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RESEARCH ARTICLE

Developing indices to study engineers' interest, confidence, and experience with global engineering work activities

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Abstract

Background: As engineering work has become increasingly globalized, prior studies have examined the intercultural attitudes and competencies of engineering students and practicing engineers. However, we lack tools to study how engineers engage in global work across industries, roles, and organizational contexts.

Purpose: The purpose of this study was to develop a tool to measure engineers' interest, confidence, and frequency in performing global work tasks. To this end, we designed the Global Task Performance (GTP) indices, which evaluate four dimensions of engagement in global engineering work.

Methods: Guided by Social Cognitive Career Theory and the Global Engineering Competency (GEC) framework, we developed and refined items through iterative team discussions, advisory board review, and think-aloud interviews. We administered the Indices as part of an alumni study at three US institutions. Responses ($N = 1223$) were analyzed to collect evidence of the instrument's validity.

Results: Analyses across the GTP indices provided criterion-related evidence of validity. Confidence and interest in global task performance were associated with global career exposure, cultural intelligence, and identification as global engineers. GTP frequency (current role and across careers) correlated with global career level and self-reported GEC.

Conclusions: Our initial validity evidence supports use of the GTP indices for assessing engineers' level of engagement in global work. These indices can inform research evaluating the career impacts of global education experiences and comparing global engagement across industries, roles, and organizational contexts. Understanding the global engagement of engineers can support data-informed decision making in workforce development, educational program design, and talent evaluation.

KEYWORDS

engineering work, global engineering competence, survey development, surveys, workforce development

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1 | INTRODUCTION

As engineering work becomes increasingly global in nature, preparing engineering students with relevant global skills and attitudes is crucial to their success (Grandin & Hirleman, 2009). Engineers are frequently required to collaborate across cultural, organizational, and national boundaries (Downey et al., 2006), which has led to a growth in global experiences for engineering students (Jesiek et al., 2019). Previous studies have focused on defining *global engineering competency* (GEC; i.e., the skills engineers need to succeed in a global workforce; Downey et al., 2006, Jesiek et al., 2014) and studying the outcomes of global undergraduate experiences (e.g., Davis & Knight, 2025; Mu et al., 2022). However, few studies have operationalized what global engineering work looks like in the tasks engineers perform in their professional roles. Existing instruments measure intercultural attitudes or self-perceived competencies, providing limited insight into the concrete ways engineers apply global skills in the workplace. Developing a way to measure the global nature of day-to-day engineering work can help educators to evaluate the impact of global undergraduate programs on post-graduation work experiences and inform the design of professional development opportunities in engineering work environments that are aligned to the needs of specific roles and career trajectories.

We address this gap through the development of the Global Task Performance (GTP) indices, which measure engineers' confidence, interest, and frequency in performing global engineering tasks. The GTP indices offer a theoretically grounded tool for measuring engineers' engagement in global work, allowing for comparisons across different roles, industries, and global contexts. Our study also contributes a unique approach to studying engineering work, which could be adapted to other aspects beyond the global focus of our study.

In this paper, we describe the process through which we developed the GTP indices and provide evidence of validity for these indices. First, in Section 2, we review the literature on global learning, alumni outcomes, and the engineering workplace to identify key research gaps. Section 3 provides the conceptual framing that guided the development of the GTP indices. In Section 4, we describe the iterative multi-phase development process used to refine the instrument and enhance its validity. In Section 5, we describe the methods used to collect evidence of validity for the GTP indices, and Section 6 presents the results of these analyses. Section 7 discusses the interpretation of validity evidence and contributions of this study to research and practice in engineering education.

2 | LITERATURE REVIEW

In this section, we provide rationale for our study by reviewing the literature on global learning for engineering students, previous alumni studies in engineering education, and research on engineering work. We show that there is notable research on global learning in students and alumni perceptions about the impact of their undergraduate experiences. However, we have little information about the impact of global education after graduation. We then review what is known about engineering work, particularly the sociotechnical and global competencies required. We conclude by identifying gaps in the literature and the purpose of our study.

2.1 | Research on global learning in engineering students

Research on engineering students' participation in study abroad, internships abroad, and in-class global activities has demonstrated that these experiences can support students' development of intercultural competence (Alves, 2018; Ball et al., 2012; Berka et al., 2017; Davis, 2020; Davis et al., 2023; Davis & Knight, 2018, 2021; Downey et al., 2006; Jesiek et al., 2014; Joshi et al., 2021; Knight et al., 2019; Levonisova et al., 2014; McNeill & Cox, 2011). Intercultural competence is defined as "the ability to communicate effectively and appropriately in intercultural situations based on one's intercultural knowledge, skills, and attitudes" (Deardorff, 2006, p. 247) and is generally viewed as one of the key desired outcomes from international education programs (Goldstein, 2022). Development of intercultural competence is connected to intentional program design and mentoring students in intercultural learning (Vande Berg et al., 2009; Vande Berg & Paige, 2012) but can be achieved across different types of international experiences (Goldstein, 2022). Within engineering education, Knight et al. (2019) found that students who completed a global engineering course and short-term study-abroad program demonstrated increased intercultural competence in post-surveys compared to pre-surveys. Similarly, in a study of a longer term study abroad and internship, McNeill and Cox (2011) found that some of the most common learning outcomes of global engineering experiences include cultural knowledge, foreign language skills,

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communication skills, and adaptability to new environments, experiences, and cultures. Overall, research in engineering education suggests that a range of program types, both at home and abroad, can support engineering students' development of intercultural competence.

Despite these positive outcomes from global learning experiences, there is little evidence that engineering students are able to translate their intercultural learning into professional engineering practice (Davis, 2020; Davis & Knight, 2025; Wrobetz et al., 2024). This challenge may in part be due to the design and focus of the global experiences. However, it is also worth noting that most research on international experiences relies on data collected during or immediately after the program (Goldstein, 2022), before participants enter the engineering workforce. A limited number of studies in the international education literature have explored the long-term impact of study-abroad experiences, finding that these programs can lead to more globally engaged individuals. For example, studies have identified long-term outcomes relating to language skills, career choices, interest in academic study, intercultural competence, and personal development (Dwyer, 2004; Paige et al., 2009). However, these studies had few engineering participants and further lacked a control group (Ogden, 2015). Consequently, there remains a limited understanding of how international and intercultural experiences manifest in the actual global work of engineers, highlighting the need for systematic ways to study and characterize global engineering practice. Addressing this gap requires moving beyond assessing intercultural competence generally to evaluating the specific tasks that define the global dimensions of engineering work.

2.2 | Alumni studies within engineering education

Researchers have explored the long-term impacts of undergraduate experiences (e.g., project-based learning, service learning, internships) on the careers of working engineers. Huff et al. (2016) explored the impacts of the Engineering Projects in Community Service program on alumni, finding that the program provided a bridge between education and the engineering workplace by equipping students with requisite workplace skills. Similarly, Heinricher et al. (2013) examined the long-term impact of the project-based curriculum at Worcester Polytechnic Institute (WPI). This study found that the WPI projects have lasting impacts particularly in the development of problem-solving and interpersonal skills of engineers. Kinoshita et al. (2014) also noted that work-related undergraduate experiences, such as internships, are correlated with engineering design, communication, and leadership skills development 3 years after graduation. Although these studies have examined the effects of experiential learning programs on engineering alumni, they have focused on alumni perceptions of learning outcomes, and there has been limited effort to characterize the impact of such programs on day-to-day engineering work activities.

In contrast, the Pathways of Engineering Alumni Research Survey (PEARS; Sheppard et al., 2011) provides an example of an instrument that asks alumni about their engineering work more directly. The PEARS instrument was created to explore the development and preparation of engineering alumni for their specific careers as well as factors influencing their success as professionals. This survey was developed from interviews with early career professionals which were conducted through the multi-institutional Academic Pathways Study and grounded in Social Cognitive Career Theory (SCCT). The PEARS instrument was then administered to alumni from across four US research universities in a study which identified several factors influencing graduates' future plans, including participation in internships or cooperative education (co-ops), study-abroad experiences, choice of major, senior-year career aspirations, and pursuit of advanced degrees (Brunhaver, 2015). Relevant to our study, the PEARS instrument included two questions asking engineering alumni about their confidence levels and frequency in completing certain tasks in their engineering work, such as technical activities, interpersonal activities, or business activities. However, although several papers were published from the study focusing on how undergraduate experiences shape career aspirations and skill development, the project team did not publish analyses of the questions about the engineering work activities. Thus, to continue our exploration of how to characterize global work in engineering practice, we next examine research on the engineering workplace.

2.3 | Research on the engineering workplace

Studies of the engineering workplace have examined the nature of engineering work, the skills it requires, processes of workplace learning, issues of diversity, and how engineers perceive their professional roles and identities (Mazzurco

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et al., 2021). A consistent theme in this literature is that engineering practice is inherently sociotechnical, meaning that the social and technical dimensions of work are deeply intertwined and cannot be separated (Jesiek et al., 2019; Leydens & Lucena, 2017; McHenry & Krishnan, 2025; Trevelyan, 2010). Within this sociotechnical system, coordination is a defining feature of engineering work, as engineers are often responsible for organizing and integrating the technical efforts of others (Trevelyan, 2007). This emphasis on coordination highlights the importance of communication as a professional skill, with engineers spending more than half of their workday engaged in communication-related activities (Passow & Passow, 2017). The specific combination of skills required, however, varies across engineering subfields, shaping how individuals perceive their work and construct their professional identities. The PEARS survey has been instrumental in capturing these occupation-specific skill requirements, offering empirical insight into the skills that engineers apply in their everyday practice (Brunhaver et al., 2013).

Learning and the development of expertise in engineering practice is widely recognized as a continuous process embedded in the performance of daily work. Much of this learning is informal or incidental, taking place through problem solving, observation, and collaboration rather than through formal training programs (Korte et al., 2025; Mazzurco et al., 2021). Through these experiences, engineers frequently act as boundary spanners who facilitate collaboration between technical and non-technical stakeholders, integrate diverse forms of knowledge, and balance competing priorities (Jesiek et al., 2017, 2021). These dynamics reinforce that engineering is not only a technical endeavor but also a profoundly social one, shaped by the contexts in which engineers operate.

