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Mapping The Engineering Education Research Landscape Across Europe

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MAPPING THE ENGINEERING EDUCATION RESEARCH LANDSCAPES ACROSS EUROPE (RESEARCH)

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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 seven European countries, with the aim of contributing

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towards understanding of the field. Data was collected from participants of a workshop held at the SEFI 2022 Annual Conference which was entitled “Mapping Engineering Education Research in Europe”. Participants were asked to comment on the presence of formal research groups and PhD Programmes, as well as incentives and funding opportunities within the context. In most countries, there was a reported absence of formal EER groups and EER PhD programmes and in some cases, PhDs focusing on EER were included within general science and engineering programmes. In most cases incentives were associated with teaching awards and interventions and funding opportunities appeared to be small and isolated. In few cases was EER considered to be as valued as disciplinary research. The overall portrait that emerges from the data collected suggests that EER within European countries does not benefit from a national support infrastructure, but rather is typically carried out by individuals or small groups of researchers.

1 INTRODUCTION

Research focused on development of EER has grown over previous decades. For example, observational data collected at the International Conference on Research in Engineering Education (ICREE) was used to examine how EER is conceptualized as a discipline, community of practice, and/or field (Jesiek, Newswander, and Borrego 2009). Elsewhere, the state of EER has been described (Froyd and Lohmann 2014) using Fensham’s (Fensham 2014) criteria for evaluating maturity levels of fields of disciplinary-based education research.

Comparative methodologies have been used to consider approaches to EER within different global contexts (Jesiek, Borrego, and Beddoes 2010; Jesiek, Borrego, and Beddoes; Streveler and Smith 2010), and EER in the USA has been compared to that in Northern and Central Europe, the authors claiming that understanding the perspectives of those within other contexts, particularly regarding what constitutes quality, is needed for development of EER (Borrego and Bernhard 2011).

Although work primarily concentrates on the US context, several papers have now been published which focus on EER within different European countries including: Portugal (Sorby et al. 2014; van Hattum-Janssen et al. 2015) Ireland (Sorby et al. 2014; Wint et al. 2022); the UK (Nyamapfene and Williams 2017; Shawcross and Ridgman 2013; Wint and Nyamapfene 2022; Wint et al. 2022a); and within three Nordic Countries (Edström et al. 2018); as well as in Europe as a whole (Bernhard 2018). However, there is a need for work comparing EER between individual countries in Europe and the authors believe that the SEFI community is a potentially valuable source of relevant data at country level.

The aim of this work is to establish a baseline position with respect to EER within Europe, and to make use of findings to recommend actions at a European level. In this paper we thus compare the development of EER within seven different European countries: Belgium, Demark; Finland; Ireland; Italy; the Netherlands; and the UK. In so doing, we present data collected from participants of a workshop held

at the SEFI 2022 Annual Conference (Wint et al. 2022b) which focused on contextual factors which influence development of EER in countries across Europe.

2 METHODOLOGY

Data was collected from participants of a workshop held at the SEFI 2022 Annual Conference which was entitled “Mapping Engineering Education Research in Europe” (Wint et al. 2022b). During one of the activities, participants were asked to write comments about the presence of formal research groups and PhD Programmes, as well as both national and institutional incentives and funding opportunities within their context. They were also asked for any other information they felt was relevant to understand EER within their country. Answers were collected at the end of the workshop. 12 people from seven different countries provided answers to the questions asked. Of these, seven participants from six different countries supplied contact details and were emailed a copy of their answers, alongside our interpretation and any further questions we had regarding their answers. They were asked to recommend anybody they thought we should contact for further information about EER within their context. Through a snowball sampling approach, a further six participants from three different countries were contacted, of which three replied, all from the same country.

The study reflects the views of a small number of self-selected participants and can therefore be considered subject to selection bias. An advertised workshop aim was to provide “insight into ways to support development of EER in the future”, and it may therefore be reasonable to propose that those who took part wanted to contribute towards the growth of EER and may possibly focus more heavily on negative aspects of EER within their context. Future work may benefit from an approach that includes a more representative sample that includes the audience of the research as well as researchers within other complementary fields such as social sciences or education and other stakeholder parties such as funding bodies and editors of research journals. Another limitation of the study relates to the fact that it takes an ‘insider’ view of the state of EER within each context. It would also be of interest to focus identifying any relationships between contextual factors and research output, for example via use of scientometric analysis (Wint et al. 2022a).

