2026 ASEE ANNUAL CONFERENCE June 21–24, 2026 | Charlotte Convention Center, NC
Host Sponsor UNC Charlotte
ASEE AMERICAN SOCIETY FOR ENGINEERING EDUCATION
Paper ID #51731

Building Global Competency in Engineering Through Intercultural Collaboration and Communication

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Abstract

Engineering as a professional practice increasingly unfolds within multicultural, digitally mediated, and globally distributed environments. Although communication is formally recognized within accreditation frameworks, engineering curricula often emphasize technical transmission more than culturally situated meaning-making. This paper presents a design-based, practitioner-oriented curricular effort to develop and pilot a scalable faculty-driven program that integrates global communication competencies into undergraduate engineering education. Three guiding questions shaped this work: (1) What global communication competencies do engineering educators identify as important for early-career engineers operating in international contexts? (2) How can a structured faculty-development and proposal-review process generate instructional modules that are theoretically grounded, instructionally useful, and responsive to identified needs? and (3) What early evidence supports faculty adoption and student engagement following pilot implementation?

The data sources utilized included an initial faculty needs assessment and resource-development survey, module proposal submissions, rubric-based module evaluation, faculty workshop assessments, and student pilot surveys. Quantitative data were analyzed descriptively, with selected correlational analyses examining relationships among perceived usefulness, relevance, adoption intent, and student confidence. Open-ended responses were reviewed thematically to identify recurring patterns in faculty priorities and student reflections. Findings indicate strong alignment between faculty-identified competencies and selected modules, high adoption intent among workshop participants, and statistically significant associations between perceived relevance and students' confidence in their communication. While findings primarily reflect short-term, perception-based outcomes supplemented by structured reflection assessment, results suggest that intentionally designed global communication modules can support student awareness and professional identity development in international engineering contexts. The paper contributes a replicable curricular development model grounded in intercultural, situated, and experiential learning theory and offers practical guidance for advancing global competency in engineering education.

Keywords: *global communication competency; intercultural communication; engineering education; design-based research; international engineering education; experiential learning; multicultural teamwork.*

Introduction

The globalization of engineering practice has fundamentally reshaped the communication demands placed upon engineers. Contemporary projects span continents, supply chains cross geopolitical boundaries, and design teams collaborate across time zones and cultures. Engineers engage not only with technical peers but also with community stakeholders, policymakers, interdisciplinary collaborators, and end users situated in a variety of cultural contexts.

Despite these realities, engineering education has historically emphasized technical proficiency while treating communication as an auxiliary skill. Although ABET Student Outcome 3 requires graduates to demonstrate the ability to communicate effectively with a range of audiences [1], research suggests that communication instruction often focuses on technical writing and presentation mechanics rather than on intercultural competence, adaptive collaboration, and conflict negotiation [2], [3]. Rico-García and Fielden Burns [4] identify intercultural communication as a critical employability skill in global labor markets, and Jiang's review of intercultural teamwork highlights recurring communication and coordination breakdowns across diverse teams [5]. Mu et al. [6] further demonstrate that intercultural growth does not automatically occur through exposure alone; structured pedagogical intervention is necessary.

Immersive international engineering programs provide compelling models [7], yet they are resource-intensive and not universally scalable. There remains a need for theory-informed, modular approaches that embed global communication competencies within mainstream engineering curricula. This paper responds to that need by describing an initiative aimed towards the development, dissemination, and early evaluation of resources designed to support faculty in integrating intercultural communication into authentic engineering learning contexts.

This work is best understood as a practitioner-oriented curricular development effort supported by early-stage evaluation. Its purpose is not to make causal claims about long-term competency development, but rather to document a replicable process for identifying faculty priorities, developing instructional resources, and gathering preliminary evidence of adoption, relevance, and student engagement. More detailed academic research questions and stronger performance-based measures will be addressed in future phases of the project.

Theoretical Framework

The conceptual foundation of this project integrates intercultural communication theory, situated learning theory, and experiential learning theory. These frameworks are intentionally integrated to provide a multidimensional understanding of how global communication competency develops within engineering contexts.

Intercultural communication theory positions communication as culturally situated meaning-making shaped by values, assumptions, identities, and power relations. Deardorff's framework conceptualizes intercultural competence as involving attitudes, knowledge, skills, and internal and external outcomes [8]. Complementary models further emphasize that intercultural competence is developmental, reflective, and context-dependent [9], [10]. For engineering education, this means that effective communication requires more than technical clarity. Engineers must learn to interpret stakeholder perspectives, recognize assumptions embedded in communication practices, and adapt technical discourse across cultural, professional, and community contexts.

Situated learning theory deepens this perspective by asserting that competence develops through participation in authentic social practice [11]. Communication skills are not abstract traits that students acquire apart from engineering work; rather, they emerge through participation in realistic disciplinary tasks. Accordingly, the instructional modules developed through this

initiative embedded communication into engineering case studies, humanitarian design contexts, stakeholder scenarios, study-abroad preparation, technical storytelling, and interdisciplinary collaboration.

