews and analyzing data, the two authors conducted an exercise to surface their interpretative lens, and a summary is shared to inform interpretation of the data presented. Natalie Wint is a Senior Lecturer in Engineering, who has recently switched from an Enhanced Research to an Enhanced Teaching Academic Pathway. In part, her interest in this research was born out of frustrations experienced when faced with a lack of support and recognition for EER, something that she had taken for granted when conducting technical research. Abel Nyamapfene is a teaching-focused academic with a passion for enhancing learning and teaching within HE through scholarly research and teacher professionalisation. His work is informed by the ongoing tensions between the dual academic functions of teaching and research within HE. Having been faced with difficult questions regarding the role of EER, the authors wanted to bring together the experiences of those in a similar position to determine if any consensus existed at this point in time.

2.4. Limitations

The nature of the research question meant that this study only reflects the views of a small number of self-selected participants who 'identify as engineering education researchers, or who consider themselves to be involved in EER'. The study is therefore subject to selection bias. The email invitation for interview participants stated that 'the growth of EER within the UK has been somewhat stifled' and that this study provided an opportunity to gather data which may 'inform ways in which the growth of EER may be supported'. It may therefore be reasonable to propose that those who took part empathised with this message and wanted to contribute towards the growth of EER. It is possible that such participants would focus more heavily on negative aspects of UK EER. Future work may benefit from a quantitative approach that includes a sample that is more representative of the EER community, and that includes the audience of the research as well as researchers within humanities, social sciences or education and other stakeholder parties, for example, funding bodies and journal editors. Another limitation of the study relates to the fact that it takes an 'insider' view of the state of UK EER, and it would be of interest to explore the views of those from other regions in which EER is better established.

2.5. Structure

In the following sections we present the findings and discussion with subsections organised around interrelated themes: who is doing EER and how their research questions are informed; who participants work with and how collaborations are formed; where EER is disseminated who it is considered to be for; and how EER is supported, resourced and recognised. Exemplary quotes are provided, followed by a number which allows the reader to look up the participant information using [Table 1](#).

3. Findings and discussion

3.1 Who is doing Engineering Education Research and how are their research questions informed?

3.1.1 Findings

Individuals appeared to have followed a variety of routes into academia, this perhaps being made most visible by one participant who had worked in industry and referred to themselves as ‘not a traditional academic’ (4). Ten of the participants were on a teaching pathway (the title given to those on education-focused career paths varied between institutions and included teaching fellows, teaching and scholarship academics or education and scholarship academics). This, despite the limited sample size, would suggest that these individuals make up a large proportion of those engaged in UK EER. One participant noted that it was not until ‘you are somebody designing and reassessing courses’ (14) that you consider doing EER. Another participant suggested that the narrow technical specialisation within UK engineering education meant that ‘people who are studying engineering are not then particularly interested in engineering education research’ (14).

Conducting EER was generally driven by a motivation to improve teaching. The majority of the ten teaching specialists interviewed described a preference for teaching, with one saying they had not wanted a role ‘heavily involved in research and with minimal teaching’ (11). Another said that EER is, ‘never going to become my full career because I really like teaching’ (6). The same was true of participants on a teaching and research (‘traditional’) academic pathway, with one having found that their technical research was ‘not necessarily satisfying all the curiosity’, and that they were not ‘the sort of person who could ... deliver a lecture and go away’ but wanted the ‘details’ (5).

Three participants had moved from a traditional academic ‘teaching and research’ role to a ‘teaching and scholarship’ role. One of the three individuals had ‘wandered in’ (6) to teaching and EER. Another claimed to have a ‘wider interest in research’ which they described as ‘making solutions, improving things, making something better’ (3). They considered that this, alongside being ‘fascinated by education’ and wanting to help in ‘supporting others to also learn and understand’, was what drove their EER (3). These findings point toward participants taking an engineering-centric problem-solving approach to EER, which was then primarily viewed as a ‘tool’ for solving perceived problems in teaching.

There were varying epistemological interpretations of what EER is, with these interpretations existing on a continuum which includes scholarship. Some participants referred to scholarship as opposed to research, with one teaching specialist speaking of there being a ‘key distinction’ (11). The same individual continued to explain that they did not consider themselves a researcher because their work was ‘more about observation and action research ... rather than saying I’m going to start out with a research question’ and that their findings were ‘emergent from practice’ (11). They instead considered themselves to be an ‘educational practitioner’ who takes ‘opportunities to share that practice’ (11). They later went on say that ‘you can kind of get too hung up on the terminology and it’s more about what value is’ (11). The same participant did, however, identify the need to take research ‘beyond the level of just saying this is what I did, and this was the outcome’ (11).

In line with the view of EER taking an engineering-centric problem-solving approach, research questions were generally formed 'as a response to a problem' (3). In some instances, research topics were issues that individuals were 'really drawn to on a personal level' (8), with one interviewee saying that 'we will always have our own agendas ... will always have the passions ... I always think that research is a really personal thing because it has to be driven' (9). One interviewee summarised the tendency to conduct research in areas of personal interest by saying 'it's thinking about what skills have I got? What skills have I brought from my background? And that's the unique contribution we can make' (13). In some instances, research direction was influenced by individuals. In one institution an engineering education researcher, who visited to provide a faculty development workshop, was described to have 'set a lot of the trajectory' (8). It was acknowledged that 'someone else could have come over with different ideas and maybe we would have gone in a different direction' and that a 'few little waypoints have a really significant effect' (8).