As engineering work increasingly transcends organizational, disciplinary, and geographic boundaries, it has become inherently global in nature. Engineering problems and projects extend beyond national borders, and engineers routinely collaborate within multinational corporations, transnational teams, and globally distributed supply chains (Downey et al., 2006; Parkinson, 2009). Among the many trends shaping the profession, the dynamics of globalization are particularly noteworthy for their pervasive and enduring influence across nearly all domains of engineering over the years (Jesiek & Beddoes, 2011). Jesiek et al. (2014) proposed a framework of GEC derived from literature reviews, interviews, and focus groups with practicing engineers, identifying three key dimensions: technical coordination; engineering cultures; and ethics, standards, and regulations. Subsequent research further refined and validated these dimensions through the development of assessment instruments to evaluate individuals' GEC (Davis et al., 2023; Jesiek et al., 2020; Mazzurco et al., 2020). This framework provides valuable insights into the competencies required for engineers to be successful in a global workplace, but the existing assessments are focused on evaluating individual competence. Our study seeks to build from this framework in a different direction to measure the global nature of an engineer's job role and career path.

2.4 | Research gaps and purpose statement

Based on this review of the literature, we see a gap in our ability to measure the global nature of specific engineers' work. We have a framework characterizing global engineering work, but we do not have a way to measure engineers' interest in, confidence in, or frequency of carrying out the global work activities described in the framework. These kinds of measurements are necessary in our larger study of the career outcomes of undergraduate programs, where we aim to evaluate "how global" the careers of engineering graduates are. These measurements could also be used by both researchers and companies to understand the global nature of engineers' careers to inform ongoing professional development for engineers in the workplace, allowing them to explore differences across industries, job roles, and career stages. With these aims in mind, the purpose of the current study is to develop a systematic approach to measuring engineers' interest, confidence, and frequency in performing global work tasks. To this end, we designed the *Global Task Performance Indices*, a set of measures intended to capture key dimensions of engineers' engagement in global engineering work. These indices include GTP confidence, GTP interest, GTP frequency (current role), and GTP frequency (across career).

3 | CONCEPTUAL FRAMING

In this section, we integrate concepts from two frameworks and existing literature to develop the conceptual grounding for the GTP indices. First, we review SCCT, which informed our decision to create multiple indices. Second, we discuss GEC, which informed the development of specific items. Third, we discuss our conceptualization of *engagement in*

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global engineering work based on both the GEC framework and other related literature. Finally, we provide a conceptual basis for each of the GTP Indices.

3.1 | Social cognitive career theory

The larger project within which the current study sits is grounded in SCCT. Because we used this theory to develop the survey used in our larger study, this framework also provides a structure for collecting evidence of validity for the GTP indices (e.g., by looking at relationships with educational experiences). SCCT could also inform applications of our indices, such as understanding how global work may look different at different stages of a career, or developing professional development training for practicing engineers.

SCCT is a conceptual model used to understand career choices. The theory is based on Bandura's (1986) social cognitive theory and suggests that career choices are the result of interactions between personal, behavioral, and contextual factors (Lent et al., 1994). Figure 1 provides an overview of SCCT and highlights the variables that are of primary interest in the development of the GTP indices.

In SCCT, learning experiences are educational or occupational activities related to one's goals, shaped by personal characteristics and contextual opportunities. These experiences influence self-efficacy (beliefs about one's ability to perform tasks) and outcome expectations (beliefs about the consequences of actions), which in turn guide interests, choice goals, and choice actions. Choice goals are aspirations to pursue a particular activity, and choice actions are steps taken toward or away from these goals. Together, they form a "career choice" that leads to performance attainments, or the skills and outcomes resulting from enacted choices, which can then generate new learning experiences (Lent et al., 1994, 2003). SCCT has been used within engineering education to study various populations, including students in co-op programs (Young, 2017), early career engineers (Brunhaver et al., 2013), and established professional engineers (Buse, 2009). Because the components of the SCCT framework (e.g., self-efficacy, interests) are responsive to particular situations and performance domains, the framework is adaptable to specific contexts as we propose to do in this study (Lent & Brown, 2006).

3.2 | Global engineering competency

The concept of GEC informs our definition of global engineering work (discussed in Section 3.3) and grounded the development of the items for the GTP indices. As the engineering workplace becomes increasingly global, engineers are required to apply global competence in the context of their engineering work. These capabilities are known as GEC, which has been characterized by several different authors (Allert et al., 2007; Downey et al., 2006; Jesiek et al., 2014;

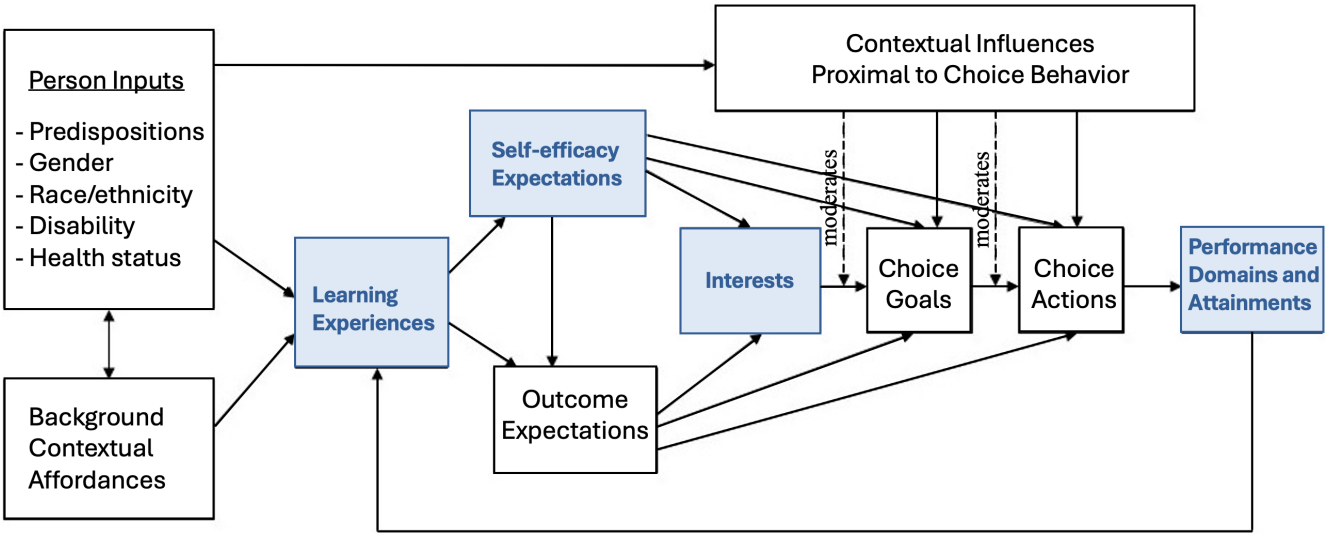

FIGURE 1 Social Cognitive Career Theory, with key elements for this study highlighted.

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Levonisova et al., 2014; Parkinson, 2009; Ragusa, 2014). For this study, we adopt the framework developed by Jesiek et al. (2014), which identified three dimensions of GEC: technical coordination; understanding and negotiating engineering cultures; and navigating ethics, standards, and regulations. *Technical coordination* involves working with and influencing others to perform necessary work according to a mutual schedule. *Understanding and negotiating engineering cultures* refers to the ability to navigate situations defined by multi-national/cultural differences in the practices and processes of technical problem solving. The dimension of *Navigating ethics, standards, and regulations* captures the ability to address ethical considerations while recognizing and adhering to diverse regulations, codes of practice, and professional standards. We adopted this framework because of its grounding in the study of engineering work through interviews and focus groups with engineers working in global contexts. It also operationalizes GEC in terms of observable, career-relevant behaviors, making it directly applicable to our instrument development. We will discuss how the GEC framework informed the development of the items for the GTP Indices in Section 4.3.

3.3 | Defining engagement in global engineering work

In this section, we provide our definition of *engagement in global engineering work* through two key points: (i) *Engagement* is the frequency of global tasks that are completed in a particular role or career path, regardless of how well these tasks are performed; (ii) *Global engineering work* includes tasks that fit within the dimensions of the GEC framework.

Our aim in this study was to develop a way to measure "how global" an engineer's career has been, rather than focusing on an individual's competence. *Competency* can be defined as "an underlying characteristic of a person which results in effective and/or superior performance on the job" (Lucia & Lepsinger, 1999, p. 5) and takes into consideration an individual's aptitude, personal characteristics, knowledge, skills, and behavior. In other words, competency is focused on how well an individual performs in a certain domain, which is what is evaluated by the existing GEC assessment tools (Jesiek et al., 2020; Mazzurco et al., 2020). In contrast, we conceptualize *engagement* in global engineering work to be the frequency of global tasks that are completed in a particular role or career path, regardless of how well these tasks are performed. By our definition, engagement in global engineering work is a characteristic of a role or career path rather than an individual, and different individuals working in the same role would have the same amount of engagement regardless of their levels of GEC. Because of this difference, we believe that although we are drawing on the same GEC framework as these existing assessment tools, we are measuring a different construct.

Our focus on work tasks aligns more closely with research of global careers in the management and career studies literature. These fields have explored types and characteristics of global work, identifying dimensions of global experiences such as the amount of physical mobility, cognitive flexibility, non-work disruption, cultural gap, differences in legal context, and types of interactions (Baruch et al., 2013; Shaffer et al., 2012). Peiperl and Jonsen (2007) describe two dimensions of global activity (time spent away from home culture and amount of interaction across cultures) and further outline a process model for global careers, including antecedents, drivers of the decision to move abroad, career outcomes, and career capital that is developed through the experience. Similarly, prior research has explored the patterns of global careers, identifying common motivations and decisions made by "global careerists," or those who have extensive global experience over the course of their career (Dickmann et al., 2018). These types of careers are often connected to early career interest in global work, either personal or based on a first international work assignment, which lead to subsequent decisions to work abroad, and result in high levels of self-understanding, self-confidence, and global career identity (Suutari, 2003; Suutari et al., 2018; Suutari & Mäkelä, 2007). Within the research on global careers, however, global work is often characterized as a series of discreet experiences (e.g., trips, assignments, contracts) rather than activities that are integrated into the daily work of a professional. Additionally, much of this literature has focused on long-term international assignments, which have historically been the approach to international business (Dickmann et al., 2018), although recent papers have begun to explore the increasingly common short-term assignments and global virtual work (Dickmann et al., 2018; Froese et al., 2025).

In our study, we wanted a more fine-grained conceptual framing of global work tasks than is offered in the existing frameworks on global careers, and one which accounted for non-travel global experiences. In contrast to the view that global work must involve travel, we conceptualize *global engineering work* as comprising any task that fits within the dimensions of GEC outlined in Section 3.2, many of which can be carried out virtually and do not require an engineer to be on a "global" assignment.

