

A Call for the Expansion of Intercultural Competency to Graduate Engineering Education

Abstract

The purpose of this theory research brief is to call for an expansion of the current research and practices regarding intercultural competency in engineering education. Intercultural competency, here meaning competencies of working and communicating across national and international context, is a necessary skill for engineers in our increasingly global and diverse society. Most often, intercultural competencies are introduced to engineering students through study abroad programs, virtual global exchange partnerships, and global engineering projects. While these programs are impactful, they are time-intensive, cost-intensive, and localized, limiting the breadth of students who need these skills to a select few. Additionally, these programs and accompanying research mainly focus on the undergraduate experience and are formed from a U.S. perspective. Domestic undergraduate students are not the only population that needs these skills. Over half of graduate students in the United States are international, creating a unique environment where the development of intercultural competency is necessary for daily interactions and future endeavors. However, few scholars have investigated intercultural competency development among engineering graduate students. In this research brief, we explore the current state of intercultural competency research and practice in engineering education, critique U.S.-centric approaches to intercultural competency and urge the research community to bring a focus on intercultural competency development to graduate student populations.

Introduction and Motivation

Intercultural competency and global competency, here meaning competencies of working and communicating across national and international context, are needed in an increasingly globalized society. Engineers across the globe are solving complex problems that have a reach beyond their national borders. The need for intercultural and global competency has been identified for engineers specifically and supported by multinational initiatives such as UN Sustainable goals [1] and Global Grand Challenges [2]. Global engagement has been identified as a required criterion, leading engineering programs to work to integrate intercultural and global competency in undergraduate curricula and programming to comply with these directives. Research in intercultural competency supports curricular interventions, by studying the outcomes and development of intercultural competencies in educational environments. However, current research is dominated by studies investigating study abroad contexts (e.g., [3]-[5]) and overarching aimed at undergraduate engineering education (e.g., [6]-[9]). While these studies and contexts are valuable, there are several populations that are not affected by these initiatives. To that end, the purpose of this paper is to synthesize the current literature in the intersecting but separate domains of (1) Intercultural Competency Research and (2) Engineering Global Competency Research to ascertain the value of these studies that may hold for graduate engineering audiences, and offer useful critiques of this research that will lead to theoretical advances in intercultural engineering competency research.

Operationalizing and Measuring Intercultural Competency

Global and intercultural competency development has been studied in fields such as business and organization management (e.g. [10], [11]), communication sciences (e.g. [12]-[14]), and general education (e.g., [15]- [17]). Researchers across these domains have sought to develop ways to measure whether and how an individual possesses “intercultural competence” or the ability to communicate and collaborate effectively in intercultural situations, involving interactions with people from diverse backgrounds regardless of location [3], [18], [19]. Others work to document the effects of intercultural experiences in individuals’ competency development journeys. In order to capture intercultural competency, researchers typically rely on several dominant scales including the Miville-Guzman Universality-Diversity Scale (MGUDS) [20], Intercultural Development Inventory (IDI) [21], and Cultural Intelligence Scale (CQS) [22].

These three scales offer complimentary perspectives. The Miville-Guzman Universality-Diversity Scale (MGUDS) was developed to measure a mindset of awareness and acceptance of both the commonalities and differences in others, also known as universal-diverse orientation (UDO) [20], [23]. Studies regarding intercultural competency have utilized this scale to specifically measure students’ comfort in intercultural interactions, how students engage with new cultures, and how they draw connections between their experiences and personal growth after they are introduced to a global experience or intervention [24]-[26]. Similarly, the Developmental Model of Intercultural Sensitivity [27] measures an individual’s orientation to cultural differences. Hammer et al. [28] expanded on this work to create a 50-item survey that categorizes an individual’s ethnocentric orientation ranging from Denial to Integration, commonly known as the Intercultural Development Inventory (IDI) [21]. The IDI has been used to evaluate cross-cultural sensitivity before and after study-abroad experiences [29] and the duration of the study-abroad experience [30]. Lastly, the Cultural Intelligence Scale (CQS) explores the relationship between metacognitive, cognitive, motivational, and behavioral dimensions to intercultural effectiveness outcomes (i.e. cultural judgment and decision-making, cultural adaptation, and task performance in culturally diverse settings) [22]. This scale has been used across applications, such as creativity and collaboration [31], multinational leadership effectiveness [32], and culture shock [33].