Research questions tended to focus on local context. One interviewee suggested that 'the university expects it (EER) to be within the university at that level' (9). This contrasted with the participant's desire to engage in wider research. The participant in question explained that their research was 'so specific to that classroom and on me, I almost feel like I need a bit more data to make it stand up' and felt the need to gain 'understanding (of) the whole rather than just understanding my part' saying that 'actually you can publish ... if you've got more insight' (9).

These perceived shortcomings were thought to lead to asking wider research questions and creating a research agenda. One participant suggested a need for an 'ongoing conversation to refine and agree what our real benchmarks are' and should be a 'consensus we meet as a group' (8) with someone else saying that 'emerging agendas are a good thing ... people who could come together and identify their common interest' (11). One teaching fellow believed this would 'make it into something bigger than just the individual people doing that', adding that 'otherwise, I don't think we will get to a point in building up' (9) whilst another participant suggested that EER needed to focus on wider issues like 'where engineering needs to move ... what do we need to do to change the sector', and 'trying to draw some clear lines about what is moving in the right direction' (8).

One teaching specialist from an arts and humanities background was less focused on engineering specific education research saying, 'what drives me is the educational aspect of it' (11).

3.1.2 Discussion of the findings

The findings suggest that conducting EER is something that would only be considered upon becoming an academic and that in the UK it is primarily conducted by teaching specialists (10 of 14 interviewees) to support teaching. Such findings are perhaps not surprising given the increase in teaching and scholarships roles which came about following both the Dearing Report and the advent of REF (section 1.2.2) and the associated expectation to engage in pedagogy. Such findings are similar to those discussed in the context of both Denmark and Sweden, where EER originated from education development and the need for academics to engage in compulsory pedagogy training (Edström et al. 2016). Similarly, Dart, Trad, and Blackmore (2021) reported that Australian engineering education researchers tend to be intrinsically motivated by learning and teaching and the possibility of impacting the student experience and the engineering profession. Elsewhere, EER has been described as a 'teaching activity' as opposed to a 'viable research area' (ASEE 2009, 2012; Olds et al. 2012) whereby the majority of the EER community conduct practice-based research in their classrooms (Godfrey and Hadgraft 2009).

Research questions of those interviewed appeared to focus heavily on the local context in which they work, something they have in common with the emerging engineering education researchers interviewed by Gardner and Willey (2016) in Australia. However, there were perceived shortcomings associated with research questions that focused on local context, and a move toward asking wider research questions and creating a research agenda. The emerging shared belief in the need for a common research agenda to underpin the growth of UK EER is consistent with the views of historian

Michael Mahoney (2004), that disciplinary unity is often achieved when a group establishes its own agenda.

3.2 Who did participants work with and how are collaborations formed?

3.2.1 Findings

Collaborations were generally informal, with limited sustainability. They were predominantly formed between engineers who taught on the same programmes, with one interviewee saying that they ‘collaborate a lot within my sphere of influence’ (4), and another claiming ‘it is easier to do pedagogy with your own department because you find people are more receptive’ (10). One participant spoke of belonging to an institutional EER group but said ‘things change quite rapidly’ and had ‘kind of gone back to the beginning’ (9) when a key member left.

Working with social scientists and education researchers was considered a form of development for engineers as they could support with methodologies, ‘reading papers’ and telling ‘you how this works’ (6). However, one participant said that their education department had ‘never been particularly interested’ and another considered that the education department ‘train the schoolteachers’ and that very few were involved in ‘proper research’ (10). Participants had varying levels of engagement with internal education research networks, with one teaching specialist saying that they ‘don’t necessarily feel invited’ (1) and that collaboration relies on ‘individual relationships’ and ‘luck’ (1). However, another participant, who had co-founded an institution wide education network, claimed it is ‘valuable because it means we’re bringing together people who have different perspectives and different expertise’ (11).

The benefits of working with social scientists and educationalists was, however, highlighted by several participants with one interviewee saying they ‘really enjoyed the input from social scientists’ (1) and that ‘they’ve got more grounding in it’ (1) and another that ‘they do the right thing’ (5). One professor suggested that engineers and social scientists ‘can learn with each other’ (2), saying that ‘social science needs a bit of hardening up in terms of its data’ (2). However, collaborations were not necessarily formed with consideration for complimentary expertise, with one participant saying that although they ‘learned something from working with them’ they did not ‘necessarily recognise up front that that was going to be one of the values of doing it’ (11).

It was notable that those with external collaborators were either senior research professors, or those who had transitioned from industry and had ‘kept those contacts going’ (4). It was less common for participants on a teaching pathway to collaborate externally, with one interviewee saying that they had ‘spent two years finding my feet in teaching’ and needed to ‘go and do a bit more networking’ (9), and another that they ‘just don’t feel like I have the external contacts or the time to develop them’ (1). A different interviewee described finding collaborators by looking ‘for more teaching fellow type people’ on ‘the staff pages’ of other universities (10). In some cases, this issue was exacerbated by the lack of funding for conferences, with one participant questioning ‘how do I talk to any of these networks when I’m not physically at a conference which I have to pay to go to and which my department won’t necessarily fund?’ (1). They went on to highlight the importance of your ability to build networks but that research success ‘shouldn’t be totally reliant on that’ (1).

