



## Institutionalizing Engineering Education Research: Comparing New Zealand and South Africa

Siddharth S.Kumar<sup>a</sup>, Yasir Gamielien<sup>a</sup>, Jennifer M.Case<sup>a,b</sup>, Mike Klassen<sup>c</sup>  
*Virginia Tech<sup>a</sup>, University of Cape Town<sup>b</sup>, University of Toronto<sup>c</sup>*  
*Corresponding Author's Email: ssiddharth96@vt.edu*

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### ABSTRACT

#### CONTEXT

Engineering Education Research (EER) is often written about as a global phenomenon, and yet it takes on quite different forms in various countries. In this study we are interested in the process of institutionalization, whereby a distinct identity and meaning of EER develops in a country and becomes embedded in organizational structures. We draw on neo-institutional theory to look at the broad relationships between national forces such as research funding and accreditation; university-level strategies such as PhD programs, centers and departments; and the emergence of scholarly associations, conferences and journals.

#### PURPOSE

This study builds on a previous comparative case study of EER in Australia, China and the USA and extends this work to look at New Zealand and South Africa, two national contexts that might be considered “peripheral” in terms of their size and global prominence in EER, but each of which have distinctive and energetic EER communities.

#### METHODS

Using a comparative case study approach, our study draws primarily on review articles that describe or analyze the field of EER in each country, supplemented by our engagement with expert informants. Analytically, using the process model of institutionalization, the cases are organized around (a) the prior structures and environments in which the organizational EER field emerges, (b) key events that create conditions for this development, (c) how political will and resources come to play, and (d) the emergent belief systems and identities.

#### OUTCOMES

Both South Africa and New Zealand show trajectories of institutionalization of EER that are strongly linked to institutional imperatives to improve engineering education teaching and curriculum. In the South African case, this is further promoted by an intense national imperative to transform the post-apartheid university system. While some SA researchers have accessed national research funding, this is not the most significant driver of the field. The respective regional contexts explain why NZ EER researchers align themselves with the Australasian body, AAEE, while the SA researchers have established their own structures.

#### CONCLUSIONS

This study offers further evidence of the very different forms through which EER is institutionalized in different national contexts. South Africa and New Zealand offer further exemplars of context where the main imperative for the field is focused on institutional reform of engineering education, rather than external research funding as has been seen in the USA.

**KEYWORDS:** Engineering Education Research, institutionalization, comparative case study

## Introduction

Over the past 30 years, Engineering Education Research (EER) as a field has developed as a distinctive domain, with a notable growth in recent years of departments and degree programs, publication outlets, research agendas, and meetings (Jesiek et al., 2009). While EER has advanced across the globe, there have been different trajectories of development in different national contexts. This paper builds on a previous paper which compared the institutionalization of EER in Australia, China and the U.S. The results of that prior study challenged the assumption that there is only one ideal form for the institutionalization of EER. In contrast, it showed that EER thrives in a symbiotic relationship with its host disciplines and institutions, in a broader context of national priorities and structure (Klassen et al., 2020) In this paper, we explore the different ways that EER has been institutionalized in two different countries, South Africa and New Zealand. We aim to determine how (and if) unique aspects of each country make the national fields of EER distinct.

Our study draws on existing literature, which we sourced by engaging with key informants in each national context. South Africa has a distinct history with regards to Higher Education and EER in terms of how the key elements of its history have shaped how the field looks today, particularly in relation to the transition from apartheid to the democratic dispensation. There is already a rich literature on EER in South Africa. New Zealand, on the other hand, has been much less studied and is usually considered together with Australia. Our study aimed to explore whether there was a distinctive New Zealand institutionalization of EER.

Prior studies looking at the development of EER as a field considered many aspects such as the formation of national scholarly groups, national-level strategies such as conferences that are held, university-level strategies like PhD programs and models and other factors such as accreditation and the availability of internal and external funding (Collier-Reed & Case, 2017; Crawford, 2016). Our study also explores a similarly wide range of factors but differs in its use of neo-institutional theory in order to understand the development of organizational structures in relation to wider social forces (Lounsbury & Yanfei Zhao, 2013).

## Theoretical Framework: Neo-institutional theory

This study draws on the following definition of institutionalization: “A structure that has become institutionalized is one that has become taken for granted by members of a social group as efficacious and necessary” (Tolbert & Zucker, 1999). Neo-institutionalism explores how institutional structures, rules, norms, and cultures constrain the choices and actions of individuals when they are a part of an institution (Breuning & Ishiyama, 2014).