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3.4 | Conceptualizing the GTP indices

Based on our definition of engagement in global engineering work, we propose four indices to study this phenomenon in the careers of engineers. We wanted a tool that would allow us to study engagement in global engineering work across a career, accounting for the fact that global activities are more common at later stages of a career (Dickmann et al., 2018; Peiperl & Jonsen, 2007). Grounding our indices in SCCT allowed us to consider constructs (i.e., self-efficacy, interest) that may indicate the potential for a global career, even if an individual has limited global engineering work experience early in their career. In developing our indices, we focused on three constructs of the SCCT: self-efficacy, interests, and performance domains. In the following sub-sections, we will conceptually outline each of our indices and their connections to the SCCT framework.

3.4.1 | GTP confidence index

The GTP confidence index is grounded in the self-efficacy construct from SCCT. Self-efficacy is defined as an individual's belief in their "capabilities to organize and execute courses of action required to attain designated types of performances" (Bandura, 1986, p. 391). Because self-efficacy is linked to a particular type of performance, an individual may hold high self-efficacy beliefs about certain activities but not others. The concept of self-efficacy has been studied and measured in different forms, but one of the most common is a focus on *content- or task-specific self-efficacy*, which refers to "beliefs in one's ability to perform the specific tasks required to succeed within a given domain" (Lent & Brown, 2006, p. 16). Our GTP confidence index draws on this aspect of self-efficacy, where we are evaluating an individual's confidence in carrying out specific global tasks in the context of engineering work.

Self-efficacy is often assessed as a latent construct, where items are expected to correlate because of a shared cause. However, in our study, the underlying domain of global engineering work is comprised of a diverse set of tasks that we do not expect to always occur together, and we therefore interpret each item as a distinct aspect of the overall construct. In this sense, our GTP index does not fully align with the SCCT construct of self-efficacy, and therefore we called our index "Confidence" to avoid confusion in interpretation. Our index is aiming to evaluate confidence in specific tasks, which together provide a sense of general confidence in completing global tasks, but this score should not be interpreted as an individual's self-efficacy for all global tasks. We discuss interpretation of the indices further in Section 4.6.

Finally, it is important to note that one way to assess competency is to have individuals rate their self-confidence on various statements, so our confidence index could overlap with existing competency assessments. However, our items (discussed in Section 4.3) are notably more specific than the items in related competency assessments. For example, the GEC scale uses high-level statements such as "I can practice engineering in an international setting" (Mazzurco et al., 2020, p. 7), which contrasts our focus on specific tasks such as communicating with international clients or obtaining licenses in different countries. The conceptualization of our items as distinct aspects of the construct also differentiates the interpretation of the GTP confidence index as compared to competency assessments, where each scale is viewed as a latent construct.

3.4.2 | GTP interest index

The GTP interest index is grounded in the interest construct from SCCT, which refers to "people's pattern of likes, dislikes, and indifferences regarding different activities" (Lent & Brown, 2006, p. 17). In SCCT, the development of interests is influenced by perceptions of self-efficacy and outcome expectations related to particular activities, and interests in turn inform an individual's intent to complete these activities (i.e., choice goals). Lent et al. (1994) suggest that although interests may continue to develop over a lifetime, they are most fluid through early adulthood, after which they can crystallize to some extent. Because interest represents a mid-point in the theoretical connections proposed by SCCT, we believe that the GTP Interest Index may be useful in understanding engineers' progression toward greater engagement with global engineering work over the course of a career. Similar to the confidence construct, interest may overlap with certain dimensions of competency frameworks (e.g., motivation), but as mentioned in the previous section, we focus on more specific task statements than comparable competency assessments. Thus, the GTP interest index is capturing interest in carrying out day-to-day activities in a specific context rather than a general interest in global engagement.

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3.4.3 | GTP frequency indices

The GTP frequency indices are grounded in the performance domains and attainments construct from SCCT. Lent et al. (1994) define the performance construct broadly and differentiate between domains (e.g., academic major or work tasks) and attainment (i.e., grades or success level in completing a task). Based on our definition of engagement in global engineering work, we focus on the performance domain aspect of this construct rather than the attainments, which differentiates the GTP indices from competency scales (as discussed in Section 3.3). Building on the SCCT concept of a performance domain, the goal of our frequency indices is to measure the scope of an individual's performance within the domain of global engineering work. In measuring experience with global tasks, we chose to distinguish between an engineer's current role and across-career performance to capture two complementary perspectives on engineers' engagement in global work. The GTP frequency (current role) index reflects the engineer's immediate work context, which may vary depending on organizational role or industry, whereas the GTP frequency (across career) index provides a cumulative view of global engagement across multiple positions and experiences. Collecting both perspectives enables differentiation between context-specific responsibilities and sustained, career-long engagement in global engineering work.

3.4.4 | Limiting our scope to four indices

We did not develop indices for other SCCT domains, such as outcome expectations, choice goals, and choice actions. Outcome expectations are "beliefs about consequences or outcomes from performing particular behaviors" (Lent & Brown, 2006, p. 17), which may be wide ranging depending on the task in question. Addressing this construct would require a different item structure compared to the GTP indices and we had less literature to draw on in this area, so we did not develop an index. We considered developing an index for choice goals (i.e., intention to pursue a particular activity) but we determined that we could not specify a time frame for intent to pursue activities that would be equally applicable to all potential participants across different career levels, which is recommended by Lent and Brown (2006) in evaluating goals. Lacking this kind of specificity, a choice goals index could end up conceptually overlapping the GTP interest index due to challenges in phrasing items that differentiate these constructs for participants. Finally, we identified existing questionnaires we could use to address choice actions and thus did not need to develop our own indices to collect this information. Despite not covering every SCCT construct, our indices enable tracing the pathway from learning experiences through self-efficacy and interests to performance domains.

4 | INSTRUMENT DEVELOPMENT PROCESS

This section reviews the process through which we developed the items for the GTP indices. Our process aligns with similar processes used in the development of survey instruments in previous engineering education studies (e.g., Leydens et al., 2018). Rather than treating instrument development as a linear task, we conceptualize it as an iterative, evidence-building process in which design decisions are continuously informed by theory, prior research, and empirical feedback. In the next sections, we will walk through each step of the process. First, we discuss our conceptualization of validity and the evidence we present through our description of the instrument development process (Section 4.1). Next, we define the intended use of the GTP indices, discuss our decisions related to item specificity (Section 4.2), and describe the development of items grounded in theory and prior literature (Section 4.3). We then discuss how we solicited expert feedback to evaluate content relevance and coverage (Section 4.4) and examined response processes through cognitive interviews (Section 4.5). Finally, we discuss how the indices are scored and the intended interpretation of these scores (Section 4.6).

4.1 | Conceptualizing validity in this study

We approach validity as a unitary construct, following the *Standards for Educational and Psychological Testing* (American Educational Research Association [AERA], American Psychological Association [APA] & National Council on Measurement in Education [NCME], 2014) and prior recommendations for engineering education survey

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development (Douglas & Purzer, 2015). Although validity has traditionally been delineated into content, criterion, and construct categories (Grimm & Widaman, 2012), we do not treat these as discrete types. Instead, we collected multiple forms of evidence that, taken together, support a coherent validity argument for the GTP indices. The AERA standards describe validation as an ongoing process that involves accumulating evidence from multiple sources throughout the processes of instrument development, implementation, data analysis, and refinement (AERA, APA & NCME, 2014). Consistent with this framework, the present study provides initial validity evidence for the GTP indices. We will argue in Section 4.6 that this instrument is made up of four formative indices (DeVellis & Thorpe, 2022), and the evidence of validity that we present is aligned to this type of instrument. In Table 1, we outline the validity evidence that we will present in this section related to the instrument development process and align it to different categories of evidence discussed in the AERA standards. We describe additional evidence sources related to instrument implementation in the Section 5.

4.2 | Intended use and specificity of the GTP indices

The GTP indices are intended to measure the level of global engagement in an individual engineer's career. These indices are designed to capture confidence, interest, and frequency of performing specific behaviors rather than an individual's competence at these tasks, making them distinct from measures of GEC (as discussed in Section 3.3). The primary intended use of these indices is for research examining patterns of global engagement in engineering work and their relationship to educational experiences and career outcomes. Within this scope, we anticipate that the indices could be used by researchers, program administrators, employers, and policymakers. Program administrators may use the indices to evaluate whether participation in global educational experiences is associated with increased engagement in global work activities after graduation. Organizations employing engineers could use the indices to understand the global dimensions of engineers' roles within their workforce, including identifying potential needs for professional development. At a broader level, the indices can be used to assess the extent to which the engineering workforce is engaged in global engineering work, providing insight into workforce readiness in an increasingly interconnected engineering landscape.

In designing the GTPP indices, we deliberately opted for a moderate level of specificity in developing the individual items. Our indices are both more granular than the statements found in related competency assessments (discussed in Section 3.4) and also general enough that they can apply across engineering roles and industries. For example, we chose to ask about "participating in international fieldwork or assignments," rather than a specific example such as "managing a manufacturing plant in an international context" to support such comparisons. Along these lines, Lent and Brown (2006) caution that although extreme specificity may be theoretically interesting, it risks capturing phenomena that lack clear relevance to practical vocational applications. Consequently, they advocate for a moderate level of specificity to balance theoretical rigor with practical utility. As our goal is to study global engineering work across an entire career, making the items more specific could lose practical utility for a broad career assessment. Finally, aiming for a moderate level of specificity also allowed us to capture the multifaceted nature of global engineering work without creating an impractically long instrument.

However, we note a few limitations in the use of the GTP indices, given our decision to develop the items at a moderate level of specificity. In attempting to capture a wide array of global engineering tasks, the GTP indices function more like all-purpose, global measures. As a result, the measures should be interpreted as first-order indicators of global work engagement rather than highly tailored, domain-specific representations of global engineering practices.

TABLE 1 Evidence of validity presented for instrument development.

Evidence source	Claim	Evidence presented
Test content	The survey items adequately represent the full scope of the formative indices	Literature review: To ensure all parts of the indices are represented Expert review: Advisory board review of item relevance and clarity
Response processes	Participants read and understand the items/response choices as intended	Cognitive interviews/think-aloud protocol: Asked participants to read items aloud and explain their reasoning for choosing an answer

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Although this level of specificity is appropriate for identifying general patterns of global work engagement across engineers, the GTP indices do not distinguish between different forms of global engineering work or capture developmental sequences through which engineers may progressively assume more complex global responsibilities. Future research could build on our work by developing more differentiated measures that capture variation in the types, complexity, and developmental progression of global engineering tasks across professional contexts.