One educator viewed their students as collaborators, stating that if they were ‘going to go and talk at a conference about something that we’ve done in the classroom, it’s much more powerful if students come and have their voice’ (11).

3.2.2 Discussion of findings

The findings suggest that collaborations between those engaged in EER were fortuitous and informal in nature, with limited sustainability and that the role played by education researchers varied across institutions. Difficulties in forming such collaborations may be associated with the

marketisation and rationalisation processes occurring within HE (see 1.2.2), something which is hinted at by one participant who wanted support finding 'collaborators not competitors'.

Despite this, there was some evidence of increasing effort to engage in external collaboration. Participants generally believed that working with others, particularly those from education and the social sciences, would be beneficial. However, time and lack of opportunity were considered as barriers. The value of collaborations between engineers and education researchers has been highlighted in previous work (Borrego and Streveler 2014; Edström et al. 2016; Streveler and Smith 2010). Borrego and Newswander (2008) highlight collaboration, as one of the primary mechanisms for engineers to learn how to do educational research. It would therefore appear necessary to focus on networking activities, both amongst engineering educators, and with those with expertise within educational and social sciences research, in order that development of EER within the UK continues.

3.3 Where is EER disseminated and who it is considered to be for?

3.3.1 Findings

Whilst some participants spoke of the role of conferences in facilitating collaboration, it was more common for them to highlight the opportunity to meet 'likeminded people' (2). Almost all of those interviewed valued conferences held by the UK and Ireland Engineering Education Research Network (EERN) with one saying 'it's very friendly, it's really small. It feels very supportive' compared to 'more combative ... more aggressive technical research conferences.' (8) This seemed particularly important for those who lacked support in their own institutions with one participant saying that 'it feels like a group of people who are all marginalised in their institutions. We've got similar stories about feeling alone ... it's reassuring to know that you're not the only one who is struggling just from a community, personal point of view.' (8) Another participant said, 'you need a community like that both to sustain you in moral terms, but also to sustain your ideas and to validate your ideas' (2). The opportunity to 'get feedback' (2), (8), (12) was reiterated by several participants, with one teaching specialist saying they were 'really focusing on conferences and not journal papers ... even though it's not going to help my KPIs' and 'underselling it a bit' because they were 'craving that interaction and discussion ... and that feedback' (8). One Professor alluded to 'the days when publication was just starting' when 'more hard physical scientists used to berate civil engineers for not publishing enough ... And they said, we go to conference because that's where it happens' (2).

Participants also felt that conferences were more accessible than journal publication as, in the words of one interviewee, 'you don't have to jump through the same hoops,' (12) as publishing, with another saying, 'it's less daunting ... and less daunting in terms of time' (9).

Desire to grow the EER community was considered to lead to a compromise in research quality. Some interviewees acknowledged that 'we want the community to grow' and that 'almost anything is accepted' (8). This was seen to result in 'very little cohesion or consistency or themes that allow you to dig into any depth' (8). It was also considered that there was 'too much I made this change to my module, and this happened' (8).

Several participants said that they didn't know which conferences to attend with one saying that they 'just picked one that seemed to have a theme that looks interesting or relevant' (8) another saying, 'it's a bit random' (1). One interviewee spoke of having 'been slapped on the wrist' and feeling 'reticent' after they were 'not encouraged to attend the conference as it wasn't considered good enough' (1). They went on to say, 'who am I supposed to ask ... where's the list of conferences that are acceptable or not' (1). This could lead to negative experiences with one interviewee saying they 'left that conference feeling quite dispirited and despondent' (8).

One interviewee said that they had 'put in to ASEE because ... that's where some of the best research is coming, you have to be talking to people in the States, because that's where a lot of the cutting edge and the deep conversations are happening, just trying to build a profile than

that that community.’ (8) Another considered that ‘the biggest impact we can have is going to SEFI and CDIO ... because you’ve got an international touchstone, you are getting through to thousands of people and you get feedback’ (2).

Others had presented their work at more general conferences including the technical symposiums of professional bodies, and higher education conferences including Advance HE and the British Education Research Association. However, one individual ‘ended up talking about the paper in a room with three people’, saying ‘it was pointless ... so I published a paper that’s been lightly peer reviewed to speak to three people’, adding that they ‘don’t go to HEA conferences at all because to me it’s just become commercial money making’ (10).

Few of the participants had experience of publishing their work, with perceived barriers to publication including a lack of time and high teaching workloads, with one teaching specialist saying that ‘it’s purely time’ and that they ‘had to focus on teaching’ (4). One interviewee commented that ‘the people who are often well placed are those of us that are on teaching focused pathways ... are quite time poor ... because ... you have a huge teaching load’ (11). One participant said that they were ‘rubbish at writing my research’ (9) and another that they had ‘lots and lots of part written papers’ (5). The same interviewee later spoke of how the same topics went ‘round and round and round’ and questioned ‘why have you not kept the documents that were written?’ (5).