For this paper, we are interested in seeing how EER has been institutionalized in the South African and New Zealand contexts, viewed through two distinct units of analysis. The first unit is the EER organizational research units that are formed at universities and the second unit of analysis applies to the broader organizational field at a national level, which is a collection of the EER organizational research units and related support organizations. An organizational field is defined as a set of organizations sharing systems of common meanings and interacting more frequently among themselves than with actors from outside the field, thus constituting a recognized area of institutional life (Machado-da-Silva et al., 2006).

To further operationalize institutionalization we draw on the conceptual framework put forward by Zapp & Powell, (2016), who traced the institutionalisation of educational research in Germany, also over a 30-40 year period. Their model consists of four main elements: *Prior Structures & Environment*, *Innovation/ Shock and Idea*, *Political Will and Resources* and *Belief System and Identity*. This is not a prescriptive model, but rather, a set of theoretical concepts that help to build narratives of how institutionalisation is formed in different contexts.

The four elements are described as follows:

- **Prior Structures & Environment:** Existing organizational actors (prior structures)
- **Innovation/shock & idea:** Key events (innovations or new policy ideas) which create contradictions in organizations' environments and thus lead to new opportunities
- **Political will & resources:** Key actors leverage existing resources to create new institutions or transform existing ones.
- **Belief System and Identity:** Often take the form of normative networks (e.g., professional associations) which shape organizational fields by creating a sense of meaning and identity for local actors

## Methodology: Comparative Case Study

Our study is focused on the following research questions:

1. In what ways has the institutionalization of EER proceeded in the two different countries in the study?
2. How can we explain these different trajectories of institutionalization in the light of national contexts?

To answer these, we draw on tools from comparative case study methodology in particular the horizontal and transversal axes of comparison (Bartlett & Vavrus, (2014)). The horizontal axis of comparison deals with how similar policies unfold in distinct locations (across the two countries for our study), and how they might be connected. The transversal axes studies across and through levels to explore how globalizing processes connect people and policies through different time scales (Bartlett & Vavrus, 2014).

Our data collection followed guidance for scoping studies (Levac et al., 2010) to locate articles that focused on the field of EER in each country. We searched leading EER journals for articles including New Zealand or South Africa, filtering for those focused on the structure of the national EER field, and also searched the conference proceedings for the two national EER societies. Papers focused on the wider field of EER, and its institutionalization, were hard to locate, so we used reference tracking and citation tracking to trace the few relevant papers we did find. In general, more literature was available for South Africa. Writing on EER in New Zealand is largely combined with EER in Australia so it was initially hard to tell a distinctive story for New Zealand.

We expanded our search by reaching out to key expert informants to help us obtain more information. Our author team includes a breadth of experience living, studying and researching engineering education in both countries. We used our personal networks and a review of EER society websites to reach out and speak to 3 informants in each country (6 total). We selected the informants based on (1) a track record of EER writing themselves, (2) active roles (past or present) in building the national field of EER, and (3) a balance of historical knowledge of field origins with an accurate picture of the current state of the field. We also sought a range of institutional perspectives, so each informant was from a different university. We used a semi-structured interview protocol to prompt the informants to talk about EER in their country, and also importantly to share relevant articles, books and conference papers on the topic that weren't captured by our scoping study. We constructed draft case reports for each country using our theoretical categories below and sent these to the informants for review. Below, we report on the two cases and conclude with a comparative analysis.

# Findings

## South Africa

### *Prior Structures & Environment*

Before the 1990s, the higher education system in South Africa looked very different to the way it does today. The apartheid system involved a highly unequal schooling system and racially segregated university provision (Collier-Reed & Case, 2017). The universities that served white students were far better resourced than those designated for others; in fact, the older established universities had all been designated as “whites-only” (Case et al., 2016). All except one of the eight universities and five of the twelve ‘technikons’ offering engineering qualifications were restricted in access for the white population (Case & Jawitz, 2003), even though they only constituted 10% of the population. Racialized patterns of students access were mirrored in academic staffing: during this period, almost all of these engineering programs were staffed almost exclusively by white academics (Case & Jawitz, 2003).