4.3 | Item development

Based on the intended use and level of specificity defined above, we developed an initial set of items for the GTP indices. First, we built on our conceptual framing of each index (see Section 3.4) to define the purpose of each index and develop the prompt participants would respond to in each case (Table 2).

After defining the purpose and prompt for each index, we developed 14 items that describe global work activities performed by engineers. These items were informed by prior research on engineering work (Agrawal & Hurd, 2016; Jesiek et al., 2019; Mazzurco et al., 2021; Passow & Passow, 2017; Sheppard et al., 2011) and aligned with the global engineering competency framework (Jesiek et al., 2014; Mazzurco et al., 2020). Our goal was to develop a list of items that could be used for all four indices by adjusting the initial prompt (prompts shown in Table 2). The initial items were developed iteratively through discussion with our core research team (the three authors) and refined over the course of several meetings as we reviewed prior research and our theoretical framework. Table 3 shows the initial list of items along with their alignment to the GEC framework. The items are listed starting with gerunds, which we use for interest and confidence indices (e.g., "communicating"), but in the frequency indices we start each item with the infinitive form (e.g., "communicate").

4.4 | Advisory board feedback

The first step in refining the GTP indices and gathering evidence of validity involved consulting our advisory board to review the initial list of items and provide feedback. Our advisory board consists of both research and industrial members. The research advisory board includes five experts in engineering education and global engineering programs. Their combined expertise spans the development and evaluation of GECs, survey design, engineering career pathways, and the coordination of international programs. Our industrial advisory board consists of four senior professionals from diverse sectors, including manufacturing, pharmaceuticals, transportation, and technology. They bring extensive experience in recruiting, training, and developing engineers for global roles. We targeted industry partners with this expertise because of our project's focus on preparing engineers for a global career, preparation which we believe occurs both during college and after graduation. Together, these advisory boards provided critical feedback on item clarity, validity evidence based on survey content, and practical relevance, supporting the creation of an instrument that is both theoretically grounded and applicable to real global engineering contexts.

We sought input from our advisory board members as an expert review of the items for our GTP indices to determine the extent to which they adequately and appropriately represented the intended constructs. We emailed all the advisory board members our initial list of items for written feedback and scheduled a meeting with the full advisory

TABLE 2 Defining the four global task performance (GTP) indices.

Index	Definition	Prompt
GTP confidence	The extent to which an engineer feels capable and self-assured in performing global tasks	How confident are you in completing the following activities as part of your job?
GTP interest	The degree of personal enthusiasm or intrinsic motivation toward engaging in global tasks	How interested are you in completing the following activities as part of your job?
GTP frequency (current role)	How often an engineer has performed global tasks in their current job role	At the organization where you currently work (or most recently worked) how often do you
GTP frequency (across career)	How often an engineer has performed global tasks over the span of their career	Over your entire career, how often have you

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TABLE 3 Initial list of items for the global task performance indices.

GEC dimension	Item
Technical coordination	Communicating with international clients and stakeholders
	Collaborating with multicultural teams
	Leading a multicultural team of people
	Providing training and support to colleagues from diverse cultural backgrounds
	Conducting performance monitoring and evaluation in cross-cultural contexts
	Managing projects across time-zones[a]
Understanding engineering cultures	Participating in international workshops, training sessions, and conferences
	Participating in international fieldwork or assignments
Ethics, standards, and regulations	Ensuring compliance with local regulations and international standards
	Obtaining licenses and certifications for engineering projects in different countries
Cross-cutting items (address multiple dimensions)	Resolving conflicts with multicultural team members
	Leading an organization that is international in scope
	Speaking different languages
	Implementing sustainable practices to minimize environmental impact[a]

[a]Indicates items that were later dropped (see Section 4.4).

board for group discussion. Through this process, we removed two items from the indices, both of which were deemed to be out of scope for the concept of global work activities. The item "Managing projects across time-zones" was felt to be less global in nature because engineers may manage across time zones within countries. The item "Implementing sustainable practices to minimize environmental impact" was also determined tonot require GEC and therefore fell out of alignment with the goal of these indices. Thus, after the advisory board review, we reduced the GTP indices to 12 items. Their evaluation offered evidence based on content, consistent with the *Standards for Educational and Psychological Testing* (AERA, APA & NCME, 2014), further supporting the validity of the newly developed survey items.

4.5 | Think-aloud interviews

Following our meeting with the advisory board, we conducted think-aloud sessions to further refine the survey questions. Think-aloud protocols aim to capture participants' thought processes as they engage with survey instruments (Wolcott & Lobczowski, 2021). These sessions are used to make the instructions and questions clearer and improve the answer choices that are listed. Participants were requested to "think" out loud as they read the instructions and answered each question on the survey. During the interviews, we prompted participants to read the instructions out loud, read each survey question out loud, fill in their answer for each question, and tell us what they were thinking as they did so. Whenever there was a pause on any question, we asked the participant, "what are you thinking?" or "what do you think the question is asking?" (Willis, 1999).

Our think-aloud participants were alumni of the Global Engineering Alliance for Research and Education (GEARE) program and the Purdue College of Engineering. Participants were recruited based on their experience in global engineering programs, engineering background, and availability to participate in a 1-h session. We selected participants with diverse career levels and backgrounds to ensure a range of perspectives on the survey items. Interview 1 was with a recent graduate working in an engineering manufacturing role. Interview 2 was with an assistant professor of mechanical engineering who had recently led a research group in Germany. Interview 3 was with a design engineer 6 years into their career. We conducted three 1-h interview sessions, one with each participant. Each session resulted in less feedback than the previous one, so we stopped after the third session when we had reached saturation on the feedback through this method.

Importantly, none of the participants in the think-aloud interviews identified issues with items in the GTP indices. Rather, early interviews resulted in minor suggestions for wording improvements in other sections of the survey, and we used this trend to determine saturation. Participants consistently indicated that the global activities items were

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adequate and elicited the intended effects. In the third interview in particular, the participant did not raise any new concerns and instead confirmed that the items were clear and accurately reflected their global engineering experiences (e.g., noting that the activities "made sense" and aligned with how they approached their work). Participants' thought processes, interpretations, and responses aligned with the intended index and item meanings, providing evidence supporting the validity of the GTP indices based on response processes. Since the items for the GTP indices did not require clarification in think-aloud interviews, we did not make any further updates to the items.

4.6 | Interpretation and scoring of the GTP indices

Based on the definitions provided by DeVellis and Thorpe (2022), we conceptualize our instrument for measuring engagement in global engineering work as a set of four formative indices. Unlike reflective scales, in which items are expected to correlate because of a shared underlying construct, formative indices comprise items that may not correlate because each represents a distinct aspect of the overall construct. In the GTP indices, the items share common effects rather than a latent cause. An individual involved in a greater variety of global activities can be considered more globally engaged. Although interest and confidence are often considered latent constructs and frequently measured with scales rather than indices, in our case, a scale did not make sense conceptually. We did not expect items within the indices to be strongly correlated with each other, as an engineer may reasonably be interested, or confident, in some of the work tasks and not others. To explore whether our expectations aligned with the data, we computed inter-item correlations for all items in each index (see Appendix A: Tables A1–A4). Consistent with our expectations, the items were primarily weakly to moderately correlated, although a few correlations were higher ($r_s \approx .73$), and most were statistically significant ($p < .001$). This pattern suggests that each indicator contributed unique information rather than reflecting a single underlying latent construct (DeVellis & Thorpe, 2022). Therefore, consistent with DeVellis and Thorpe's (2022) recommendations for developing indices, we sought to provide evidence of validity for these indices through expert judgment (Section 4.4) and criterion-related evidence, examining the relationship of the indices to other relevant variables (Section 6).

The score for each index is calculated by averaging the scores for all items with equal weighting. Consistent with the conceptualization of these measures as formative indices, the purpose of aggregation is not to estimate a latent construct but to summarize multiple indicators representing distinct aspects of global engineering work. With this definition in mind, the GTP indices can together be interpreted as providing a general indication of an individual's engagement in global engineering work. As discussed in Section 3.4, we view engagement as broader than task completion so that, building on SCCT, we can explore early engagement indicators that may lead to task engagement later in a career. Specifically, higher scores on the GTP confidence index can be interpreted as general confidence in completing global engineering tasks, which can inform interest in such tasks. Similarly, higher scores on the GTP interest index can be interpreted as general interest in completing global engineering tasks, which may lead individuals to set goals and subsequently make career choices to achieve roles where they have such opportunities (Lent et al., 1994). Both indices can be viewed as early engagement in global engineering work and interpreted as a demonstration of potential for future global task engagement. In contrast, higher scores on the GTP frequency indices should be interpreted as broader and more frequent engagement in global engineering work tasks. The current role index can be used to make comparisons of global engagement across roles and career levels, while the across career index can be used to explore differences in global engagement between individuals on different career trajectories. None of the GTP indices is intended to indicate competence at completing global tasks, but rather the level of engagement in global engineering work (see Section 3.3 for further discussion of this distinction).

5 | METHODS

Guided by the Standards for Educational and Psychological Testing (AERA, APA & NCME, 2014), we collected validity evidence from survey data for the four GTP indices: GTP confidence, GTP interest, GTP frequency (current role), and GTP frequency (across career). The study reported in this paper is part of a larger multiple-case study examining how undergraduate global experiences influence engineers' global career outcomes. The larger project focuses on three global engineering programs that have been running for at least 10 years at different universities in the United States, each requiring students to spend at least one semester abroad through study or internship experiences. We

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administered a survey including the GTP indices and other measures to participants, both from the alumni of these global engineering programs and a comparison group of alumni from the same universities who did not participate in such programs during college. In this section, we describe the larger survey and data collection process (Section 5.1), the participant profile of the respondents (Section 5.2), how we selected variables from the larger survey to use in our validity study (Section 5.3), and the analyses we conducted to collect evidence of validity (Section 5.4).

5.1 | Data collection

To provide context for our validity study of the GTP indices, we provide an overview of the larger survey in which they were included (Table 4). The larger survey was developed to align with constructs from the SCCT theory discussed earlier, and we integrated questions from several existing survey instruments. Table 4 summarizes the survey content, including its alignment with SCCT dimensions and the sources from which we borrowed or adapted survey questions. We did not use all the measures listed here in our validity study, as many were included to address the research questions of the larger study. However, we chose measures for use in the current analysis from this larger list, which we discuss more in Section 5.3.