In some cases, the low publication rates appeared to be associated with a lack of confidence, with one participant saying that they did ‘not feel very competent about’ the use of ‘language and communication’ (5). One participant, who was a senior research professor, acknowledged that those mainly involved in EER were teaching specialists, some of whom had ‘never done research’ (2). This was viewed as a potential obstacle as they may not ‘understand what world leading means ... don’t understand what the world stage is’ and ‘don’t read widely enough’ (2). A different interviewee who had moved from a traditional academic pathway to a teaching pathway commented that ‘you could be a scholarly engineering academic and do lots of reading and improve the student practice but decide not to write, not to publish. But it just seems that’s not the whole the whole journey’ (10).

When asked an open question about publication, participants referred to two main journals, these being the Journal for Engineering Education (JEE), and the European Journal for Engineering Education (EJEE). Of the two, the JEE was considered ‘the place that they (the university) would look on’, and publishing in it would be like ‘taking on a bit of a Goliath’ (5). This was considered implicit from the relatively small number of ‘papers from Europe they publish’ and was put down to the fact that UK EER studies were typically either qualitative or were based on small sample sizes (5). A different interviewee considered the UK and USA had ‘very different perspectives on what we’re expecting from research’ (9). They added that publishing in the JEE ‘is daunting’ and that they ‘don’t feel I’m in the same league’ and ‘if I were to write something, I think they would pick it apart’ (9). In comparison, one research professor who had reviewed articles for the JEE, but had ‘never published in it’, referred to it as ‘pompous and over trying to be archival’, (2) which demonstrates how EER is interpreted in different contexts.

Another participant instead suggested that ‘one of the key places that perhaps at the moment most of us should be publishing is the EJEE.’ However, they added that whilst they had presented at SEFI conferences, they had ‘a very mixed track record with getting things into the journal’ (5).

Discussions around where to publish EER were linked with conversations about criteria for quality. It was noticeable that the majority of those who spoke critically about the quality of EER were those with successful research careers. One professor who had ‘sat on four research assessment panels’ and had reviewed EER articles claimed that some of it was ‘not research’ giving the example that ‘three anecdotes do not make even data, let alone conclusions ... you know, student A said ... and student B said this. And at the end, seven of them were happy.’ (2) The same participant went onto say that it was considered ‘the brutal reality’ that ‘nobody in the education REF panel will take the slightest notice of EER because they don’t think it’s sociologically valid ... nor is it going to be believed by the engineering panels, because they think it is copping out because it’s not quantitative enough

and it's not hard enough' (2). A different interviewee, who had also reviewed engineering education papers, agreed that some papers are 'just someone anecdotally saying things ... they've almost gone, oh, it's qualitative, so I can just write down what I think, or I can just write down what people have said to me. And there's no structure to it ... they've not understood the limitations of the research or what that foundation of that research is and how there are different views or there are different ways in which we can write about reality and how we conceive of that will change the research and what we're doing' (12). In contrast, a teaching specialist said, 'you can do the smart things, but unless you read a lot of literature to say why you're doing it, you're not allowed to publish based on common sense' (1).

There was a perceived mismatch between the intended audience of EER and the current mediums for dissemination. Some participants felt that their target audience were fellow engineering education practitioners. However, there was a general feeling that they were 'not talking to those people', partly because this audience did not read the targeted journals or attend EER conferences. They also considered that 'because of impact', EER would need to engage 'people who have that interest, who are line managing or who are training people in teaching' (8).

One participant commented that it would be 'a retrograde step to start worrying too much about only writing for the big journals.' (5) However, they saw a problem in that 'we do not necessarily have ways of disseminating the other stuff' within the UK and concluded that 'we need to not only get better at finding ways of integrating, working together, but we also then need better ways of bringing that information to the wider community.' (5) One professor said that whilst their research findings may have been mentioned 'to a few of their staff' they didn't 'think it made the slightest difference' (2).

Another participant observed that the way in which EER was written and the use of 'sociology language' can put 'your target audience (here considered to be engineering educators) off', saying that it 'comes in how you write it' and ensuring to include 'things that I would just assume as knowledge' (9). The same participant suggested that if we raise 'standards in terms of people's ability to do this kind of work, that so will raise standards in terms of their ability to read and understand it.' (11)

3.3.2 Discussion of the findings

Whilst EERN and SEFI were considered to be the best conferences to attend, there were mixed views about the benefits of attending conferences and it is clear that participants feel a need for more information about the most suitable events for them to engage with. Despite this, attending conferences was generally seen as a beneficial activity, both for allowing the interviewees to get feedback on their research, and to meet people with similar interests and values. These findings are similar to those obtained within different contexts. For example, conference participation has previously been shown to be an important activity for researchers within EER at all stages of development within Australia (Gardner and Willey 2016). Elsewhere Edström et al. (2016) have described the important role of the Nordic Network for Engineering Education Research (NNEER) in helping isolated individuals to exchange thoughts with likeminded individuals, something which was considered particularly important in contexts where there were limited funding opportunities. In other work, Communities of Practice are considered to support isolated member who were not supported within their own institution (Pitterson et al. 2020).

Despite the acknowledgement that unpublished work had little impact on engineering education, the majority of those interviewed did not generally publish their work in academic journals, something that was primarily attributed to lack of time, confidence and a preference for conferences and conference proceedings. These findings echo those of Shawcross and Ridgman (2013) who found that UK based EER researchers preferred to publish via conferences rather than in journals, stating a ratio of 3 conference papers for each journal publication.