To supplement quantitative studies, other scholars have sought to qualitatively evaluate intercultural competency. For example, Pennington and Wildermuth [34] interviewed first-year honors’ students on their short-term study abroad experiences regarding perceptions of their intercultural communication development. Findings from the study resulted in higher intercultural knowledge and awareness, willingness to engage in intercultural communications, and verbal and nonverbal sensitivities. In addition to increased cultural awareness, research has found that cultural immersion experiences results in reflexivity on worldview and attitude, growth in cultural empathy, and adaptation of behaviors and skills [35]. However, very few of these studies have extended to graduate student populations.

Global Competency Development in Engineering Education

In engineering, given both the globally interconnected industry and ABET accreditation criteria to educate globally-minded engineers [36], many universities and colleges have sought to introduce global programming to engineering as part of extracurricular or formal programming. Many of these are framed around global study abroad experiences, with scholars noting that even short-

term experiences can lead to heightened understandings of globalization and cultural awareness [37]-[39]. However, the continuous limitations of privilege, cost, and time additions on degree completion continue to be evident, and rarely have extended to graduate student populations (with the exception of a few instances noted in literature via NSF IGERT programs and similar, such as the study performed by Berdanier et al. [40]). Literature documenting these programs also consider whether and how intercultural *engineering* expertise is being built through these circumstances, outside of the learning that simply happens through broadening perspectives through travel.

More recently, to overcome these tangible limitations of time and money, engineering education researchers are exploring ways to embed intercultural competency within extant core engineering courses through the use of micro-modules and course tie-ins. Often, the modules are country specific and cover the cultural norms and historical events that inform the modus operandi of engineers in each respective country (e.g., [41], [42].) This approach leads to the development of cultural awareness and *engineering* culture awareness. To address behavioral intercultural competencies, some courses delve into communication and leadership styles to educate students on effective communication in intercultural contexts. LaFave et al., [43] utilized cross-cultural communication modules and an interactive design project to develop intercultural competencies. The students were assigned in groups with various first languages and instructed to solve a technical challenge and complete critical reflections. By the close of the semester, the students exhibited higher levels of adapting to cultural contexts, openness in intercultural interactions, and managing their own cultural identity while supporting others' identities. This study demonstrates that behavioral and identity related competencies can be developed in engineering courses.

While these are laudable efforts with some advantages if faculty are invested in these learning objectives, we specifically note that efforts to date have been focused on undergraduate students, rather than graduate students, who are both uniquely constrained in terms of limitations on extraneous travel, but represent a population ripe for understanding developing intercultural competencies given their potential as technical leaders in academia and industry sectors.

[Intercultural] Competency Development in Graduate Engineering Students

Broadly, most competency development literature focused on engineering graduate students focuses on research and professional skills development, rather than global and intercultural competency. For example, when it comes to competency development in engineering doctoral education, the center of attention is on developing the competency in “written, oral, and graphical communication in both technical and non-technical environments; and the ability to identify and use appropriate technical literature” [36]. In graduate student education, writing competency and communication competency are often the focus [44]. Other literature also introduces and emphasizes the importance of intrapersonal competencies like time management, self-regulation, emotional intelligence, resilience; and interpersonal competencies like teamwork, communication, and negotiation [45]. Within these studies, however, few studies actually analyzed transferrable skills related to intercultural competency, global competency development, or research competency development among engineering graduate students.

Main and Wang [3] are two of the only researchers to date who have conducted intercultural competency research among engineering doctoral students, and the results demonstrate that female

engineering doctoral students are more likely to score higher on the MGUDS-S than male engineering doctoral students. Proficiency in multiple languages is positively associated with doctoral students' intercultural competency.

Several additional papers assessing the current status of graduate students [3], [4] recommend having work/volunteer-related international experience due to the positive correlation of international experiences to the development of intercultural/global competencies in their studies, but we believe such experiences are not practical for graduate students with research commitments, funding obligations, and busy schedules. Given the focus on independent research outcomes rather than coursework, it is even more unlikely that graduate students are able to travel abroad for even a few weeks at a time. However, given Main's [3] findings, combined with the fact that over half of engineering graduate students at US institutions are international [46], we highlight that many graduate students are already bilingual, trilingual, or more, yet the educational community has generally failed to harness the valuable perspectives they bring. Together, this indicates a highly U.S.-centric point of view on the intercultural competency literature in engineering to date—focused on the development of U.S. students rather than attending to the competency development and/or leveraging the strengths of the international students studying here. We also proposed that we as a research community need to actively avoid ethnocentrism in intercultural development literature by critically querying for whom intercultural competency development interventions exist and who benefits from them. This critical line of thought yields substantial opportunities for re-theorizing and re-conceptualizing how intercultural competencies may happen in engineering graduate programs.

