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Reflections on the Competencies of the 'Global Engineer'

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ABSTRACT

CONTEXT

The term 'global engineer' has been bandied around in accreditation documents and aspirational curriculum statements for some time. Universities worldwide offer programs designed to foster 'global engineers' equipped with 'global perspectives' and 'global competencies', with guidelines of graduate attributes in the international agreements governed by powerful players. However, varied interpretations of the term under different cultural contexts challenge the goal of ensuring equivalence in educating engineering students to truly function on a global scale.

PURPOSE OR GOAL

This paper will explore the concepts of 'global engineer' and 'global engineering competencies', and how they have value in engineering education, from intersectional Australasian and South African perspectives. It aims to add the voice of engineering educators from positions that are not well represented in the literature and encourage critical evaluation in considering developing global competencies.

APPROACH

The authors used literature to inform self-reflections about the theme of 'The Global Engineer'. The self-reflections were then analysed and organised to create a frame for a collaborative reflection. To assure the validity of the process, thematic analyses were iteratively produced via further collaborative discourse.

OUTCOMES

Through a collaborative process of ongoing discussion, reflection, and analysis, four themes were identified: *competencies, culture, positionality,* and *drivers*. The theme of competencies is the subject of this paper, while the rest are in preparation for a future journal submission.

RECOMMENDATIONS

The thought-provoking discussion between the authors suggested that the engineering competencies, as defined by many governing organisations, may not be universally applicable. Engineering competencies should be framed within a strategic context of institutions, regarding measures of accreditation, audience, subject domain, and geographic location. Qualifications, expertise, and experiences should be considered as drivers to shape how the engineering profession is practised and positioned globally.

KEYWORDS

Global engineer, engineering competencies, accreditation, graduate attributes.

Introduction

Universities around the world advertise programs that develop graduates who are ‘global engineers’ with ‘global perspectives’ and ‘global competencies’ (Bourn, 2018; Lohmann et al., 2006; Sunderland et al., 2014). While one might expect there to be a shared understanding of what ‘global’ means in this context, a variety of views of what constitutes a ‘global engineer’ has emerged in anecdotal discussions with engineering educators and also in the literature (Downey et al., 2006; Jesiek et al., 2014; Mazzurco et al., 2020; Parkinson et al., 2009).

The idea of developing global engineers seems to be a worthwhile goal in the context of an increasingly globalised world and the rise of transnational corporations that employ engineers to manage their empires, to drive technology and, with it, grow the global economy. It also makes sense in the wake of international agreements such as the Washington Accord which continues to gain signatories from national accreditation bodies. Such agreements rely on the recognition of substantial equivalence of programs and to allow for international mobility of engineering graduates and better distribution of labour.

However, if there is slippage in the meaning of the terms being used in the development of the relevant competencies (or graduate attributes), then how can the engineering educators involved in this process be sure of this equivalence? This of course has implications for whether an engineer trained in New Zealand, for example, can really function as a ‘global engineer’ in India, even though both countries are signatories of the Washington Accord. Another issue is whether the discourse around the term ‘global engineer’ rests on an unspoken cultural bias that advantages some but disadvantages others, much in the way that international agreements such as the Washington Accord serve the interests of powerful players like the United States rather than more egalitarian ideals (Lucena et al., 2008; Matemba & Lloyd, 2019).

Literature review

Engineering education and practice is centred on specialist mathematical and scientific knowledge that empowers graduates to practice as engineers (Downey et al., 2006). Alongside these specialist skills are transferable ‘professional practice’ skills that engineering educators aim to develop in students. These include problem definition, communication, teamwork and cultural competence, amongst others. The discussion on which engineering competencies are required for a ‘global engineer’ focuses on these professional skills with the differentiation that for *global* engineering competencies, there are the added dimensions of place and context. Development of global competencies is often associated in the literature with international work experience or immersion.