As shown in Table 4, we borrowed and adapted many questions from existing surveys as part of the larger study. In particular, we used many questions from the PEARS survey (Chen et al., 2012; Gilmartin et al., 2011), which aligns

TABLE 4 Larger survey sections and SCCT alignment (GTP indices bolded).

SCCT dimension	Example measures	Questions sources	Why included?
Person inputs/background	Age, gender, race/ethnicity, nationality, language fluency	Demographic conventions	Provides contextual variables for interpreting variation in global career outcomes.
Learning experiences	Participation in study abroad, non-travel intercultural experiences, extracurricular activities	Davis (2020), Gilmartin et al. (2011), Hubbard and Rexeisen (2020), Paige et al. (2009)	To explore connections between learning experiences (e.g., study abroad, internships) to later career outcomes.
Self-efficacy	Confidence in performing global work activities	Global task performance index	SCCT suggests that learning experiences lead to self-efficacy as an intermediate step toward career outcomes.
Self-efficacy	Cultural intelligence inventory (CQS)	Ang et al. (2007)	A commonly used instrument that we can use to evaluate the GTP indices.
Interests	Interest in performing global work activities	Global task performance index	SCCT suggests that learning experiences lead to interests as an intermediate step toward career outcomes.
Choice actions	Degrees earned, job title, role, industry, promotions, PE licensure, salary history	Claussen et al. (2021), Gilmartin et al. (2011)	To explore how undergraduate global experiences shape career decisions.
Performance domains – global work tasks	Frequency of performance of global work activities in current role and across career	Global task performance index	We asked about frequency in both current role and across career to distinguish between situational, role-specific engagement and sustained, career-wide engagement in global work activities.
Performance attainments – GEC	Global engineering competency scale (GECS)	Mazzurco et al. (2020)	To explore engineers' self-perceptions of how well they perform global work (beyond interest and confidence).

Note: Bold values indicate GTP indices.

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closely with our goals due to its focus on the career trajectories of engineering alumni and its grounding in SCCT (see Section 2.2 for information about PEARS). Additional details about specific items in this larger survey can be found on our project website (Davis et al., 2026).

We deployed the survey to potential study participants during the fall of 2024, including both the target group of alumni who had participated in global engineering programs as undergraduate students and the comparison group of engineering alumni from the same institutions who did not participate in such programs. The strong alumni connections maintained by these different programs were crucial to our efforts. We implemented several established recruitment measures from previous alumni studies (Chen et al., 2012; Perkins, 2011; Sheppard et al., 2004). An initial "coming soon" email was distributed to inform prospective participants about the upcoming survey launch, followed by an official invitation email the subsequent week. Two reminder emails were sent at staggered intervals thereafter to encourage participation. Additionally, announcements were shared via LinkedIn alumni groups to broaden outreach. To enhance response rates, all participants were offered gift cards for completing the survey. The survey was initially distributed to the target group, and responses from this group informed the recruitment of participants for the comparison group as we aimed to achieve a similar distribution across groups in terms of engineering discipline, industry, and individual demographics. The study was approved by the Purdue Institutional Review Board.

5.2 | Participants

Table 5 provides the demographic information of the 1223 respondents to our survey across all three institutions. Participants were categorized into two groups based on their undergraduate experience: the target group, consisting of alumni who participated in undergraduate global engineering programs, and the comparison group, consisting of alumni who did not participate in such programs. Across all institutions, men comprised the majority of respondents, followed by women, with very few identifying as nonbinary or opting not to disclose their gender. Racially, the sample was predominantly White, with smaller representations of Asian, Black or African American, Hispanic, and multiracial alumni. This demographic make-up aligns with the historical participation of our case programs, although the program

TABLE 5 Demographic information for survey respondents.

Characteristic	Target ($n = 595$)	Comparison ($n = 628$)
Gender		
Men	377 (63%)	437 (70%)
Women	211 (35%)	184 (29%)
Nonbinary	1 (0.2%)	0 (0%)
Not disclosed	6 (1%)	7 (1%)
Race/ethnicity		
White	438 (74%)	472 (75%)
Asian	75 (13%)	60 (10%)
More than one race	47 (8%)	46 (7%)
Black or African American	11 (2%)	14 (2%)
Hispanic	14 (2%)	18 (3%)
American Indian or Alaska Native	2 (0.3%)	4 (1%)
Not disclosed	8 (1%)	14 (2%)
Years of professional experience		
0–5 years	277 (47%)	220 (35%)
6–10 years	166 (28%)	130 (21%)
11–15 years	76 (13%)	101 (16%)
16–20 years	36 (6%)	70 (11%)
21+ years	40 (7%)	107 (17%)

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participants have become more diverse over time. We also include a summary of the participants by discipline in Appendix B: Table B1.

To seek evidence of validity for the GTP indices, responses were pooled into a single dataset ($N = 1223$) to maximize sample diversity and statistical power. Institution-level analyses were not the focus of this study but will be explored in future work.

5.3 | External criterion variables

Following DeVellis and Thorpe's (2022) recommendations for formative indices, we present criterion-related evidence supporting the validity of these measures by assessing the relationships between the GTP index scores and theoretically relevant external criteria. The goal was to determine whether the four GTP indices behaved as expected in relation to external indicators of global engagement, experience, and professional advancement. We selected eight external criterion variables based on their theoretical alignment with the SCCT framework and their relevance to the GTP indices. In Figure 2, we show how each GTP index fits within the SCCT framework and list the criterion variables associated with each index. In Table 6, we list the eight criterion variables, their question format, and alignment to SCCT.

We note that not all dimensions of the GEC and cultural intelligence (CQ) inventories were used as criterion variables, as they do not all conceptually align with one of the GTP indices. We focused on the dimensions most relevant to each index, ensuring that the criterion validation reflects meaningful, theoretically aligned outcomes. It is also important to note that we conceptually differentiate the relationships of CQ and GEC to the GTP indices. We view CQ as a potential cause of engagement in global engineering work, whereas we view GEC as an outcome developed through such engagement. The full list of items for CQS and GECS is shown in Appendix C: Tables C1 and C2. We explain the criterion variables selected for each index in the following sub-sections.

5.3.1 | Criterion variables for GTP confidence

For the GTP confidence index, we chose three criterion variables: global career level, behavioral CQ, and global engineer self-identification. Global career level was included because we expect greater exposure to global tasks to enhance

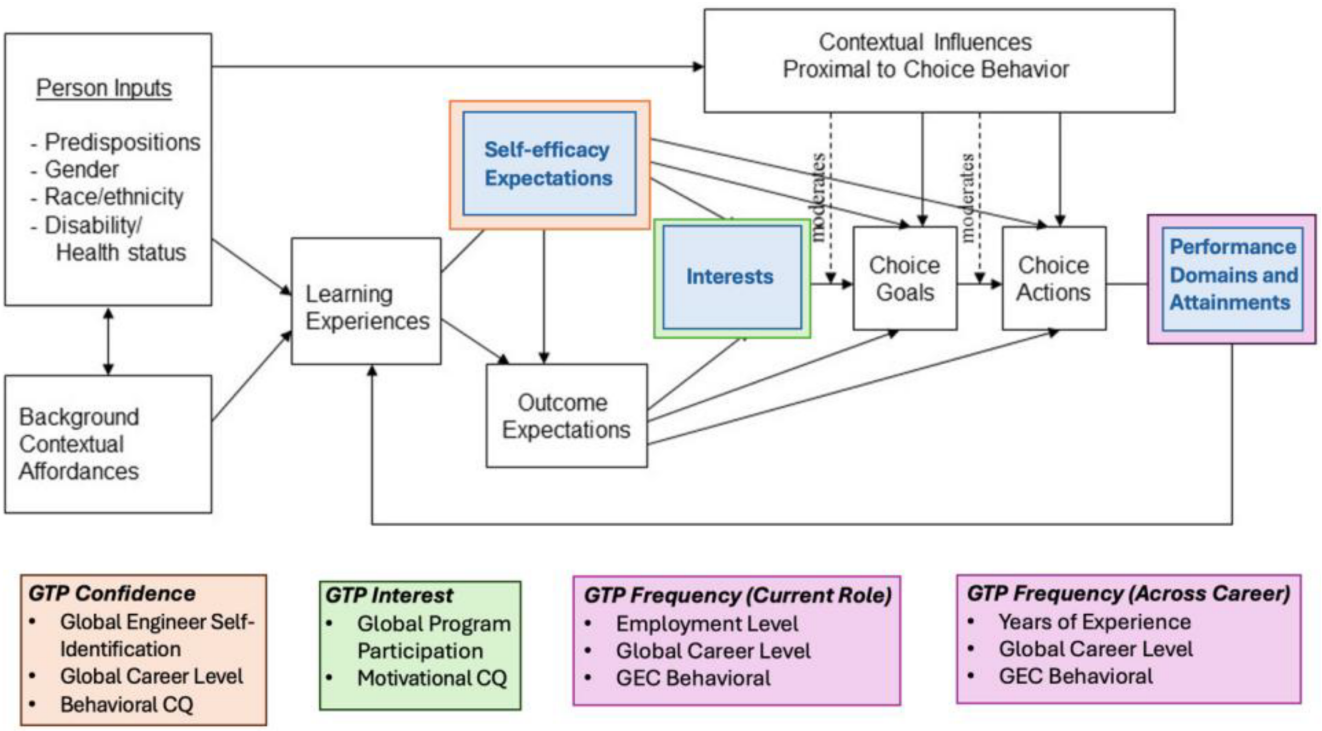

FIGURE 2 Mapping of GTP indices and external criterion variables to the SCCT framework.

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TABLE 6 Criterion variables, descriptions, and alignment with SCCT.