A Call to Action for the Future of Intercultural Competencies Work Extending into Graduate Education

Given that graduate engineering students pursuing Master's and PhDs will likely continue into roles in industry and academia as technical thought leaders at the forefront of technical decision making, we argue that ignoring the intercultural competency development of graduate students is a missed opportunity. Because engineering graduate programs across the nation employ and educate over 50% international students [46], it is essential to develop global competencies in these future leaders, considering the educational needs of both international and domestic students studying together in the United States.

We offer the following commentary on the state of intercultural competency and global engineering competency development, with a call to action in extending this work to graduate student populations in engineering. First, it is essential that we find ways to overcome the logistical limitations of intercultural competency interventions. The fiscal costs of study abroad and other international experiences are well known, ranging from flights, lodging, excursions, and living expenses, and often fall on the student to cover. Additionally, a time cost occurs during term the student is abroad. Engineering programs are complex and relatively inflexible [47]. A semester or term abroad may delay degree completion due to course availability and scheduling. These costs may be reduced by the study abroad course itself, the department, or the college, however the number of students may be restricted by the budgets of the respective entity. Instructors and researchers are addressing these limitations through modules or course-tie ins to provide more opportunities for students to engage in intercultural competency development. However, results

vary based on the structure of the course and can lead to an intense workload, for both instructors and students, that is not sustainable for continued growth [6], especially for graduate students actively pursuing research degrees.

For graduate students, we offer that the inherently globally diverse graduate student body present at most research-intensive universities offers a unique opportunity to study intercultural competencies and interactions in authentic environments. If we take the national graduate student population as representative sample, a given research group or graduate level course would have an approximate 50/50 split of U.S. domestic students and international students. These two environments, i.e. research groups and courses, are hubs of potential intercultural interactions and learnings over long periods of time. Further, graduate research labs at research-intensive universities regularly attend international conferences. Conferences are additional environments to develop intercultural competencies specific to engineering. The norms of graduate education (i.e., lab environments and conferences) establish a distinct area for intercultural competency development that is widely accessible to students.

Second, across disciplines, it will be essential to find situated ways to understand whether and how intercultural competency is developed for (graduate level) engineers. One major limitation of the instruments currently available is the cost. Prominent scales, such as Intercultural Development Inventory (IDI) [21], Global Competencies Inventory (GCI) [48], and Intercultural Readiness Check (IRC) [49] are only accessible behind paywalls. Survey instruments that are cost-conscious and widely available (e.g MGUDS and CQS) evaluate intercultural competencies in a broad context that do not adequately capture the nuances of engineering specific contexts (e.g. technical material and problem solving) [50]. The nuances in engineering contexts have been studied qualitatively, however a quantitative tool that measures intercultural engineering competencies and what those competencies entail is necessary to reach a broader population.

Lastly, in recommending new approaches to studying intercultural competency in graduate level engineering, we advocate for researchers to take a decolonial approach to investigating intercultural competency development. Recent conversations [51]-[55] based on decolonial theory from other fields [56]-[58] highlight the importance of resisting western and Eurocentric epistemologies when engaging with students. Eichhorn [59] notes that the refusal to recognize the false narrative of western engineering and technical superiority and resistance to learning to work with true global interdisciplinarity and diversity are barriers to decolonization. We urge the intercultural competency research community to challenge the conceptions of what intercultural competencies are, how these competencies are measured, the desired impact of the competencies, and whether the solutions and interventions feed into cycles of power inequity. A critical approach to re-theorizing intercultural competency will transform educational theory and the methods employed to theorize updated models for graduate intercultural competency.

Conclusions

Throughout this review, we have discussed that the need to expand intercultural competency research and to include graduate engineering education cannot be overstated. Current approaches in intercultural competency research largely are focused on undergraduate education and are grounded mostly in U.S. centric perspectives, failing to address the complex nature and

opportunities available within the graduate programs. Graduate students, who are the future leaders in both academia and industry, engage with uniquely diverse individuals and globally interconnected environments that demand robust intercultural competencies. This review serves as a call to action and invites the academic and professional engineering communities to reimagine how we define, measure, and foster intercultural competencies, ensuring a more inclusive and effective approach to global engineering education.

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