Lohmann et al. (2006) identify that the development of global professional competencies needs to be coherently integrated into the students’ field of study in order to effectively develop these skills. Downey et al. (2006) demonstrate that the stated global competency of “working effectively with different cultures is fundamentally about learning to work effectively with people who define problems differently” (p.107), emphasising the difference between the engineer’s own practice and the context in which they are working - a change in space, place, culture or context. Jesiek et al. (2020), while acknowledging the uncertainties of the definition of ‘global engineering competencies’, explicitly differentiate these from a) attributes (professional and technical) that are not global in nature but rather required for *any practising engineer*, and b) attributes which are important for *any global professional*, not only engineers (such as foreign language ability and cultural knowledge). They define global engineering competencies as “those capabilities and job requirements that are uniquely or especially relevant for effective engineering practice in global context” (p.471) and they identify them as fitting into three dimensions which emphasise the physical location and context of the engineer in relation to their practice: *technical coordination* which describes working with and influencing other people (Trevelyan, 2014); *engineering cultures* which incorporate how to navigate ‘national differences in engineering practice’; and the *ethics, standards and regulations* category where contextual differences in responsible practice for engineers is included. This emphasis on the different contexts where an engineer is educated

and where they practice as central to global engineering competencies, is further reflected in accreditation guidelines around the world where reference is made to being able to work internationally (ABET, 2024; EA, 2019; ENZ, 2022; EUAEE, 2024; IEA, 2021).

Downey & Beddoes (2011) have collected the personal journeys of a diverse cohort of engineering educators from the United States interested 'in global engineering', but acknowledge that these do not include the "multitude of positions and perspectives outside the United States". This paper adds to our understanding of what constitutes the competencies that contribute to the concept of a 'global engineer' by expanding the view to engineering educators in different spaces, places, cultures and contexts. It forms part of a larger study into global perspectives on the 'global engineer'.

Methodology

Capturing the thoughts, understandings and interpretations of each author's contribution was key to the methodology for this study. In order to provide a grounding to create a framework for individuals each author independently wrote a half-page self-reflection on the term 'global engineer' sans guidance or prompts. Once all of the self-reflections were recorded, each author read three articles and listened to part of a podcast. The three articles, Downey et al. (2006), Jesiek et al. (2020), and Lucena et al. (2008) were selected due to their applicability to the study. The podcast was selected because the 'global engineer' was discussed in detail (SEFI Podcast, 2017). These four sources of literature, along with the initial self-reflections acted as a framework for the authors to engage in a polylogue where interpretations were guided by the collaborative nature of untangling the literature along with the self-reflections (Markauskaite et al., 2022). The polylogue was recorded and thematically analysed to answer the guiding research question: "How do perspectives on the concept of the global engineer differ across Australasian and South African contexts". The data was independently coded by three coders and achieved a reliability above the expected coding reliability score (Nunnally & Bernstein, 1994). After the themes were presented, they were again member checked by all of the contributors as a way to assure further reliability and validity of the findings (Iivari, 2018).

Positionality

Positionality statements are becoming increasingly common in engineering education research, in trying to make explicit how the identity of the researcher(s) and their perspectives on the phenomenon under investigation inform their approach to research (Secules et al., 2021). This is perhaps especially important in engineering education where interpretivist approaches contrast with the positivist epistemology typical of technical research (Hampton et al., 2021). Although positionality statements have been critiqued as potentially perpetuating coloniality (Gani & Khan, 2024), our study could arguably be framed as a synthesis of all of our positionalities with regard to the concept of the 'global engineer'. Before unpacking the analysis of our reflection we present below a brief snapshot of our different backgrounds and experiences self-identified as relevant to the topic of the 'global engineer', noting that one commonality across all of the authors is that we teach into Washington Accord accredited programs.

BCR: I am a white, male South African professional mechanical engineer working as an academic at the University of Cape Town (UCT). My background is in engineering education, and I work extensively with the Engineering Council of South Africa on the policies and standards associated with the accreditation of engineering programmes.

BK: I am a white, male South African with a mixed background - my ancestors are English, Scottish, Afrikaner and Jewish. I was trained as a chemical engineer but received a Masters in energy studies, supervised by someone in anthropology who used the opportunity to 'get the engineer out of me'! I now work as an engineering academic at UCT and enjoy cross-disciplinary research.

CD: I am an engineering educator and researcher, working as a curriculum development manager in the Engineering Faculty at the University of Auckland. My background is in science

education, and learning design in industry and in higher education, in New Zealand and previously in South Africa.