Variable	Description	Items	Scale	SCCT alignment
Global program participation (GPP)	Participation in global undergraduate experience	Single item	Yes /No	Learning experience
Global engineer self-identification	Self-perceived global professional identity	Single item	Yes/Not sure/No	Self-efficacy
CQ – Motivation	Motivational cultural intelligence	Five items	1 (strongly disagree) – 7 (strongly agree)	Interests
Global career level	Extent of global exposure and engagement in professional roles	Single item	1 (none) – 5 (very global)	Performance domain
Employment level	Job seniority and professional advancement	Single item	0 (Unemployed) – 6 (Executive/C-level)	Performance attainment
Years of experience	Total post-undergraduate professional experience	Continuous	Years	Performance attainment
CQ – behavioral	Behavioral Cultural Intelligence	Five items	1 (Strongly disagree) – 7 (strongly agree)	Performance attainment
GEC – behavioral	Behavioral dimension of global engineering competency	Five items	1 (Strongly disagree) – 7 (Strongly agree)	Performance attainment

confidence in performing them. Behavioral CQ was selected because the ability to adapt one's behavior appropriately in intercultural interactions may enhance confidence in navigating global engineering work. Self-identification as a global engineer was also included as an indicator of confidence, as holding an identity as a global engineer could indicate confidence in carrying out global engineering work. This item asked participants whether they considered themselves global engineers, with response options of "yes," "not sure," or "no." The term "global engineer" was intentionally left open to participants' interpretation. This item was adapted from the PEARS survey (Gilmartin et al., 2011), where it was used to evaluate engineers' sense of engineering identity. We changed the wording to "global engineer" rather than simply "engineer."

5.3.2 | Criterion variables for GTP interest

To examine criterion-related evidence of validity for the GTP interest index, we assessed its associations with motivational CQ and participation in global undergraduate experiences. Following Van Iddekinge et al. (2011), who posit that interests influence performance by governing motivational choices, we treated motivational CQ as a proximal criterion for interest in engaging in global engineering work. Many of the items on the motivational CQ scale are phrased to align with the concept of interest, such as "I enjoy interacting with people from different cultures." Conceptually, we are suggesting that a general interest in engaging globally may inform interest in engagement in global engineering work. We also included participation in global undergraduate experiences as a criterion variable, as we expected that alumni who had participated in such experiences would report higher levels of interest in global engineering work. Although SCCT suggests self-efficacy as an intermediate step between learning experiences and interest, the literature on outcomes from global undergraduate experiences in engineering education indicates interest in global work as a common outcome (e.g., Davis & Knight, 2017; Knight et al., 2020).

5.3.3 | Criterion variables for GTP frequency (current role)

For the GTP frequency (current role) index, we used global career level, behavioral GEC, and employment level as the criterion variables. Global career level reflects participants' self-assessment of how global their career has been, and we expected that individuals who believe they have had a global career would also be carrying out more global tasks in their current role. Behavioral GEC was included as a theoretically related construct capturing individuals' capability to perform global engineering work. Consistent with SCCT, we expected that higher levels of competence

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(i.e., performance attainments) would be associated with more frequent enactment of global work tasks (i.e., performance domains). Employment level was included as an indicator of structural opportunity because we expect that individuals in higher positions within an organization would have more opportunities to perform global tasks in their current roles. Together, these variables represent complementary dimensions of global engineering work, including career orientation, capability, and opportunity, and provide a theoretically grounded basis for evaluating whether the GTP frequency (current role) index behaves as expected in relation to relevant external criteria.

5.3.4 | Criterion variables for GTP frequency (across career)

The GTP frequency (across career) index was evaluated using global career level, behavioral GEC, and years of experience as criterion variables. Global career level and behavioral GEC were included for the same reasons described in the previous section, and we expect similar outcomes between the two GTP frequency indices. To capture differences between these two indices, however, we use years of experience rather than employment level for the across career index. This criterion variable is intended to account for the role of career tenure, as individuals with more experience have had greater opportunity to accumulate engagement in global engineering work over time. Collectively, these variables provide criterion-related evidence by examining whether the GTP frequency (across career) index relates to theoretically relevant indicators of global career orientation, capability, and accumulated opportunity for engagement in global engineering work.

5.4 | Data analysis

In our analyses, we examined the relationships between each index and its corresponding external criteria using Spearman rank correlations for ordinal or continuous variables and one-way analyses of variance (ANOVA) for categorical comparisons. When ANOVA results were significant, Tukey's HSD post hoc tests were conducted to identify specific group differences. All analyses were performed in R Statistical Software (Version 2026.01.0 + 392; R Core Team, 2026), with significance determined at $p < .05$. In Table 7, we outline the validity evidence, which we will present in the Section 6, related to the implementation of the GTP indices and align it to different categories of evidence from the AERA standards (discussed in Section 4.1).

TABLE 7 Evidence of validity presented for instrument implementation.

Evidence source	Claim	Data/evidence presented
Relations to other variables (test–criterion relationships)	The GTP confidence index correlates with self-identification as a global engineer, behavioral CQ, and career level	Spearman correlation: GTP confidence ↔ global career level & cultural intelligence behavior One-way ANOVA: GTP confidence ↔ self-Identification as global engineer
Relations to other variables (test–criterion relationships)	The GTP interest index correlates with motivational CQ and participation in global programs	Spearman correlation: GTP interest ↔ cultural intelligence Motivation One-way ANOVA: GTP interest ↔ global undergraduate program participation
Relations to other variables (test–criterion relationships)	The GTP frequency (current role) index correlates with behavioral GEC and career level indicators	Spearman correlations: GTP frequency (current role) ↔ job level, GEC behavioral & global career level
Relations to other variables (test–criterion relationships)	The GTP frequency index (across career) correlates with experience, behavioral GEC, and career level	Spearman correlations: GTP frequency (across career) ↔ years of experience, GEC behavioral & global career level
Theoretical relationships between GTP Indices	The GTP indices will be correlated with each other. GTP Interest and GTP confidence will predict the GTP frequency indices	Pearson correlations: GTP confidence ↔ GTP interest ↔ GTP frequency indices Regression: GTP confidence and GTP interest ↔ GTP frequency indices *t*-test: GTP frequency indices differ

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6 | RESULTS

We provide detailed results of our analyses for the test–criterion relationships for each index in Sections 6.1–6.4. The results for our analyses of relationships between the GTP indices are reported in Section 6.5.

6.1 | Global task performance confidence

Results of all analyses for the GTP confidence index are shown in Table 8. A one-way ANOVA revealed a significant difference in GTP confidence across participants who identified as global engineers, those who did not, and those who were unsure ($F = 87.12$, $p < .001$). Post hoc comparisons indicated that all group differences were statistically significant, with participants identifying as global engineers reporting the highest confidence on the GTP index, and those who selected "not sure" scoring higher than participants who selected "no." Additionally, GTP Confidence was moderately correlated with global career level ($r_s = .442$, $p < .001$) and behavioral CQ ($r_s = .45$, $p < .001$). Together with the group differences, these associations provide criterion-related evidence that the GTP confidence index reflects participants' confidence in their ability to engage in global engineering work.

6.2 | Global task performance interest

Results of all analyses for the GTP interest index are shown in Table 9. The GTP interest index had a strong positive correlation with motivational CQ ($r_s = .566$, $p < .001$), indicating that participants who were more motivated to engage in cross-cultural interactions reported higher interest in performing global engineering work. A one-way ANOVA further revealed significant differences in GTP interest index scores based on prior participation in global programs ($F = 116.9$, $p < .001$), with participants who had global experience reporting higher scores ($M = 3.40$, SD = 0.84) than those without ($M = 2.87$, SD = 0.90). These findings represent criterion-related evidence for the validity of the GTP interest index.

6.3 | Global task performance frequency (current role)

Results of all analyses for the GTP frequency (current role) index are shown in Table 10. As expected, the current role index demonstrated a strong positive correlation with global career level ($r_s = .639$, $p < .001$), indicating that participants who describe their career as global are also engaging more frequently in global engineering work in their current role. Behavioral GEC showed a moderate positive association with the current role index ($r_s = .405$, $p < .001$), suggesting that participants who engage in global engineering work in their current role also perceive themselves as competent in these tasks. Employment level showed a weak positive association with the current role index ($r_s = .249$, $p < .001$), consistent with the idea that engineers at a higher level in the professional hierarchy may have more global responsibilities.

TABLE 8 Summary of test–criterion relationship analyses for GTP confidence.

Test comparison	Test type	Statistic	*p*-value	*n*	*M* ± SD
Global career level	Spearman correlation	$r_s = .442$	<.001	1215	GTP Conf: 3.03 ± 0.85 Global car: 2.71 ± 1.31
Behavioral CQ	Spearman correlation	$r_s = .450$	<.001	1223	GTP Conf: 3.03 ± 0.85 Behavioral CQ: 5.09 ± 1.15
Global engineer self-identification	One-way ANOVA	$F(2,1219) = 87.12$	<.001	1222	No: 2.80 ± 0.83, $n = 668$ Not sure: 3.01 ± 0.78, $n = 187$ Yes: 3.48 ± 0.74, $n = 367$
Yes vs. no	Tukey HSD	$\Delta M = 0.682$	<.001		
Yes vs. not sure	Tukey HSD	$\Delta M = 0.467$	<.001		
Not sure vs. no	Tukey HSD	$\Delta M = 0.215$	.003		

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TABLE 9 Summary of test–criterion relationship analyses for GTP interest.

Test comparison	Test type	Statistic	*p*-value	*n*	*M* ± SD
Motivational CQ	Spearman correlation	$r_s = .566$	<.001	1223	GTP interest: 3.13 ± 0.91 CQ Mot: 5.57 ± 1.03
Global program participation	One-way ANOVA	$F(1,1221) = 116.9$	<.001	1223	No: 2.87 ± 0.90 Yes: 3.40 ± 0.84

These findings are consistent with theoretical expectations and provide criterion-related evidence supporting the validity of the GTP frequency (current role) index as a measure of current engagement in global engineering work.

6.4 | Global task performance frequency (across career)

Results of all analyses for the GTP frequency (across career) index are shown in Table 11. The across career index had a strong, positive correlation with global career level ($r_s = .645$, $p < .001$), indicating that participants who describe their career as global also report having performed specific global tasks more frequently across their career. Behavioral GEC ($r_s = .426$, $p < .001$) was moderately correlated with the across career index, suggesting that stronger self-rated behavioral competency is related to career-long engagement in global tasks. Years of experience showed a weak but significant positive association with the across career index ($r_s = .197$, $p < .001$), suggesting that longer career tenure contributes in a limited way to overall engagement in global engineering work. These findings represent evidence of the validity of the index as a measure of long-term involvement in global engineering tasks.

6.5 | Relationships between GTP indices

We conducted Pearson correlations to examine relationships among the GTP indices (Table 12). GTP interest and GTP confidence scores were strongly correlated ($r = .59$), consistent with SCCT, which suggests that self-efficacy informs interests. Both indices were also strongly correlated with GTP frequency (current role; $r = .50$–$.56$) and GTP frequency (across career; $r = .51$–$.61$). The two frequency indices were also strongly correlated ($r = .81$), reflecting the conceptual linkage between role-specific and career-wide engagement in global engineering work, consistent with the performance domain expectation of SCCT.