The difficulties in selecting a journal, were compounded by a lack of clear understanding of the types of work that various journals would accept. For example, publishing in the JEE was considered

unachievable by those that mentioned it, a finding which is, to some extent, consistent with those of Nyamapfene and Williams (2017) who proposed that UK-based researchers believed the JEE to be more focused on the USA context, and that the quality of UK-based EER did not meet that expected by JEE. In comparison, EJEE was seen as a more viable option for those conducting research in the UK, this perhaps being a consequence of what de Graaff (2017, 590) claims to be 'one of the strengths of EJEE ... that the journal does impose a high scientific standard, yet we are not rigid in terms of requesting particular methods'.

Jesiek, Newswander, and Borrego (2009) have also reported on issues of inclusivity and exclusivity in relation to publication, particularly by those whose work was rejected by existing journals, and who felt that there wasn't anywhere to publish their research. Elsewhere, work has highlighted differences between JEE and EJEE (Borrego 2007; Borrego and Bernhard 2011) and it is thus critical that such differences are understood by UK researchers in order that they are able to be successful in publication.

Choosing a means of dissemination is, in some respects, related to who the audience is considered to be. The findings suggest that the audience of EER is primarily considered to be other educators, along with policymakers. However, there was a perceived gap between those conducting research and those considered as beneficiaries (educators) of the research. The belief that few outside the EER community are aware of the findings or implications of EER is consistent with the silo effect reported by Wankat (2004) and Wankat, Williams, and Neto (2014) and is, in part, a consequence of the number of different general and disciplinary journals in which EER can be published. As highlighted by the work of Jesiek, Newswander, and Borrego (2009) and Jesiek, Borrego, and Beddoes (2010a, 2010b), researchers risk isolating themselves from practice if development of EER as a discipline is not consistent with promotion of practical interventions. Jamieson and Lohmann (2009; 2012) believe that encouraging academics to apply findings of EER in practice constitutes a hurdle to the EER community.

This risk was recognised by some participants, who believed that EER should be written in a way that makes it understandable to engineering educators, or as Borrego and Bernhard (2011, 37–38) suggest when describing the characteristics of quality EER, 'in a form that engineering academic staff can understand and use'. In this sense, de Graaff (2014) urges us not to repeat the mistakes of the 1960s and 1970s when education researchers, predominantly social scientists, published their work in journals that were read by other researchers and not practitioners.

Discussions regarding where to publish were often related to conversations about quality. Although there was a general consensus that there is a need to produce EER of high quality, there was less understanding about what this means and how it would be achieved. The development of EER in the UK thus necessitates further conversation around what is expected of quality EER, something which is complicated by the way in which the norms of EER are being adopted from those of engineering research (Beddoes 2012), but which may be informed by the criteria for quality EER presented by Borrego and Bernhard (2011). Elsewhere, when considering EER in Australia, Gardner and Willey (2016) suggested that the one way to change the perception of EER, would be if established researchers 'show leadership by undertaking high quality research'.

3.4 How is EER supported, resourced, and recognised?

3.4.1 Findings

Discussion around support, resource and recognition was broadly split into five different categories: funding (both internal and external); time; formal development opportunities; career progression; and respect from colleagues.

The ability to publish in 'the big journals' (5) was linked to securing funding for EER. One interviewee believed that 'you can't get funding until you've published, but it's not published until you've got funding' and suggested that 'we need to show that we've got research credentials to be able to get the stuff we need. But how do you build those research credentials if you don't

have the support?' (9). Another participant agreed, saying that the 'community need to prove the value of what we're doing here', and later admitting that 'it's kind of a bit chicken and egg' (11).

One interviewee suggested that the 'first change has to be to get universities to recognise that those of us who are on teaching focused pathways actually have value to contribute' as 'you can do a lot when it comes to education research, without a huge amount of funding if you're given the time' (11). Another participant agreed that research could be conducted with fairly limited resource, but that it was easier for colleagues to get hundreds of thousands of pounds for technical research than the smaller amounts needed for EER. They later commented that they had tried to justify the need for funding of EER by their institution in light of the fact that 'even saving one student from academic withdrawal will pay for this' (10). A different teaching specialist had been 'quite successful at securing internal money' but that they 'had to really fight for that' and had 'support from senior leaders' (8). One professor was lucky in that they had 'always controlled a decent teaching budget' (12).

However, a different participant believed there was 'expectation from the funding bodies, that the institutions should be funding this work and the institutions say like go and find your own funding'. They described this as 'an impossible situation' (3). One participant believed that 'unless you were kind of leading the field ... it'd be a very hard sell', later adding that they had self-funded their PhD in engineering education (9).

Whilst one research professor viewed 'teaching only people' as 'an identifiable community that needs funding' (2), a teaching specialist believed that those involved with EER 'don't exist for the research councils' (3). Another expressed a lack of optimism in EER researchers' chances of securing research council funding, saying 'the proposals just won't look very impressive alongside you know really rigorous studies that people want to do within their discipline' (11). Another interviewee said that 'the educationalists want to ring fence' education research funding and that you would be 'an outsider ... in terms of terminology and track record' (5). A different participant agreed saying that 'it's very competitive across the whole of education, not just engineering education' (9).

One participant considered that 'industry will support you ... because they get your students', claiming that pedagogy would support a firm's 'competitive advantage' (10).