3 RESULTS

The findings for each country are presented below and summarised in Table 1.

3.1 Belgium

Aside from one formal group (Leuven Engineering and Science Education Center, KU Leuven), participants only acknowledged ‘loose’ departmental centres. Participants were not aware of PhD programmes in EER, only science and technology. Whilst there was believed to be a national focus on STEM education, this did not extend to education research. There was a lack of national incentives or funding, but it was possible to receive institutional funding, albeit challenging.

3.2 Denmark

In Denmark, participants did not comment on the presence of formal research groups but did express concerns that formal structures may discourage entrants from technical research. PhDs in EER were typically considered to be obtained through, and drive, publication. EER was thought to be valued as much as disciplinary research at an institutional level and philanthropic funding was mentioned as being available at a national level. Participants referenced a national "points-based system" (which is taken here to mean the Danish bibliometric research indicator or BFI), Denmark's national system for measuring research output, which forms part of a performance-based model of distribution of the new block grant based on production of research-based publications (Deutz et al. 2021). The system makes use of a tiered rating of publication channels (e.g., peer reviewed journals and publication houses) and assumes articles published in a given journal are equal in quality, or books published by the same publisher are of equal quality (Deutz et al. 2021). A new political agreement in December 2021 saw the termination of the BFI, with participants commenting that the impact of this on EER funding was unknown.

3.3 Finland

The Professional Growth and Learning (PGL) Research Group (Tampere University) was the only group identified. The group is led by Professor Petri Nokelainen who was believed to be the only EER professor in Finland. Although the group was thought to focus primarily on vocational education, they were known to publish EER, primarily within behavioural science journals. As highlighted previously, computing education research appears to be much stronger than EER in Finland (Edström et al. 2018). Groups included The Learning and Technology Group (LeTech) and that of Computing Education Research and Educational Technology (both at Aalto University and led by Professor Lauri Malmi). Another 'loose' group, focused on computer science education research, was claimed to exist at the University of Turku. A network of researchers from different Finnish universities who focused on computer science education and the behavioural sciences, was also reported to exist. Overall EER publications were believed to be written by individuals without any formal support structures, official research groups or themes. No structured PhD programmes were identified. Some doctoral students were claimed to focus on computer science or engineering education. Incentives or sources of recognition (including funding) were not identified at either a national or institutional level.

3.4 Ireland

As reported previously (Wint et al. 2022), EER research groups were claimed to exist within the Irish context, with one participant saying formal groups were needed to achieve critical mass. There was a disagreement between participants as to whether structured PhD programmes existed, but they were considered beneficial to generate output. There were inconsistencies with respect to the degree to which EER was incentivised or recognised within institutions, with one participant claiming, "education research won't get promotion within engineering" and another (from the

same institution) saying “EER is recognised reasonably”. At a national level there was no evidence of recognition or incentives, with one participant saying EER was “still a developing area”. There was believed to be “very little” and “limited” EER funding, and indeed that for interdisciplinary research, which was “difficult” to obtain.

3.5 Italy

No EER groups or PhD programmes were identified within the Italian context. However, both the META and METID (Politecnico di Milano) were mentioned, the former focusing on: epistemology; ethics of technology and engineering; philosophy of science and technology; science and technology studies (STS); and sociology of knowledge. In one university, institutional incentives included prizes for innovation in teaching, with related publications being recognised as relevant for the prize. Career path was considered to be determined by publications within a specific research area. However, EER journals were not acknowledged on lists of recommendation. Funding was believed to be an important incentive which did not exist within Italy.