We also conducted regression analyses to explore the expected theoretical relationship between the four indices (Table 13). GTP confidence and GTP interest were both significant predictors of the GTP frequency indices. These findings are consistent with SCCT, which posits that interest and self-efficacy (confidence) influence performance domains, through intermediate steps related to career choices. Notably, confidence had a slightly stronger influence than interest on GTP frequency (current role), whereas the reverse pattern emerged for GTP frequency (across career). This suggests that confidence may play a more prominent role in shaping immediate task engagement, while interest may be more influential in guiding longer-term career trajectories.

We conducted a paired samples *t*-test to examine differences between GTP frequency (current role) and GTP frequency (across career). Results indicated a statistically significant difference between the two measures ($t = -2.74$,

TABLE 10 Summary of test–criterion relationship analyses for GTP frequency (current role).

Test comparison	Test type	*n*	Mean ± SD	Statistic	*p*-value
Global career level	Spearman correlation	1213	GTP current: 2.29 ± 0.87 Global car: 2.71 ± 1.31	$r_s = .639$	<.001
Behavioral GEC	Spearman correlation	1221	GTP current: 2.29 ± 0.87 GEC beh: 5.73 ± 1.04	$r_s = .405$	<.001
Employment level	Spearman correlation	1221	GTP current: 2.29 ± 0.87 employment: 2.74 ± 1.43	$r_s = .249$	<.001

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TABLE 11 Summary of test–criterion relationship analyses for GTP frequency (across career).

Test comparison	Test type	*n*	Mean ± SD	Statistic	*p*-value
Global career level	Spearman correlation	1215	GTP career: 2.33 ± 0.79 Global car: 2.71 ± 1.31	$r_s = .645$	<.001
Behavioral GEC	Spearman correlation	1223	GTP Career: 2.33 ± 0.79 GEC beh: 5.73 ± 1.04	$r_s = .426$	<.001
Years of experience	Spearman correlation	1223	GTP career: 2.33 ± 0.79 Experience: 9.77 ± 8.41	$r_s = .197$	<.001

$p = .006$), with scores slightly higher across the career ($M = 2.33$, SD = 0.79) than in the current role ($M = 2.29$, SD = 0.87). This difference is what we would expect theoretically, given that some engineers may not be in a global role currently but have engaged in global engineering work at other times in their career. However, the magnitude of this difference was negligible (Cohen's $d = -0.05$). This pattern suggests that although the two indices are closely aligned, they are not identical.

7 | DISCUSSION AND IMPLICATIONS

This study contributes to ongoing efforts in engineering education to characterize the nature of engineering work and explore connections between undergraduate experiences and engineering career outcomes. In this paper, we described the development of four GTP indices: confidence, interest, frequency (current role), and frequency (across career), which aim to measure an engineer's engagement in global engineering work. We also provided initial validity evidence for this instrument by presenting both the instrument development processes (test content and response processes) and analysis of data collected from alumni of three universities, including a target group who had participated in undergraduate global programs and a comparison group who had not. Because the developed indices are formative rather than

TABLE 12 Correlations among GTP indices ($n = 1223$).

Variable	*M*	SD	1	2	3	4
1. GTP interest	3.13	0.91	—	.59**	.50**	.51**
2. GTP confidence	3.03	0.85		—	.56**	.61**
3. GTP frequency (current role)	2.29	0.87			—	.81**
4. GTP frequency (across career)	2.33	0.79				—

Note: **$p < .01$.
Abbreviations: *M*, mean; SD, standard deviation.

TABLE 13 Regression models for GTP frequency (current role) and GTP frequency (across career).

	Current role			Across career		
Variable	β	SE	*p*	β	SE	*p*
Intercept	—	0.081	.005**	—	0.071	<.001***
GTP confidence	0.411	0.029	<.001***	0.224	0.024	<.001***
GTP interest	0.260	0.027	<.001***	0.479	0.025	<.001***
model fit						
R^2	0.362			0.406		
F	346.2 (2, 1220)		<.001***	416.7 (2, 1220)		<.001***

Note: β = standardized coefficients. *$p < .05$; **$p < .01$; ***$p < .001$.
Abbreviation: SE, standard error.

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reflective measures, we followed the recommendations of DeVellis and Thorpe (2022) and presented evidence of test–criterion relationships. Our results represent initial evidence of the validity of the GTP indices, demonstrating consistent and theoretically coherent relationships with relevant external variables. Collectively, the findings suggest that the GTP indices can serve as meaningful indicators of how engineers are engaging with global engineering work across contexts and career stages.

In developing the GTP Indices, we offer a new angle for studying global careers by introducing *engagement in global engineering work* as a concept of interest separate from competency. We suggest that the frequency of global tasks that are completed in a particular role or career path, regardless of how well these tasks are performed, can be a useful assessment of "how global" engineering roles are and allow for comparisons across organizations, industries, and career stages. We built on the existing framework of GEC (Jesiek et al., 2014), which has been used previously to develop instruments to assess individual competence (Jesiek et al., 2020; Mazzurco et al., 2020), and contribute a theoretically grounded tool for measuring the engagement in global engineering work. By grounding the GTP indices in SCCT, we seek to understand how engagement in global engineering work may develop from confidence and interest toward frequent performance of global engineering tasks. The analyses presented in this paper support these theoretical relationships, but future studies can continue to explore these connections as well as more extensively characterize differences between the GTP frequency current role and across career indices.

The GTP indices will allow us to evaluate the long-term impacts of global programs on global task performance in the engineering workplace as part of our larger study. Beyond our study, the GTP indices can support engineering educators in conducting longitudinal evaluation of global learning experiences for engineers to better prepare a global engineering workforce. Prior studies have highlighted the potential of global experiences to foster intercultural competence (e.g., Davis, 2020; Knight et al., 2019; McNeill & Cox, 2011), and a few studies have focused on GEC explicitly (e.g., Davis et al., 2023; Wrobetz et al., 2024), but there has been a limited focus on career impact after graduation. The GTP indices provide a means for evaluating claims that undergraduate global experiences lead to global career outcomes using quantitative data collected from engineering alumni. By sharing these indices, we aim to enable other engineering educators to extend this work and gather data from alumni across a wide range of undergraduate experiences. Expanding research and evaluation of global engineering programs beyond graduation is important not only to inform the design of programs but also to provide evidence that can argue for their continued existence and expansion.

We believe that the GTP indices can also contribute to research on engineering workforce development. Our development of the indices builds on prior research of practicing engineers, particularly studies that have explored the inherently sociotechnical nature of engineering work (Jesiek et al., 2019; Korte et al., 2025; Mazzurco et al., 2021; Trevelyan, 2010). We were inspired to create the GTP indices based on questions found in the PEARS study (Gilmartin et al., 2011) but which have not been extensively analyzed. Thus, there remains much we can learn about the day-to-day work of engineering and how it compares across different roles, industries, and global contexts. Empirical research focusing on the day-to-day work experiences of engineers is still surprisingly limited (Jesiek et al., 2019; Trevelyan & Tilli, 2007). These indices provide a unique approach to studying engineering work, which could be adapted to other aspects beyond the global focus of our study. Based on the inputs of our industrial advisory board for this project, we also see potential for these and similar indices to be used in industry to understand the nature of individual engineers' work tasks that could inform relevant training opportunities. With recent calls to expand research focused on engineering workforce development (Liu & Brunhaver, 2025), we position the GTP indices as a meaningful step toward research that can have practical implications for workforce development both before and after graduation.

Despite these contributions, we wish to note several limitations to our current study. The validation sample was drawn from only three universities, which may limit the generalizability of the findings to other institutions, disciplines, or cultural contexts. Although the indices were designed to be broadly applicable, some items may require adaptation to capture context-specific nuances in organizational or cultural settings, potentially affecting measurement consistency. Additionally, the study relied on self-reported survey data for the criterion variables, which may be influenced by recall bias or social desirability, and did not include direct observation of global task performance. Future research should address these limitations by expanding validation samples, testing the indices in diverse cultural and organizational contexts, and incorporating alternative data collection approaches (e.g., task tracking) to gain a more direct evaluation of global task performance.

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8 | CONCLUSION

In this study, we presented the development and initial validation of the GTP indices: GTP confidence, GTP interest, GTP frequency (current role), and GTP frequency (across career). Together, these indices provide a structured approach to examining engineers' engagement with global engineering work over the course of their careers. We described the stages involved in the development of the GTP indices, the initial deployment of the instrument, and initial evidence of validity. Our results suggest that the GTP indices serve as meaningful indicators of how engineers perceive and enact global work across diverse career contexts. This study contributes a new instrument, which can serve as a practical tool for educators and program administrators seeking to assess program impact, inform curricular improvement, and provide evidence of the long-term value of global engineering education. We also offer a new approach for studying engineering work, which can inform future research in this area beyond our focus on global career development. Ultimately, the GTP indices provide a foundation for ongoing research and evaluation efforts aimed at preparing engineers who can effectively engage with the global dimensions of engineering practice.

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DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

CONSENT TO PARTICIPATE

All participants in this study provided consent via signed consent forms, per the requirements of the IRB.

CONSENT TO PUBLISH

The consent forms used in this study explicitly stated that the research would be published.

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APPENDIX A: Full List of Survey Items is Shown in Table 3 in the Paper

TABLE A1 Spearman correlations for GTP frequency (current role) index items.

Variable	*n*	*M*	SD	1	2	3	4	5	6	7	8	9	10	11	12
1 – GTPCu1	1223	2.78	1.45	–											
2 – GTPCu2	1223	3.54	1.32	0.62***	–										
3 – GTPCu3	1223	2.15	1.2	0.63***	0.53***	–									
4 – GTPCu4	1223	2.37	1.43	0.49***	0.52***	0.47***	–								
5 – GTPCu5	1223	1.94	1.23	0.66***	0.47***	0.65***	0.47***	–							
6 – GTPCu6	1223	3.03	1.52	0.33***	0.33***	0.31***	0.28***	0.31***	–						
7 – GTPCu7	1223	1.71	1.12	0.38***	0.29***	0.37***	0.29***	0.44***	0.19***	–					
8 – GTPCu8	1223	2.73	1.31	0.43***	0.54***	0.43***	0.56***	0.41***	0.35***	0.28***	–				
9 – GTPCu9	1223	1.18	0.57	0.23***	0.11***	0.27***	0.21***	0.28***	0.18***	0.26***	0.19***	–			
10 – GTPCu10	1223	2.3	1.19	0.52***	0.57***	0.46***	0.62***	0.46***	0.37***	0.34***	0.62***	0.21***	–		
11 – GTPCu11	1223	1.9	1.25	0.48***	0.44***	0.48***	0.61***	0.46***	0.33***	0.28***	0.56***	0.25***	0.65***	–	
12 – GTPCu12	1223	1.8	1.33	0.49***	0.36***	0.51***	0.56***	0.52***	0.3***	0.32***	0.41***	0.28***	0.49***	0.57***	–

Note: *$p < .05$. **$p < .01$. ***$p < .001$. Spearman correlation shown for ordinal variables.
Abbreviation: GTPCu, global task performance frequency (current role).