### *Innovation shock/idea*

The first real signs of change came in the 1980s as the racial restrictions on access started to be lifted. This accelerated during the 1990s into the post-apartheid period which also saw massive policy shifts which resulted in a rework of the entire institutional landscape (Case et al., 2016). The racially separate institutions were reworked into a unified system which involved a number of institutional mergers leading to the consolidation of 26 public universities. Student enrolments grew rapidly in the post-apartheid period, with an overall doubling of the student population in first two decades, and significant shifts in student demographics at most of the institutions (Mabokela & Mlambo, 2017).

The important White Paper on higher education of 1997 consolidated the idea that education, and higher education specifically, needed to be a key driver for the transformation of the post-apartheid society (Department of Education, 1997). Thus, issues of equity and access remained at the forefront of political priorities. This was a fertile environment for the growth of Academic Development in universities, which had started at the historically white English universities in the 1980s but which now became a centrally funded national imperative for all institutions.

### *Political Will & Resources*

One of the key groups that had a significant influence on shaping EER as a field in South Africa was the Centre for Research in Engineering Education (CREE). CREE was originally established in 1996 with the aim that Engineering Education could be recognised as a sustainable research field (Fraser, 2008). CREE initially focused its attention on the students who had been educationally disadvantaged from the apartheid education system and who were struggling academically (Kloot, 2021). This focus shifted to incorporate researchers who worked in science disciplines and laid the groundwork for establishing a national network and organizing the first two national conferences in Engineering Education in 1997 and 2000 (Jawitz, 2001). CREE was limited in national scope and role given its home in a single university, University of Cape Town (UCT). The national void was ultimately filled by Engineering Council of South Africa (ECSA), whose primary role was based around the accreditation of engineering programs and the regulation of the practice of registered persons. ECSA initiated plans for a new organization that could coordinate events such as national conferences and this had led to the formation of the South African Society of Engineering Education (SASEE) in 2010 (Collier-Reed & Case, 2017).

Another factor influencing EER as a field in South Africa was the availability of funding to support Academic Development efforts for curriculum development and student support. Significant industry funding came in for bridging programs during the 1980s and in the post-

apartheid period, government funding came in to support these foundation programmes and academic development efforts directly. Many EER researchers were employed in such programmes. Another important route of government funding supporting EER academics came through the University Capacity Development Grant (UCDG) established in 2018 (Moyo & McKenna, 2021) which supported institutions to build internal efforts to improve their teaching and learning.

With the establishment of SASEE and the growth of national funding, a number of other universities became very active in EER, including the University of Pretoria, the University of Johannesburg, and the Cape Peninsula University of Technology. In these universities, EER scholars have often been able to access internal funds to support their work and to present this at conferences. However, most of the work tends to be centred on key individuals and the convening of informal research groups. Some EER research have successfully obtained funding from the National Research Foundation (NRF), a body which funds research across the spectrum of all disciplines in South Africa. More recently CREE and SASEE have also made some funding available to researchers.

In 2019, a team of CREE researchers with funding from the Department of Higher Education and Training established a programme to support PhD students in EER.

### *Belief Systems & Identity*

The establishment first of CREE and then SASEE were key structures around which the EER community coalesced. Papers published in the conference proceedings of these bodies have always been peer-reviewed, thus building legitimacy for the field as EER researchers were able to support their universities in attracting research subsidy. A significant recent development in this regard is the establishment of the Southern Journal of Engineering Education (SJEE) recently launched by SASEE. This is a new scholarly forum for the publication of original research that is relevant to the international engineering education community. This will be an open access publication which will value critical perspectives on the unique challenges facing engineering education in South Africa and the Global South (Chance, 2021). This will allow for a significant further consolidation of the EER community in South Africa given the requirement for academics to be publishing their research.

## **New Zealand**

### *Prior Structures & Environment*

New Zealand only established independent degree granting universities in 1961 (previously all operated under the umbrella of a body called the University of New Zealand) and until the late 1980s these public universities were regulated through the University Grants Committee (UGC), which allocated funding and managed the system's accountability (Crawford, 2016). Academics in permanent positions at universities have always been involved in both teaching and research and the PhD model was established to follow the UK, involving original research and dissertation to be conducted, with limited organization-based course work.