3.6 Netherlands

In the Netherlands, all four technical research universities were involved in founding the 4 TU Centre for Engineering Education (4TU.CEE) which focuses on improvements and innovation within engineering education and, as such, was considered to promote EER. Groups at some of the fourteen “Research Universities” (RU) were also identified and included: Education and Learning Sciences (Wageningen University & Research) which included full professors in education and learning sciences; Eindhoven School of Education (Eindhoven University of Technology), part of the faculty of Applied Science and Science Education with 4 full professors and a number of emeritus professors with varying links to engineering education research; the Philosophy & Ethics Group at the Department of Industrial Engineering & Innovation Sciences (TU Eindhoven); TU/E innovation Space; the Department of Learning, Data-Analytics and Technology (University of Twente) with 3 full professors; The Leiden Delft Erasmus Universities Centre for Education and Learning embedded in the department of Software Technology at Faculty of Electrical Engineering, Mathematics & Computer Science (TU Delft); Science Education Research Group at the Faculty of Applied Sciences (TU Delft); PRIME (TU Delft); Research on Education Innovation at the Faculty of Architecture and the Built Environment (TU Delft); and Ethics Education for Engineers within the section Ethics & Philosophy of Technology (TU Delft). Most groups were said to conduct wider research in education and were also involved in secondary school STEM teaching. In addition, almost all other RUs were described as having educational science research groups in which higher education research and science education research, is done. In addition, there were also reported to be a few stand-alone engineering education researchers who supervise PhD students. Groups were also identified within the University of Applied Sciences (UAS) including: one at Utrecht UAS, who focused on Vocational Engineering Education (VET); and the Sustainable Talent Development Group (The Hague University of Applied Sciences).

The 4TU.CEE was said to have a structured PhD programme with several themes. Clusters of PhDs existed within some of the RU education groups, but stand-alone PhD researchers who did their PhD on an engineering education topic in a conventional engineering research group also existed. They were typically cited as having supervisors from two fields, one engineering specialist and one (engineering) education specialist. The PhD degree earned was reported to be dependent on the Faculty students were formally assigned to (e.g. Aerospace Engineering).

In all institutes involved in the 4TU.CEE, EER publications were said to be accepted as part of Tenure Track criteria. Incentives and recognition at an institutional level were believed to have improved since publication of Room for everyone's talent framework (VSNU, NFU, KNAW, NWO and ZonMw, 2017) which led to a programme aiming to encourage promotion of individuals on the basis of education.

National incentives included: Knowledge Sector Plans, government funding available for sectors to develop knowledge for the future; Comenius Fellowships, three level of grants for lecturers for evidence-based interventions; and the lifelong learning component in the Energy Switch Initiative funded by the province South Holland:

Funding for 4TU.CEE was reported to come from the universities involved. The centre was claimed to co-fund PhDs, innovation projects and fellowships that all focus on (practice-oriented) EER. In addition to European funding, national and regional funding sources were said to exist. For example, government funding included National Regie Orgaan Onderwijs (NRO) that has various calls related to Higher Education and EER. It was considered difficult to compete within the social sciences/education domain because of the limited funding available to them, as well as the lack of awareness of EER within the wider education field.

3.7 UK

As reported previously (Wint et al. 2022a), a small number of research groups were believed to exist within the UK and considered "instrumental in creating opportunities to bring researchers together to create a critical mass of support". There appeared to be a lack of structured EER PhD programmes, although there were individuals completing EER PhDs. However, structured programmes were considered as beneficial due to the fact that EER is "often far more aligned to social sciences than the first degrees of many people who begin to engage in EER". These issues were considered similar for staff who were thought to have little time because of the need to fulfil "the rest of their responsibilities", but who also needed support moving from a science and/or engineering background. In the case of participants who attended the workshop, EER was recognised and rewarded at an institutional level, and was considered a "strong piece of evidence for career progression", something which has been noted, particularly in the case of teaching pathway staff, previously (Wint et al. 2022a). Participants agreed that funding was limited, but also highlighted the role that institutional barriers play in preventing individuals applying for funding. For example, for many calls only those in academic posts were eligible to apply, whereas those in other positions (for example teaching support staff/teaching developers

were not allowed). The same was said to be true of PhD supervision, this again limiting participants' access to resources used to conduct EER.