The same participants who had praised the specialist support provided by the subject centres also spoke of the activity they supported with one saying that 'it enabled me to claim grant income from education' and to 'seed-corn a bit of money out from that into the rest of the community' (2). Another had since been successful in obtaining some external funding, something which they attributed to 'fitting with the opportunity.' (5) They also suggested that funding could be obtained through 'back-door studies'. One participant identified the Royal Academy of Engineering as a potential source of funding. However, it was acknowledged that they were 'very small funds' and that there were 'a small number of authors they go to as consultants to produce their reports', this being referred to as 'buying the reliability of a known supplier' (5).

Discussion regarding reward and recognition primarily focused on the difference between academics in a traditional (or research based) academic role, and those on a teaching pathway. One reason for the lack of participation of 'traditional' academics was considered to be that there was little incentive for those on the research pathway because 'if you've got 40% of your time to work on research. Do you put that into engineering education research where the impact factor is going to be relatively low? Or do you put it into your disciplinary research, where you can get a higher impact factor and so will advance your career?'(11). Such metrics were primarily discussed in the context of REF. For example, one participant, who worked at an institution at which teaching track positions did not exist, said that they needed to 'make sure that you'd got a (technical) paper, at least one ... to retain a research allowance in workload' as the institution 'don't really recognise pedagogy related work' (5). In some cases, the existence of the teaching specialist role was seen as a direct impact of REF. For example, one individual had been transferred to the teaching stream prior to REF 2014, when their institution was 'looking at members of staff who perhaps wouldn't make the grade for submission' (10). A different interviewee speculated that many staff

had been transferred to a teaching and scholarship role because they had not been considered 'REF-able' (13).

The views about the creation of teaching specialist roles varied and their existence was not viewed as entirely beneficial to the development of EER within the UK. One interviewee considered that it was up to individual institutions as to how they respond to external 'impositions' such as REF, later adding that they wouldn't 'like that this is solved by putting us in a teaching fellow capacity. That almost feels like a second class' (3). They later described a 'push and pull with the desire to support scholarship' and considered that there was potential for REF to stifle support for EER, with institutions suggesting that academics do less scholarship in case it meant they had to submit them into the REF (3).

The perceived lack of respect associated with teaching specialists appeared to be related to the circumstances around the decision to move staff onto a teaching pathway which happened 'at a time in which there wasn't much of scholarship and therefore they assumed that it meant that they were in teaching only contracts' (3). A different participant added that 'part of the problem when they created these teaching fellow routes (was) that they weren't specifically for people interested in pedagogy.' and said that they were 'just doing the day job still' (10). They later added that 'by simply being on the teaching fellow (pathway) it doesn't make you an ideal candidate to do engineering research' (10).

It was noticeable that those who believed that the increasing number of teaching staff supported the development of EER, were successful research professors, one of whom 'moved to pedagogy' in their 'late 50s, early 60s' because 'the brain is dead ... 'there's no point in trying to pretend you can be a researcher at my age', and who believed the role gave 'some credit and promotion possibilities to those good people who chose to concentrate on being world class teachers' (2). However, they later commented 'it's creating two classes now', saying that 'researchers still get more kudos', something which they attributed to being 'driven by proxies like they can earn bigger grants' and that 'the proxies used to assist the researcher progress are easier for deans to come across than proxies for teachers' success' (2). A different professor claimed that 'if you're looking for respect from all your colleagues, you're not going to get it if you go into education research' (12).

One teaching specialist described a 'real disparity' between teaching and research staff because 'you can't get promoted without doing this work (EER), but you're not being given time,' claiming that there was 'a serious EDI (equality, diversity and inclusion) issue at the heart of it' (11), this being reiterated by another teaching specialist who said 'I'm not contracted to do research, but I have to do research to get promoted' (1). The issues of high teaching loads was brought up by several participants with one saying that their workload meant they had 'got no energy for journal papers' (8), and others that they weren't well supported as they didn't have time 'ring fenced' (9) and that pedagogical research was 'by choice.' (10) A different interviewee said that the institution would rather 'you spend more time making the course better to improve the NSS results' (10). One participant claimed that those involved in scholarship had more 'strategic vision' which made it more likely that they were asked to do managerial and administrative tasks such as 'sort(ing) the NSS' (3).

Only one participant had a strikingly different view, saying 'your contact hours are still low ... so allows that time to go and do that research that you want to do' (10). They also believed that there was a need to understand that 'some people have to be doing that big income generation research to allow you to have the autonomy to do what you want to do' (10).

Another disparity was perceived to occur during promotion processes as a result of academics on the traditional research and teaching pathway being likely to 'have a pot of money' which allowed them to disseminate work externally and via open access. This was believed to result in a situation in which research staff 'get more citations'. The participant summarised these issues by concluding that 'actually you just can't win' (11). A different participant commented that it really 'frustrate(s) me ... it's easy to achieve certain quality in some areas more than others.' (5)