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TABLE A2 Spearman correlations for GTP frequency (across career) index items.

Variable	*n*	*M*	SD	1	2	3	4	5	6	7	8	9	10	11	12
1 – GTPCa1	1223	2.88	1.24	–											
2 – GTPCa2	1223	3.51	1.15	0.61***	–										
3 – GTPCa3	1223	2.24	1.13	0.61***	0.46***	–									
4 – GTPCa4	1223	2.39	1.28	0.46***	0.48***	0.45***	–								
5 – GTPCa5	1223	2.09	1.16	0.63***	0.43***	0.63***	0.45***	–							
6 – GTPCa6	1223	2.97	1.4	0.31***	0.31***	0.25***	0.26***	0.29***	–						
7 – GTPCa7	1223	1.86	1.16	0.39***	0.29***	0.41***	0.29***	0.49***	0.17***	–					
8 – GTPCa8	1223	2.7	1.21	0.41***	0.48***	0.41***	0.54***	0.39***	0.33***	0.3***	–				
9 – GTPCa9	1223	1.23	0.64	0.25***	0.11***	0.29***	0.23***	0.31***	0.19***	0.32***	0.2***	–			
10 – GTPCa10	1223	2.35	1.13	0.52***	0.53***	0.44***	0.58***	0.47***	0.35***	0.37***	0.58***	0.24***	–		
11 – GTPCa11	1223	1.9	1.13	0.44***	0.39***	0.47***	0.6***	0.46***	0.31***	0.31***	0.51***	0.29***	0.63***	–	
12 – GTPCa12	1223	1.8	1.19	0.45***	0.3***	0.49***	0.54***	0.51***	0.28***	0.32***	0.38***	0.33***	0.48***	0.6***	–

Note: *$p < .05$. **$p < .01$. ***$p < .001$. Spearman correlation shown for ordinal variables.
Abbreviation: GTPCa, global task performance frequency (across career).

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TABLE A3 Spearman correlations for GTP interest index items.

Variable	*n*	*M*	SD	1	2	3	4	5	6	7	8	9	10	11	12
1 – GTPIn1	1223	3.47	1.11	–											
2 – GTPIn2	1223	3.75	0.99	0.73***	–										
3 – GTPIn3	1223	3.45	1.14	0.63***	0.62***	–									
4 – GTPIn4	1223	3.28	1.16	0.65***	0.68***	0.58***	–								
5 – GTPIn5	1223	3.3	1.24	0.65***	0.63***	0.68***	0.6***	–							
6 – GTPIn6	1223	2.86	1.25	0.37***	0.35***	0.35***	0.38***	0.4***	–						
7 – GTPIn7	1223	2.44	1.38	0.38***	0.33***	0.36***	0.32***	0.44***	0.17***	–					
8 – GTPIn8	1223	3.23	1.13	0.6***	0.62***	0.54***	0.67***	0.55***	0.44***	0.36***	–				
9 – GTPIn9	1223	2.09	1.19	0.32***	0.27***	0.34***	0.28***	0.4***	0.44***	0.33***	0.35***	–			
10 – GTPIn10	1223	3.05	1.12	0.57***	0.58***	0.46***	0.65***	0.49***	0.43***	0.28***	0.65***	0.38***	–		
11 – GTPIn11	1223	2.77	1.22	0.61***	0.56***	0.51***	0.65***	0.53***	0.45***	0.31***	0.62***	0.42***	0.7***	–	
12 – GTPIn12	1223	2.8	1.36	0.62***	0.54***	0.56***	0.7***	0.62***	0.43***	0.41***	0.57***	0.39***	0.58***	0.67***	–

Note: *$p < .05$. **$p < .01$. ***$p < .001$. Spearman correlation shown for ordinal variables.
Abbreviation: GTPIn, global task performance interest.

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TABLE A4 Spearman correlations for GTP confidence index items.

Variable	*n*	*M*	SD	1	2	3	4	5	6	7	8	9	10	11	12
1 – GTPCo1	1223	3.46	1.07	–											
2 – GTPCo2	1223	3.77	0.95	0.71***	–										
3 – GTPCo3	1223	3.45	1.1	0.65***	0.64***	–									
4 – GTPCo4	1223	3.29	1.12	0.63***	0.67***	0.58***	–								
5 – GTPCo5	1223	3.29	1.17	0.66***	0.63***	0.69***	0.59***	–							
6 – GTPCo6	1223	2.92	1.21	0.37***	0.37***	0.36***	0.41***	0.44***	–						
7 – GTPCo7	1223	2.23	1.25	0.36***	0.3***	0.33***	0.29***	0.4***	0.19***	–					
8 – GTPCo8	1223	3.24	1.11	0.59***	0.63***	0.56***	0.67***	0.57***	0.46***	0.36***	–				
9 – GTPCo9	1223	2.12	1.17	0.35***	0.31***	0.38***	0.33***	0.44***	0.43***	0.37***	0.39***	–			
10 – GTPCo10	1223	3.12	1.08	0.6***	0.64***	0.53***	0.7***	0.56***	0.46***	0.34***	0.69***	0.42***	–		
11 – GTPCo11	1223	2.8	1.18	0.61***	0.57***	0.55***	0.66***	0.58***	0.49***	0.33***	0.64***	0.47***	0.71***	–	
12 – GTPCo12	1223	2.73	1.32	0.63***	0.55***	0.58***	0.7***	0.63***	0.44***	0.35***	0.59***	0.42***	0.64***	0.71***	–

Note: *$p < .05$. **$p < .01$. ***$p < .001$. Spearman correlation shown for ordinal variables.
Abbreviation: GTPCo, global task performance confidence.

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APPENDIX B: Additional Data on Participant Characteristics

TABLE B1 Undergraduate majors of participants.

Undergraduate major	Target	Comparison
Aeronautical and/or Astronautical Engineering	31 (5%)	51 (8%)
Agricultural and/or Biological Engineering	17 (3%)	19 (3%)
Biomedical Engineering	41 (7%)	40 (6%)
Chemical Engineering	72 (12%)	64 (10%)
Civil Engineering	38 (6%)	55 (9%)
Computer Engineering	20 (3%)	24 (4%)
Computer Science	5 (1%)	3 (0.5%)
Construction Engineering	8 (1%)	16 (3%)
Electrical Engineering	41 (7%)	46 (7%)
Engineering Management	0 (0%)	1 (0.2%)
Environmental and/or Ecological Engineering	19 (3%)	7 (1%)
Industrial/Systems Engineering	33 (6%)	45 (7%)
Interdisciplinary/Multidisciplinary Engineering	5 (1%)	6 (1%)
Materials Engineering	12 (2%)	17 (3%)
Mechanical Engineering	238 (40%)	213 (34%)
Mining Engineering	0 (0%)	1 (0.2%)
Nuclear Engineering	3 (0%)	12 (2%)
Other	15 (3%)	8 (1%)
Total	595 (100%)	628 (100%)

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APPENDIX C

C.1 | The Cultural Intelligence Scale (CQS)

Read each statement and select the response that best describes your capabilities. Select the answer that BEST describes you AS YOU REALLY ARE (1 = strongly disagree; 7 = strongly agree).

TABLE C1 Items for CQS from Ang et al. (2007).

CQ factor	Questionnaire item	Item statement
Metacognitive CQ	MC1	I am conscious of the cultural knowledge I use when interacting with people with different cultural backgrounds.
	MC2	I adjust my cultural knowledge as I interact with people from a culture that is unfamiliar to me.
	MC3	I am conscious of the cultural knowledge I apply to cross-cultural interactions.
	MC4	I check the accuracy of my cultural knowledge as I interact with people from different cultures.
Cognitive CQ	COG1	I know the legal and economic systems of other cultures.
	COG2	I know the rules (e.g., vocabulary, grammar) of other languages.
	COG3	I know the cultural values and religious beliefs of other cultures.
	COG4	I know the marriage systems of other cultures.
	COG5	I know the arts and crafts of other cultures.
	COG6	I know the rules for expressing nonverbal behaviors in other cultures.
Motivational CQ	MOT1	I enjoy interacting with people from different cultures.
	MOT2	I am confident that I can socialize with locals in a culture that is unfamiliar to me.
	MOT3	I am sure I can deal with the stresses of adjusting to a culture that is new to me.
	MOT4	I enjoy living in cultures that are unfamiliar to me.
	MOT5	I am confident that I can get accustomed to the shopping conditions in a different culture.
Behavioral CQ	BEH1	I change my verbal behavior (e.g., accent, tone) when a cross-cultural interaction requires it.
	BEH2	I use pause and silence differently to suit different cross-cultural situations.
	BEH3	I vary the rate of my speaking when a cross-cultural situation requires it.
	BEH4	I change my nonverbal behavior when a cross-cultural situation requires it.
	BEH5	I alter my facial expressions when a cross-cultural interaction requires it.

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C.2 | Global Engineering Competency Scale (GECS)

Read each statement and select the response that best describes your capabilities. Select the answer that BEST describes you AS YOU REALLY ARE (1 = strongly disagree; 7 = strongly agree).

TABLE C2 Items for GECS from Mazzurco et al. (2020).

Behavioral GEC
Q1. I am capable of working as a global technical professional.
Q2. I can work effectively in the global engineering profession.
Q3. I can practice engineering in an international setting.
Q4. I can collaborate and work towards common goals as a member of a multicultural team.
Q5. I can function effectively as a member of a multicultural technical team.
Cognitive GEC
Q1. I am familiar with cross-national differences in intellectual property laws.
Q2. I am familiar with cross-national/cultural differences in professional ethics.
Q3. I am familiar with cross-national/cultural differences in engineering practice.
Q4. I understand how culture affects perceptions of the engineering profession throughout the world.
Q5. I understand cultural differences relating to product design, manufacture, and use.

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