The Institution of Professional Engineers New Zealand (IPENZ), now rebranded to Engineering New Zealand, was established in 1982, evolving from earlier entities that were invested in the regulation of professional engineering qualifications. By the 1980s concerns had started to surface in the profession about the overall numbers of engineering graduates, and particularly about the number of women graduating out of these programmes who made up only 2.5% of graduating engineers in 1980 (Godfrey, 2003).

### *Innovation Shock/Idea*

In 1989 there were three key developments that were the impetus for the development of EER in New Zealand.

At the level of the overall higher education system, a significant reform in 1989 created a new unitary statutory framework for all tertiary education, also advancing marketization with each university given the freedom to set their own fees. Another major shift came in 2001 with the implementation of the Tertiary Education Advisory Commission (TEAC), established to map out a new direction for tertiary education. Along with creating a new government agency to allocate government funding, the TEAC had specifically proposed to separate research funding from funding for teaching and learning specifically (Crawford, 2016). Overall, these changes meant that universities had to make sure their curricula fitted into the overall qualifications framework, and had to be more accountable for the quality of their teaching and learning.

A second key development also took place in 1989 with the founding of the Australasian Association for Engineering Education (AAEE). From the outset it involved both Australian and New Zealand engineering educators, even though AAEE is a special interest group of Engineers Australia (this is its main “home” although it also functions as a technical society for Engineering New Zealand). AAEE describes itself as a professional association of academics, support staff, postgraduate students, librarians, professional engineers and employers who all have vested interest in fostering excellence and innovation in engineering education (AAEE, 2021). AAEE started holding national conferences in 1989, and established a journal in 1991. Much of their early work focused on describing teaching innovations and practices (Klassen et al., 2020). Emerging EER researchers in New Zealand became involved in AAEE quite early on, recognized the value it poses and brought this knowledge back to New Zealand. In doing so, this influenced other researchers interested in the field and hence some of these key individuals were also a big driving force of the emergence of EER in New Zealand. These researchers also presented their work at American engineering education conferences such as ASEE and FIE. Notably, Elizabeth Godfrey developed an international reputation early on for her work on women in engineering (Godfrey, 1992).

A third development in the same year, 1989, was the establishment of the Washington Accord, a global system for the accreditation of four-year engineering degrees, of which IPENZ was a founding signatory. IPENZ was also instrumental in facilitating the Sydney and Dublin Accords which accredit the other engineering qualifications. In 2017 IPENZ was rebranded as Engineering New Zealand.

### *Political Will & Resources*

New Zealand has struggled to establishing a critical mass of EER researchers, given the smaller size of the higher education system. Some of the key institutions involved in EER in New Zealand are the University of Auckland (UoA), University of Canterbury (UC) and the University of Waikato, those with the most longstanding engineering programmes. The Faculty of Engineering at the University of Auckland drew on the framework of the Scholarship of Teaching and Learning (SOTL) in building institutional structures to support staff development in engineering education (Godfrey & Rowe, 2007). SOTL has now been engrained as a part of the faculty performance reviews and as a necessity for promotions, with growing expertise on describing course objectives and building constructive alignment in the curriculum. Similar work is also being carried out at UC. The University of Waikato is home to the Engineering Education Research Unit (EERU) which focuses on improving learning outcomes for engineering students (Waikato, 2021).

In terms of funding, from the 2000s onwards, following the TEAC, the government has provided extra performance-based funding to tertiary education providers based on whether they meet their specific targets in alignment with government expectations (Crawford, 2016). Engineering faculties have thus prioritised building the quality of teaching and learning and in cases have internally supported engineering education efforts. This has tended to be a bigger impetus for EER than external research funding, although some faculties of Engineering built collaborations with faculties of Education in order to obtain external grants.

### *Belief Systems & Identity*

It can be seen therefore that nationally there is only a small group of researchers in New Zealand doing work related to EER, mostly driven by institutional imperatives related to improving teaching and learning. As a small group they have struggled to find their own distinctive identity compared to EER being carried out in Australia, and have thus tended to align with AAEE since this organisation gives the scale that is needed, rather than trying to run their own national conference.