The level of institutional support for EER was perceived to be variable and inadequate. Several participants alluded to support being dependent upon chance, with one saying that they were 'quite lucky' (8) to have a line manager who supported their involvement in EER and another alluding to their line manager noticing that they had been 'interested in doing that (meaning engineering education research) ... and started giving me opportunities' (5). A different teaching fellow recognised that they had benefited from a line manager who 'is really good in budgets for CPD, for us' (9). In comparison, a different teaching specialist said 'my line manager is not interested in the teaching' and had refused their request for development in education research methods (1). One teaching specialist said that EER is 'not supported or resourced' but was 'tolerated' something they attributed to colleagues realising that they were 'behind the times as an institution' (8). They viewed the available institutional support as being about 'asking the right people at the right time.' (8) In comparison, a different interviewee highlighted that they had been discouraged from EER because it might 'disturb the status core of the course by investigating it' and that 'you have to then see that the political climate within a department can constrain potential for new research' (10). Another considered that their institution supported EER 'on paper, as in aspirationally' and that 'the desire is there' but that 'whether the resources, the time, the processes are well designed for scholarship ... that's another matter' (3). The lack of resource was attributed to the belief that the 'institution doesn't understand what it means by scholarship' and that 'those who are doing it is almost like we are shaping it. And we're actually saying this is what you need to support'. A recognised effect of EER being a developing field was that 'we're all just on our own' (10). There was a lack of mentors, one participant claiming that 'this is one of the most frustrating things and I just don't feel like I have any one more senior to rely on or call on for support' (8).

The lack of opportunity for either formal development or informal mentoring is significant given the general consensus that EER was 'different from the kind of research' that participants would normally do and that 'they don't really know how to go about it' (11). This was considered to result in a gap in 'skills, but also confidence' (11). For example, some teaching specialists were unsure of their ability in EER with one saying, 'I don't see myself as an engineering education research person because I'm not embedded in the social sciences enough' (13) and another saying, 'I just don't feel like I know the politics enough to be able to navigate the system to make the case for it' (8). They questioned whether this was because they were on a teaching pathway and excluded from the REF exercise.

One participant considered that 'CPD is overlooked' (5), and whilst academic development departments were believed to play a role in introducing participants to education research, there was a desire for discipline focused training. Three interviewees spoke of obtaining a teaching qualification, with one saying it 'got me more excited again about pedagogy' (10). A different participant claimed that teaching support was 'way too generalist ... not very impactful' (3) with another saying that it 'didn't really go into any depth when it came to engineering specific education research ... I don't think I even realised it even existed' (8).

The benefits of discipline specific training were reiterated by two of the more mature participants who both spoke of the Higher Education Academy Subject Centres which were believed to bring together a 'legitimate group of people interested in being professional about teaching' (5), with one participant speaking of 'suddenly finding a community' (5). In comparison, the newly established Advance HE was considered to 'suffer from being entirely generic and centralised, having almost no engineers and therefore absolutely no credibility' (2).

3.4.2 Discussion of the findings

A major finding from this study is that within the UK there is currently no dedicated career pathway for EER-specific faculty. This situation is similar to Ireland and Portugal (Sorby et al. 2014), which are also characterised by low levels of participation in EER, just as is the case in the UK. This is in marked contrast to the US, where dedicated EER departments are the norm, and EER participation levels are high. Similarly, in Denmark and Sweden, which both have a strong track record of supporting

pedagogic and didactic research, EER is viewed as a bona fide academic career pathway, and in both countries, there are established and well-funded research-based pedagogical centres (Edström et al. 2016). This contrasts with the findings reported here for the UK, where EER is primarily undertaken as a secondary 'hobbyist' activity mainly by teaching specialists and late career research and teaching academics. These findings suggest that the establishment of dedicated career pathways for EER-specific faculty may serve as a catalyst for the development and growth of EER. For instance, with respect to Australia, Godfrey and Hadgraft (2009) note that the existence of several appointments to full Professor level based on EER and scholarship achievements has validated EER as a career pathway within Australian academy.

The findings highlight the difficulties UK academics face during the transition to EER and indicate a need for wider support. There appears to be a lack of formal development opportunities for those engaged in EER, and whilst academic development departments seem to play a role in introducing participants to education research, there is a desire for discipline focused training. Training in research methods is considered particularly important given that those involved in EER communities in the UK are often engineering academics and, as such, tend to possess expertise in research within their own engineering discipline (Borrego and Bernhard 2011), or have limited experience in conducting research, for example those from an industrial background. The provision of such opportunities is something that should be encouraged within the UK context given the suggested link between understanding of the relevant methodologies and quality of EER (Malmi et al. 2018).

The study also highlights the lack of funding opportunities for EER within the UK. This is not unique to the UK, but is also experienced in other countries such as Ireland, Australia (Godfrey and Hadgraft 2009), Portugal and Ireland (Sorby et al. 2014), and in the three Nordic countries, Denmark, Sweden and Finland (Edström et al. 2016). Specifically, Edström et al. (2016) points to the lack of proactive funding on the European level as a contributory factor to the stunted development of EER in Europe. (219), with Malmi et al. (2018) claiming that it is difficult to receive support for EER as it is not a good fit with the criteria defined for Horizon 2020 funding. Such findings are particularly significant given the work of Sorby et al. (2014), who argue that EER in the U.S. primarily emerged as a result of consistent funding within the U.S., with two-thirds of publications within the JEE between 1998 and 2002 acknowledging funding from the National Science Foundation (NSF) (Wankat 2004). Such findings perhaps suggest that lack of funding may be a limiting factor in the development of EER within the UK context.

The findings also point at variable, inadequate and unsustainable levels of institutional support for EER. There was a perceived opportunity cost associated with partaking in EER, something which was particularly relevant for those who were submitted to the REF in which EER does not appear to be valued. This is consistent with findings from Dart, Trad, and Blackmore (2021) that Australian academics perceive that engaging in EER competes with institutional expectations to publish in their technical disciplines.

