



## MAPPING THE ENGINEERING EDUCATION RESEARCH LANDSCAPE IN IRELAND AND THE UK (RESEARCH)

**N Wint**<sup>1</sup>

Swansea University  
Swansea, UK  
0000-0002-9229-5728

**M Murphy**

TU Dublin  
Dublin, Ireland  
0000-0002-8343-0684

**A Valentine**

University of Melbourne  
Melbourne, Australia  
0000-0002-8640-4924

**B Williams**

CEG-IST, Instituto superior Técnico, Universidade de Lisboa, Portugal  
Lisbon, Portugal  
TU Dublin  
Dublin, Ireland  
0000-0003-1604-748X

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### ABSTRACT

The growth of Engineering Education Research (EER) has led to claims about it becoming a globally connected field of inquiry. This paper presents data on the development of EER within the UK and Ireland with the aim of contributing towards

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<sup>1</sup> *Corresponding Author*

*N Wint*

*n.wint@swansea.ac.uk*



our understanding of the field. A computer-aided process was used to extract the names of authors, affiliated with UK and Irish institutions, that had published in a sample of 13 different EER journals in the years 2018 and 2019. We identified 122 UK authors and 17 from the Republic of Ireland.

Selected experts in both countries were contacted to obtain complementary data that were used to build a picture of the research landscape in which EER practitioners function.

Similarities and differences between EER in both geographic contexts were identified. In both there were few institutions listed as having EER centres, and it was more common for participants to refer to individual researchers. There also appeared to be a lack of formal PhD programmes and funding opportunities in EER within both countries. Whilst recognition for EER in the UK was primarily associated with teaching awards and fellowships, in Ireland EER outputs appeared to be as valued as disciplinary research activities.

The overall portrait that emerges from the data collected suggests that in both the UK and Ireland, EER does not benefit from a national support infrastructure but rather, is typically carried out by individuals or small groups of researchers.

## 1 INTRODUCTION

The last few decades have seen an increasing amount of research which focuses on the evolving nature of engineering education research (EER). The approach to such work varies. For example, Jesiek, Newswander, and Borrego [1] made use of observational data collected at the International Conference on Research in Engineering Education (ICREE) to examine how EER is variously conceptualized as a discipline, community of practice, and/or field. Froyd and Lohmann [2] make use of Fensham's [3] criteria for evaluating the maturation of fields of disciplinary-based education research to describe the state of EER.

Elsewhere, work has considered EER within the global context [4], [5], [6], with some making use of a comparative methodology when considering the approaches taken in different geographical locations. For example, Borrego & Bernhard [7] compared approaches to EER in the US and Northern and Central Europe. They concluded that the growth of EER depends upon understanding the perspectives of researchers within other contexts, as well as valuing diverse views on what constitutes quality.

Several pieces of research focus on the development of EER within different contexts including: the U.S.A. [2]; Portugal [8], [9]; Ireland [8]; Australia and New Zealand [10]; Europe [11]; as well as within three Nordic Countries [12].

More recently, this work has included the use of scientometric analysis to determine trends in the number of EER publications and is thus useful for quantitative comparison. This paper compares the development of EER within the UK (consisting of England, Wales, Scotland and Northern Ireland) and the Republic of Ireland. In so doing, a computer-aided process is used to extract the names of authors, affiliated with UK and Irish institutions. The findings are discussed in the context of

complementary data obtained from selected experts within each location. Previous work [8] within the Irish context has described the status of EER, based on Fensham's [3] criteria. In the UK, two different studies have described low levels of engagement in EER, with a lack of peer reviewed articles [13], with most of the published research being single authored, or associated with single institutions [14].

## 2 METHODOLOGY

### 2.1 Publication data

This research adopts a case study approach, this being suited to the detailed and complex analysis necessary to answer questions about contemporary phenomena within real-life contexts [15]. We define our cases as the EER landscape within both the UK and Ireland. This includes EER centres within universities as well as national organisations that support, fund, and disseminate EER such as research networks. The research methodology was approved by research ethics committees at both Swansea University and TU Dublin.

A computer-aided process was used to extract the names of authors affiliated with UK and Irish institutions, who had published in a sample of 13 different EER journals in the years 2018 and 2019.