Table 1 Comparison of EER landscapes in eight European countries

EER Landscape	Research Groups	PhD programmes	Institutional Incentives	National Incentives
Belgium	1 formal group (LESEC, KU Leuven), 'loose' departmental centres	Only programmes in science and technology	Challenging to receive institutional funding.	Lack of national incentives/ funding. Focus on STEM but not STEM education research.
Denmark	Lack of formal research groups	Obtained through, and drive, publication	EER valued as much as disciplinary research	System for measuring research output/ distributing funding. Philanthropic funding
Finland	PGL Research Group (Tampere University). Other groups focused on computer education. EER conducted by individuals without support structures	No structured PhD programmes. Some students focused on computer science/EER	Incentives or sources of recognition (including funding) not identified	Incentives or sources of recognition (including funding) not identified
Ireland	Small number of groups, with CREATE at TU Dublin being the most established.	Some PhD opportunities exist	Small incentives. Research count towards promotion.	EER developing nationally. No specific funding. Some relevant projects receive funding.
Italy	No EER groups identified, but both META and METID (Politecnico di Milano) groups mentioned	No PhD programmes	Prizes dedicated to innovation in teaching, with related publications being recognised.	Career path determined by publications within specific research area. EER journals not acknowledged on recommendation list. Lack of funding.
Netherlands	Numerous groups identified, some associated with science education research, higher education research, secondary school STEM teaching and vocational training. All four technical research universities involved in 4TU.CEE	Structured PhD programme at 4TU.CEE. Clusters of Engineering Education PhDs within some of the education groups, stand-alone PhD researchers	In all institutes involved in the 4TU.CEE, EER publications accepted as part of Tenure Track criteria. Incentives and recognition improved since the publication of the Room for everyone's talent framework.	Knowledge Sector Plans (government funding to develop knowledge for the future). Comenius Fellowships for evidence-based interventions. 4TU.CEE funding to co-fund PhDs, innovation projects and fellowships. European funding, national and regional funding (e.g., NRO)
UK	Small number identified	Lack of structured PhD programmes	Supports progression in "teaching" roles. Small funding opportunities	Institutional barriers to applying to limited funding opportunities. Teaching awards and teaching fellowships

4 SUMMARY

This work is limited by the number of EER landscapes considered, and the possibility of participant selection bias. Future work would benefit from inclusion of a wider range of countries and participants, as well as collection of further detailed data, for example pertaining to variation in institutional incentives and rewards. Despite this, the findings suggest a consistent picture of lacking national EER infrastructures and are considered representative of the case for other European countries. Except for the Netherlands, few formal EER groups were identified. There was a lack of structured PhD programmes, with PhDs typically being 'standalone' within engineering departments or obtained via publication. Institutional recognition focused on teaching awards. In some cases, there were small funding opportunities and EER counted toward promotion. Few national funding opportunities were identified. In some contexts (Denmark, Italy, and the UK), funding was linked to research output exercises which typically did not acknowledge EER. In some countries (Ireland and the UK) the interdisciplinary nature of EER limited funding opportunities as grants were designated to educationalists or technical engineering work.

EER appears to be most developed within the Netherlands where establishment of the 4TU.CEE (which is funded by the four partner universities) appears to have contributed towards increased PhD and funding opportunities. Regional and national funding opportunities, particularly those focused on the knowledge sector and lifelong learning also appear to have helped with growth of the field. Work around career pathways also seems to be beneficial. Initiatives such as 4TU.CEE are likely to provide several benefits. It provides space for development of clear strategies that focus on national needs, as well as opportunities for collaboration and researcher development. Such approaches allow for the critical mass needed to carry out ambitious and well-structured projects with wider reaching impact and this, in turn, is more likely to attract interest from researchers from different disciplines, as well as other stakeholders such as policymakers, professional institutes and industry. Based on findings from the Netherlands, which appears to benefit from establishment of a common centre and regional/national level strategy, we recommend the creation of both national and European position papers which outline strategic priorities which align with national policy. Such approaches have been taken in contexts in which engineering education is newly emerging such as Malaysia (Alias and Williams 2011) and could be facilitated by SEFI. In the absence of external financial support, it seems clear, particularly given increased pressures placed on universities and staff, that development of EER within European countries depends upon institutional recognition, and it is thus suggested that European institutions learn from initiatives which encourage promotion of individuals on the basis of education.

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