CDD: As a black Caribbean national living in Australia, I have a complex identity which is drawn from the many places I have lived (i.e., Canada, USA, Barbados, Trinidad and Tobago) as well as spaces (virtual jobs). These places include experiences as a software engineer, a project management consultant, all combined into my now career as a socio-technical academic.

CM: I am a neurodiverse (dyslexia and attention deficit disorder) Tangata Tiriti male with a background in Science (Microbiology), Arts (Philosophy) and Engineering (Environmental Engineering). I work at the University of Auckland as a Professional Teaching Fellow in Civil and Environmental Engineering and as the Associate Dean Postgraduate Taught.

SD: I see my background as combining STEM, education, and international development, which are synthesised in my current role in humanitarian engineering at the University of Technology Sydney. Prior to embarking on my PhD, I worked in STEM education around Australia and overseas in Vanuatu, Namibia, and elsewhere. Part of my teaching involves cross-cultural skills, for example in collaboration with Engineers without Borders.

TM: I am a white, female electrical engineer of European Jewish and Italian descent who grew up and studied in South Africa, and emigrated to Australia. I have practised as an engineer and project manager in telecommunications in South Africa, Belgium and Australia before completing my PhD and moving into academia, researching engineering education.

YH: I am a new PhD in Software Engineering and an early-career researcher working in the Engineering Faculty at the University of Auckland. I completed my Bachelor's and Master's degrees, and accumulated five years of industry experience as a software engineer and a product manager in China before commencing my doctoral research in AI in Education in New Zealand.

Findings

A considered critique of concepts and underpinnings of the term 'global engineer' is what emerged from the data. There was consensus that the term was problematic to define and explore independent from the *positionality* of those considering the proposition, or the *cultural context* in which the term is used. Within these considerations, the data also reveals challenges in identifying the *competencies* that align with the concept of global engineering, and explored the *drivers* for the use of the term in engineering education. Of these four themes (the words in italics above), this paper explores only the concept of global engineering competencies, and highlights the open questions still remaining about what these are, and where they have value in engineering education. Discussion of the other themes will be the subject of future publications.

The *competencies* of a global engineer emerged as a theme with discussions focussing on *what* the competencies of a global engineer should be, and *where* we aim to have engineers practice as 'global engineers'.

The *what* of global engineering competencies

The concept of *what* constitutes global engineering competencies identified necessary but not sufficient competencies. Here competencies mean an ability as well as capacity to perform in this field based on standards given our individual attributes. The initial reflections identify those competencies that allow engineers to operate either in other countries, or in global companies in roles that require this international perspective. One of the authors identified a wide range of 'professional skills':

> *including but not limited to a wide and informed view of the current global trends and issues, strong interpersonal and cross-cultural skills, good business acumen and negotiation skills. Finally, a strong ability to abstract and take a longer or more system view.*

This was supported by another of the authors who identified global engineers needing an "*agile set of engineering skills that are in high demand in a globally competitive market*".

Added to this are the technical skills needed to be an engineer: "*[e]ngineering curricula have traditionally privileged what could be considered classic engineering theory*". This technical aspect saw different views, with an author commenting on engineering involving "*the practical application of (universal) physical laws, [so] it goes without saying that these laws are applicable globally".* Others critiqued this view and saw the perceived 'neutrality' of engineering science and the concept of global engineering competencies as privileging Western culture, for example:

> *For me the term 'global engineer' has connotations of a Western engineer having the skills to collaborate in international contexts, particularly in the Global South. … my 'gut' doesn't see it as a term applied to engineers from non-Western backgrounds.*

In many of the reflections, the summary of competence centred on 'cultural competence', which was also critiqued by the participants. One of the authors emphasised the privilege of Western culture:

> *Not sure that global competencies are talking only about the cultural aspect, because you can work in three different countries and still not be able to work in the 4th…the .. qualifying term global it's a little bit of a colonialistic kind of view that we can go anywhere and be everything to everyone else when in truth, we shouldn't be.…To me it's not more of the culture, but a little bit of a colonialist idea coming in there.*

This concept of cultural competence was critiqued being a catch-all for global engineering competencies:

> *A global engineer is globally competent, they [Jesiek et al.] equated that to kind of intercultural skills. Is that all it is or is it? Is it more than just the ability to work in different contexts? … reading it a bit critically … it seemed maybe a little bit reductionist in saying only that global competence can… it's solely intercultural competence.*

Adding to the reflections is the concept of whether these skills identified can actually be 'taught' at an undergraduate level or whether the '*where*' may actually be 'out in the world':

> *You don't learn that in an undergraduate degree. You learn that in practice. And you, you know, maybe students can be given some kind of little window into… this thing called cultural competency, but when they actually get into the space, then they realise, 'Oh, OK, there are these differences and I have to adapt' but there is no way that this can be taught in an engineering education degree.*

This link between *what* the skills are in terms of *where* they are developed and practiced emerged as central to the reflections of global engineering competencies.

The *where* of global engineering competencies

Looking at *where* engineers practice as a component of global engineering competencies, the reflections on the source material identified that this was central to the discussions of the global engineer. Global engineering competencies allow you to work 'overseas', as captured in this reflection:

> *Downey paper and they say typology of methods for achieving global competency and they offer five strategies ….they really put it on traveling overseas or the traveling internationally for that global competency.*

The position of our group was that this does not capture the extent of what is required, summarised as:

> *It's more than just the skill of being able to work internationally … I do think that this notion of being a global engineer needs to stretch beyond that into the space where context matters.*

One of the authors identifies the ability to translate between geographical places and disciplines as competence, identifying the ability to "*transfer knowledge and skills between and within contexts of culture, environments/infrastructure and communications*".

Another of the authors highlighted the context and agreed that it is not solely the issue of being competent to work internationally:

> *Global engineer for me is more like with a global view rather than it's just about working in the global markets, and another aspect is even you are only like working for local markets, working for local issues, but such kind of local engineer should also have a global view. It is because you can find the solutions, international solutions and localise them.*

This critique was summarised as the *"tension between how the notion of competencies is framed, with 'global' suggesting 'anywhere in the world' or that you are an engineer able to operate in the world (which could be your community)*." After a visit by one of the authors to the National Council of Examiners for Engineering and Surveying (USA), it appears that for engineers this tension is central to how they practise in the USA, as engineers are licensed by each State. The notion of 'global' as framed by geographical spaces is narrowed to engineers being able to work across their own country. These engineers have to operate 'in the world' which, for them, spans significant cultural and technical differences depending on which State they are licensed to practice in.

The view of the educators on the concept of competencies for educating a global engineer gives insight into the challenges that the concept of the global engineer poses when considering the context of engineering education. Standardisation of accreditation across the globe does obscure local contexts of the students and their educators. We believe it is valuable to consider these critiques in designing and delivering engineering programmes that promise to develop the global engineer. What are widely considered global engineering competencies, may not be what is asked for, needed or appropriate. This paper adds the voice of engineering educators from positions that are not well represented in the literature and encourages critical evaluation in considering developing global competencies.

Concluding comments

This initial exploration into understanding how the term 'global engineering' is used and actioned produced four themes; *competencies, culture, positionality* and *drivers.* With our focus initially on the *competencies* of the 'global engineer', we reflected first on its implications in our own educational practice, and in relation to selected publications. Our own individual positionalities emerged strongly, demonstrating how the term 'global engineer' is informed by much more than just the terms' ontological lexicons. The embedded characteristics found within our positionality statements alluded to a contextual meaning for what a competency may look like. The result of this iterative, reflective collaboration is much more of a thought provoking discussion than a conclusion.

In view of this, it is suggested that the engineering competencies as defined by many governing organisations (one of which is the Washington Accord) may not be universal, and is challengingly applied via confounding variables such as *international*, *world* and *global*. The profession, as named - engineering - along with the practitioner (i.e., engineer) can only be characterised by the context where the activity occurs and, then again within the disciplinary sector of performance. Framing the competencies from a strategic context of an institution which includes the measures of accreditation, audience, subject domain and more, coupled with geographic location will and should set the foundation for the engineering practice. Thus, the profession should consider qualifications, expertise and experiences as drivers towards how the profession is practised, when thinking comparatively about its future and how it is positioned globally.

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