The journals were selected because they were indexed by Scopus and were established journals that had been publishing for at least several years. Related journals which focused heavily on technology aspects were not included (such as *Computer Applications in Engineering Education* and *IEEE Transactions on Learning Technologies*), as were journals that did not focus on a tertiary setting (such as *Journal of Pre-College Engineering Education Research*).

The thirteen selected EER journals were (i) *Advances in Engineering Education*, (ii) *Australasian Journal of Engineering Education*, (iii) *Education for Chemical Engineers*, (iv) *European Journal of Engineering Education*, (v) *Global Journal of Engineering Education*, (vi) *IEEE Transactions on Education*, (vii) *International Journal of Electrical Engineering Education*, (viii) *International Journal of Engineering Education*, (ix) *International Journal of Engineering Pedagogy*, (x) *International Journal of Mechanical Engineering Education*, (xi) *Journal of Engineering Education*, (xii) *Journal of Engineering Education Transformations*, (xiii) *Journal of Professional Issues in Engineering Education and Practice* (now *Journal of Civil Engineering Education*).

122 UK authors and 17 from the Republic of Ireland were identified.

### 2.2 Complementary data

This data was complemented by that obtained from the answers to five questions

1. Are you aware of any research teams/groups in the UK that focus on EER? If so, please name the relevant groups/leads/institutions



2. If there is no recognised EER team, are there individual active engineering education researchers? Can you share their names for the purposes of this study?
3. Are you aware of any institutions that have a structured programme, such as a PhD programme, which specialises in EER?
4. Are you aware of any incentives or recognition at your institution, or others within the UK, for publication within the EER community?
5. Is there funding or support for Engineering Education Research?  
Have any academics/researchers secured institutional, national or international funding for EER? If yes, could you provide source, objective and size of the funding?

In Ireland, the questions were emailed to all 17 of the identified authors. Nine authors who came from five different institutions, as well as one emeritus professor replied. In addition, the relevant deans of engineering and heads of engineering from 16 institutions in Ireland were emailed with the same set of questions. Eight deans/heads of engineering replied. Through this process, a further 17 academics were referred, with three responding. This resulted in a total of 21 individual participants from eight different institutions.

In the UK, where a larger number of authors were identified (122), a purposeful sampling approach was used whereby those contacted were considered to be “actor(s) who have been visible in the dominant EER communities” [12]. 12 individuals were approached, with nine replying. Through a snowball sampling approach, a further three participants were contacted, of which two replied. This resulted in a total of 11 participants who came from nine different universities. 10 participants answered via email, whilst one answered during a video call.

There was also an attempt to understand whether EER projects were funded within the UK. The Gateway to Research (GtR) website, which enables users to search and analyse information about publicly funded research, was used to identify work funded by UK Research and Innovation (UKRI) who are responsible for directing research and innovation funding provided by the governmental science budget. UKRI is composed of 7 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, as well as Innovate UK who support business-led research and innovation. Search terms included “engineering education”, “engineering” and “education”, “STEM education”, “STEM” and “education”.

### 3 RESULTS

#### 3.1 Publication data

In quantitative terms we note a difference in the number of authors published from the two national contexts in the years 2018 and 2019 and that there were more from the Republic of Ireland relative to its population, as well as the number of academic staff employed by HEIs.

When considering these findings it is important to note that the computer aided process only considered articles published in 13 different EER journals in the years 2018 and 2019, and the extent to which findings represent long term EER activity within both the UK and Ireland is limited. It is also possible that the most common mode of dissemination is via conference papers as opposed to publications within journal, as has been noted as the case in previous work [13], [14].

*Table 1: The number of authors, affiliated with UK and Irish institutions, that had published in a sample of 13 different EER journals in the years 2018 and 2019.*

	Authors	Population (million)	Number of HEIs/ Academic Staff	Authors per million population	Authors per HEI/academic staff
Ireland	17	5.2	18/9,977 [16]	3.3	1.1/0.002
UK	122	67.1	214/224,530 [17]	1.8	0.6/0.0005

### 3.2 Ireland

Respondents from Ireland identified a small number of research groups, with the CREATE group at TU Dublin, which is typically made up of 20 individuals, being most commonly identified as directly focused on EER. Other groups noted include the Technology Education Research Group at the University of Limerick, the Sustainable Infrastructure Research and Innovation Group (SIRIG) at Munster Technological University, and the Engineering Education for Sustainable Development (EESD) group that is active in University College Cork. There were pointers to other looser networks and affiliations, such as the Irish Network for Gender Equality in Computing (INGENIC).