The REF also seems to lead to a clear disparity in the way that those who conduct EER, who in this study were predominantly teaching specialists, feel valued. For some, this was a direct result of having been moved to a teaching specialist pathway so that they did not have to be submitted to the REF. The lack of recognition is consistent with previous research in the USA in which EER has been referred to as a 'hobby' or 'side activity', conducted 'later in [one's] career' (Jesiek, News-wander, and Borrego 2009) as opposed to a 'viable research area' (ASEE 2009, 2012; Olds et al. 2012) and is considered to be of lower status and value within engineering schools than technical work (Beddoes 2012). In the context of Australian higher education, EER has been described as not 'real' research' (Gardner and Willey 2016) and early career researchers have been claimed to be 'more vulnerable' than those who had achieved a level of status and had 'freedom to choose to work on what interests them' (Gardner and Willey 2016). Elsewhere, a change to focussing on EER, which is perceived as a 'soft discipline', has been perceived as a mistake which is punished by reduced reward and recognition (Dart et al. 2019; Williams and Figueiredo 2012).

In a practical sense, the majority of teaching specialists had high teaching loads which left little time for research, something which was also reported in the Australian context (Dart, Trad, and Blackmore 2021). In the majority of cases, institutional support was dependent on the support of individuals such as a line manager or Departmental Head, something which was also found in the Australian situation (Dart, Trad, and Blackmore 2021; Gardner and Willey 2016).

The findings also suggest a desire for both discipline specific teacher training, as well as development in educational research methods. The need for discipline specific teacher training has been highlighted on several occasions, with Felder, Brent and Prince (2011) saying that 'in the absence of discipline-specific examples it is easy for engineers to dismiss (instructional development) programme content as irrelevant to their courses, subjects, students, and problem' (90).

It is therefore clear that individuals involved in UK EER are faced with the challenges of developing new expertise in educational research (Beddoes 2012), as well as challenges associated with the reconciliation or negotiation process involved in developing the values of a different research community (Gardner and Willey 2016). This development process may be significant given the substantial differences between what Jones (2011) considers to be the high paradigmatic field of engineering in which a positivistic paradigm is applied, and low paradigmatic fields such as education research, in which there is less agreement in appropriate research questions and methodologies and is an issue which is compounded by the lack of discipline specific educator training available within the UK.

5. Conclusions

This study demonstrates the many similarities between EER within the UK and the rest of Europe, for example the lack of formal PhD programmes and EER Professorships reported in Portugal and Ireland (Sorby et al. 2014), as well as the lack of a sustainable source of funding (Edström et al. 2016; Sorby et al. 2014). However, one undeniable difference between the UK and elsewhere appears to be the impact of the REF, which is believed to have influenced the increase in Teaching and Scholarship roles (Locke et al. 2016), but which has also acted to strengthen differences between pedagogy and other research, and which has been claimed to have discouraged development and investment in interdisciplinary and emerging research disciplines (Higgins 2020).

Despite this, there does appear to be some appetite for the development of EER within the UK, with the majority of individuals involved being intrinsically motivated teaching focused academics. Although research questions tended to be of personal interest and focused on the participants' local context, there was a perceived need for both an emerging research agenda, and a consensus in quality criteria. It was uncommon for those involved in EER to collaborate, especially with colleagues external to their own institution, or with education researchers and social scientists. However, there was a desire to meet 'likeminded' individuals, this being one of the reasons for the preference to disseminate work at conferences as opposed to within journals. These findings, alongside the acknowledgement that education research can be done with very little resource, suggests that there is potential for the formation for UK based teams who research common, national challenges.

The relative lack of publication was associated with both the acknowledgement that UK EER is not yet of the quality needed for either publication in some journals or to obtain funding, and a lack of confidence that researchers had in their ability to produce quality research. There was a distinct lack of professional development and informal mentoring opportunities, as well as dedicated time or recognition for partaking in EER. To remedy this, the UK could take a leaf from SEFI, the European Society for Engineering Education, which, in 2008, established an EER working group, the Engineering Education Research Working Group (WG-EER) and introduced a dedicated EER track at SEFI's annual conferences (Bernhard 2018). Following these two initiatives, the number of EER contributions by European researchers has increased year-on-year. The UK could also emulate European universities and schools of engineering in establishing dedicated EER professorships and lectureships and offering PhDs in EER. This could significantly improve both the capacity and quality of EER in the UK (Bernhard 2018).

In light of the view that UK EER appears to be conducted by intrinsically motivated individuals, it is clear, particularly given the increased pressures placed on universities and their staff, that the development of EER within the UK will be dependent upon both institutional and national recognition for the work involved, as well as access to opportunities to both network and collaborate, and to develop expertise in research methods. It will be necessary to include consideration for the diverse backgrounds of those involved and the experiences that they bring, as well as facilitating collaboration between individuals from different disciplines. The creation of a research agenda should be facilitated by conversations between all stakeholders including policymakers, professional institutes, as well as academia, industry and engineering students. There is a need to establish quality criterion, as well as guidance about what is required for publication. Such activities could be facilitated by those who have been successful within UK EER, but also by EER researchers in other countries in which EER is more established.

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