At some points New Zealand participants have expressed the need for their own national event (Swan & Godfrey, 2013). It has also been proposed that EER researchers might align themselves with Ako Aotearoa, a government-funded organisation committed to supporting the country's tertiary sector teachers, trainers and educators to be the best they can be for the learners' success (Swan & Godfrey, 2013). There are currently no graduate programs specifically targeting engineering education in NZ and because of that, doctorates in this field have been few. However, through the interests of enthusiastic individuals, this is slowly starting to change and appointments at the Full professor level based on achievement related to scholarships in Engineering Education, have also validated engineering education as a career pathway (Godfrey & Hadgraft, 2009). This said, most EER scholars also carry significant technical research interests, which have often been easier for securing funding. In this regard, a significant new development in 2020 is the establishment of "Engineering practice and education" as a new Field of Research which opens up eligibility for distinct research funding (<https://aaee.net.au/for-codes/>). To date EER researchers either have to apply through Engineering or Education without a distinct niche for the field.

## **Discussion and Conclusion**

This study has sought to identify the forms of institutionalization that have emerged to support EER in two countries, South Africa (SA) and New Zealand (NZ), building on an earlier study that examined Australia, China and the USA. Moving beyond these larger and potentially more prominent players in the global field, we are able to further develop the argument about how the evolution of EER is intimately connected to the national context and the opportunities and constraints it affords.

Our first research question sought to describe the different trajectories of institutionalization in each country. Here we identified some key features for each context. In South Africa we noted the establishment of key structures around which the community cohered, firstly CREE located predominantly in one university although aiming for national reach, followed by SASEE which more readily made that ambition possible. South African EER researchers have had regular national conferences since the late 1990s. In New Zealand, EER researchers have mostly aligned themselves with the Australasian body, AAEE. In both countries EER has a strong practice focus, helping universities respond to national imperatives for curriculum and teaching reform.

In terms of the forms of EER institutionalization that have emerged in these countries, we see similar forms at the university level where the work is tightly embedded in the institutional commitments of a few key universities. The role of individual champions has been significant. Thus, EER academics in both contexts are located within disciplinary departments and/or faculties of engineering. PhD students have mostly attached themselves to individual academics as is possible in the British style research-based PhDs. A very recent development in South Africa has seen government funding allowing for the establishment of a cohort style model for supporting PhD students in EER.

Our second research question sought to explain the differences in these trajectories. There are some key differences between SA and NZ which provide challenges in conducting this comparative case study. A key dimension is scale, with the NZ higher education system being much smaller than that of South Africa, even though it enrolls a greater proportion of

its youth cohort (but coming off a significantly smaller population base). Regionally there are also significant differences, with South Africa having a very different trajectory to the surrounding countries on the continent and thus a much more advanced infrastructure for engineering education. NZ has very close ties with its regional neighbor, Australia, and there are many similarities in their higher education systems.

Both SA and NZ have significant political imperatives driving efforts to improve teaching and learning, particularly in engineering which has a key economic focus for the country. Both have seen significant reform of the higher education system, although South Africa's was arguably more impactful given the need for an entire overhaul of the apartheid structures.

A key difference in explaining the different trajectories is that South African EER researchers have benefited from distinct resources coming their way, firstly with industrial funding for academic development from the 1980s, through to targeted funding from the post-apartheid government. South African EER researchers have also managed in some cases to obtain research funding for their efforts, and this has arguably opened up routes to promotion based purely on EER outputs. Publications are a significant aspect of promotion in South African universities and are directly linked to research subsidies to institutions, and in this regard EER researchers have made their mark. In NZ, the systems for funding and assessment of research mean that it is very challenging for an individual academic to focus their research purely on EER, and thus most adopt a hybrid approach including technical research in their portfolios.

Our approach in this study has inherent limitations and thus we also consider these findings to be preliminary pointers for future work. There is definite scope for a follow-up study which seeks to obtain perspectives from a broader range of participants, especially in relation to the South African case where the field has become relatively institutionalized.

Overall, this study offers further support for the thesis that EER takes very different forms in different contexts. This is a key consideration for the global community in the field, to be sure that outputs from one context are not simplistically judged against those from another. The countries under consideration in this study are potentially more useful comparators to many other emerging EER communities around the globe than the USA and China. We note the value of regional communities such as in Australasia, but at the same time a national system that is big enough with targeted resources can sustain national bodies such as South Africa. A really crucial point relates to scale of analysis. At a university level, EER researchers in South Africa and New Zealand operate in relatively similar structures. However, at the next level these contexts function very differently. This is also a crucial point for consideration of global bodies such as REES/REEN that aim to draw together representation from national structures.

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