One distinguished researcher questioned whether EER is a disciplinary field, as it relies on engineering to exist. This researcher noted that the definition of EER coming from the US was too narrow to be useful, which was taken to mean that generating knowledge of engineering education through research and the EER agenda were not sufficiently broad. Certainly, in looking at the breadth of respondent comments, there were numerous indicators that activities can be interpreted as intending to inform practice, for example preparing students, improving engineering education, changing the nature of engineering, and impacting society [1].

There appear to be no restrictions or limitations on EER activity, and publications in this field count towards research active status, and support promotion applications. There was no evidence of structured PhD programmes in EER. However, a number of institutions clearly support PhD research projects in EER with numerous respondents confirming this. This occurs across the HE sector – within universities, technological universities and institutes of technology.

At a national level there was no evidence presented of targeted funding for EER. However, several funded projects were noted as addressing research questions



within EER. At an institutional level, there appears to be some small local support (essentially seed money) for projects within the general definition of EER. One researcher noted receiving significant EU support for international collaborative projects to identify attributes that would inform the practice of educating engineering students.

### 3.3 UK

A small number of research groups were identified, the most commonly cited being the UK Engineering Education Research Network. UCL, Bristol University and Warwick Manufacturing Group were mentioned as institutions hosting EER groups by numerous participants, with one saying that “the only substantive group would have to be there at UCL. That’s about the only formal one”. There seemed to be confusion around whether some researchers were part of a group, with one participant considering that “because there’s nothing formal within the university to promote that it will tend to be a loose, informal coming together of people...if they don’t fit within the university structure, then it often it, you know it is built around individuals. So often it will fizzle and die people or move on”. It was therefore more common for EER activity to be associated with individuals within each institution, with one participant describing it as limited to “one or two people. Sometimes they work together, sometimes they don’t.” The same participant claimed that it would be beneficial to “mobilize” individual researchers “around a national priority or something...you know, if you’ve got 50 institutions, you’ve got 50 contributions to your data set”.

Participants were unable to identify any formal PhD programmes, with one participant saying that this would imply “a more US approach to PhD than the UK individual scholar approach”. They added that “many of the interested academics have one or two PhD students” but that this would not “constitute a programme”. A different participant commented that such PhDs were “done within the typical the institutional PhD frameworks” and were often completed by international students who had financial support from their own governments, or those who had support of the department (especially in the case of candidates who were already staff) or through trusts. Some participants mentioned that the title of the PhD would be associated with the department and therefore, in the majority of cases, candidates would obtain a PhD in Engineering. This has implications for the identity of engineering education researchers, but also how their skills and expertise are perceived and the career opportunities that may be available to them. Other participants identified both UCL’s MSc Engineering and Education and the Engineering Education BSc from the University of Sunderland which both include some elements focused on conducting education research.

Views around incentives or recognition for publication were polarised, with answers being linked to both teaching career pathways and Research Excellence Framework (REF). Those who spoke about 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), mentioned the need to produce pedagogical research or scholarship in order to achieve promotion. Internal funding for education research and Fellowship of Advance HE and the National Teaching Fellowship awards programme were also mentioned as incentives.

Opinions about the role REF played in incentivizing researchers were mixed. For example, one participant believed “change in terms for 2021 REF enabled EER publications to be submitted for assessment in the engineering panel which gave them a little more status.” In comparison, a different participant believed engineering panels “won't understand what you're doing” and that was assuming that “you've got to get through all the institutional culture that's against it before you can even get to that point”. However, they did add that “REF could be such a facilitator for what we're doing” suggesting “that unless a discipline can demonstrate in the REF it is doing discipline-based education research it should be marked down”. A different participant claimed there were “more disincentives” associated with EER than incentives, which they considered to include a lack of “journals with sufficient rating for REF submission while at the same time being practitioner relevant”, something which they considered made it “difficult for newer researchers to use the field to advance their academic careers” and meant that for more experienced researchers “it can be a part time activity while also pursuing their core engineering discipline”.

Funding for EER was considered to be “very limited”. Some participants had access to internal funds from their own institutions. The Higher Education Academy (now called Advance HE), the Office for Students, QAA, the Nuffield Foundation, and Leverhulme Trust as well as the Engineering Professors' Council (EPC) and the Royal Academy of Engineering were all named as possible sources of small amounts of money. However, opportunities were sporadic, and organisations were described as not “really properly commit(ing) to something a little bit more like a programme of work”. Obtaining funding was described as mostly “coat tailing on other grants” which looked at “tangential things”. The lack of availability of funding was considered, by one participant, to result in “pigs feeding at a troth (*sic*)” and dispersed efforts, as opposed to the development of a sustainable community.

In comparison, a different participant considered the lack of funding to be a “perceptual problem rather than a real one”, something which they attributed to education research not requiring a lot of funding, and many institutions having small pots of money available. They believed that “the real gap to people doing EER is their own skills and lack of understanding of social sciences research methods, but that often gets masked as lack of funding”.

Funding from UKRI (Identified using Gateway to Research) appeared to take three different forms. In the first instance PhD studentships focused on research within engineering education were funded through EPSRC Doctoral Training Partnerships (DTP), a type of funding provided to UK universities to support multiple studentships. The funding is allocated to universities with significant EPSRC research activity, by means of an algorithm and it is up to the university holding a DTP to allocate

studentships within their organisation. This funding source is therefore dependent on the local environment. The second form of funding was for projects that focused on engineering outreach work. The third type of funding was for development of software for education purposes and was typically funded by Innovate UK.

*Table 2 Comparison of EER landscapes in the UK and Republic of Ireland*

<b>EER Landscape</b>	<b>UK</b>	<b>Republic of Ireland</b>
Research Groups	Small number of research groups, with UCL Centre for Engineering Education being the most established	Small number of groups, with CREATE at TU Dublin being the most established.
Degree Programmes	MSc Engineering and Education (UCL) and BSc Engineering Education (University of Sunderland) both include elements focused on conducting education research	PhD at TU Dublin, MSc at DCU
National Incentives	REF (both incentive and disincentive) Fellowship of Advance HE and the National Teaching Fellowship awards. Lack of sustainable sources of funding, with small amounts of money periodically being available from various sources.	No specific funding line for EER, but some relevant projects have received funding.
Institutional Incentives	Some small amounts of funding. Scholarship counts towards promotion for Teaching Pathway Academics.	Some small incentives. Research outputs count towards promotion.

#### 4 SUMMARY AND ACKNOWLEDGMENTS

There do not appear to be any explicit differences between the EER landscapes that would explain the increased number of authors in EER in Ireland compared to the UK. In both contexts there are only a small number of established research groups and formal doctoral qualifications. There is also a lack of external funding with internal incentives consisting of small amounts of funding and progress toward promotion. It is possible that the smaller number of institutions within the Republic of Ireland means that it is easier to collaborate and that there is less competition for the scarce funds available. It is also clear that REF has an impact on the research culture and environment within the UK context and could explain why it is more likely for EER to be considered as research activity for academics within Ireland.

The assumed desire for the UK and Ireland to remain at the forefront of engineering education developments creates the need for clear strategies that focus on national needs and collaboration, something which could be further facilitated by the UK and Ireland EERN, which was mentioned as providing a vibrant community across both of the regions considered. 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. Such an approach would allow for the critical mass needed to carry out ambitious and well structured projects with wider reaching impact. This, in turn, is predicted to attract interest from researchers from different disciplines, including education and the





social sciences, as well as funding possibilities. Researchers within the UK and Ireland should also pursue opportunities to work with international colleagues, particularly those from contexts in which EER is more established. This will allow them develop their research expertise, take part in larger projects and contribute to international developments.

Policymakers should consider funding priorities. For example, as Malmi et al. (2018) point out, whilst the US National Science Foundation support EER, within Europe funding is difficult as it does not align with criteria set out by Horizon 2020 funding [18].

In the absence of external financial support it seems clear, particularly given the increased pressures placed on universities and their staff, that the development of EER within both the UK and the Ireland will be dependent upon both institutional and national recognition for the work involved.

Further work in this area should focus on comparing the trends in publication across a wider timeframe, and comparison with more countries within Europe.

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