Experiential learning theory further informed the design by emphasizing iterative cycles of action, reflection, feedback, and revision [12,13]. Intercultural communication competence is strengthened when learners have structured opportunities to practice communication strategies, reflect on their effects, and revise their approaches in response to real or simulated constraints. Together, these frameworks position global communication competence as a core dimension of professional engineering identity rather than as an isolated "soft skill."

Research Questions

This study was guided by three interrelated questions examining both the curricular development process and early evidence of implementation:

1. What global communication competencies do engineering educators identify as most important for early-career engineers working in international or intercultural contexts?
2. How can a structured faculty-development and proposal-review process generate instructional modules that are theoretically grounded, instructionally useful, and responsive to identified needs?
3. What early evidence supports faculty adoption and student learning following pilot implementation?

These questions reflect the dual purpose of the project: to develop useful curricular resources for engineering educators and to gather early evidence that can inform future, more rigorous research on intercultural competency development.

Methods

This project used a design-based research orientation, combined with mixed methods, to develop, refine, and evaluate a scalable curricular intervention to strengthen global communication competency in engineering education [14]. The work centered on the intentional design and study of instructional artifacts within authentic educational contexts.

Because this initiative was practitioner-oriented, the evaluation was designed to examine feasibility, alignment, faculty adoption, and early student engagement rather than to establish causal effects. The project, therefore, emphasizes useful design knowledge, evidence of implementation, and refinement for future study.

Design-Based Research Rationale

Design-based research (DBR) was selected because the project sought not merely to evaluate existing instruction but to design and test a new instructional system addressing a clearly defined practice problem: preparing engineering students for intercultural and globally distributed collaboration [15]. The intervention comprised a structured development-and-dissemination

pipeline that included an initial call for participation, needs assessment, proposal review, instructional module development, faculty workshops, and student pilot implementation. The DBR approach integrated theoretical commitments with practical evidence across iterative phases. Intercultural communication theory informed competency framing. Situated and experiential learning principles informed instructional design. Faculty and student feedback informed decisions on refinement and future dissemination. The aim was to generate usable design knowledge applicable across international engineering education contexts and to identify more detailed research questions for subsequent phases.

Phase 1: Faculty Invitation and Needs Assessment

The research team shared an invitation via the ASEE newsletter, inviting members to participate in both a research study and a collaborative resource-development opportunity. The response was strong, with more than 85 members completing the initial survey. Of those respondents, 75 proceeded to develop and submit module proposals.

The initial survey included Likert-scale items and open-ended prompts designed to identify faculty perceptions of important global communication competencies, instructional needs, preferred module formats, and potential implementation contexts. Open-ended responses were reviewed using inductive thematic coding. The research team identified recurring priorities and clustered them into competency domains that informed module solicitation criteria and later review decisions.

Participants identified adaptive communication across cultures, conflict resolution in diverse teams, empathy and perspective-taking, stakeholder engagement, and digital collaboration as priority competencies. Case studies, applied group activities, guided reflection, and adaptable classroom resources were among the most requested instructional formats. These findings directly shaped the structure of the module-development call and the evaluation rubric used in the next phase.

Phase 2: Proposal Review and Module Development

Submitted proposals were evaluated using a rubric that considered theoretical alignment, clarity of learning objectives, instructional coherence, engineering authenticity, innovation, and assessment strategy. Three reviewers independently scored each submission, achieving strong agreement prior to consensus discussion. The intraclass correlation coefficient was .84 before consensus review, indicating strong consistency in reviewer scoring.

Following their independent review, reviewers discussed proposals and reached consensus on final selections. Fifteen modules were selected for development and publication through the ASEE International Division platform. The selected modules addressed a range of topics, including empathy, cultural humility, cultural intelligence, humanitarian co-creation, storytelling, Wikipedia authorship, podcasting, culturally aware argumentation, communication-as-design, and structured intercultural interventions.

This process was intended not only to select high-quality proposals but also to support faculty as curriculum developers. Selected authors refined their modules with attention to theoretical grounding, instructional usability, and adaptability across engineering contexts.

Products as Findings

Within a design-based research framework, instructional artifacts function as important project outcomes and sources of design knowledge [16]. The fifteen-module suite reveals expert-defined commitments about global communication competency in engineering education. The breadth of topics demonstrates that global communication is multifaceted and sociotechnical. It includes empathy, cultural humility, audience adaptation, stakeholder engagement, multimodal communication, ethical co-creation, and reflective practice [17].

The emphasis on authentic cases reflects the importance of situated competence development. The inclusion of multimodal genres, such as podcasting, storytelling, and Wikipedia authorship, recognizes that engineers must communicate across technical and nontechnical audiences in increasingly visible global spaces. Modules addressing structured intercultural interventions further reinforce that competence requires scaffolding rather than passive exposure.

Table 1. Global Communication Competency in Engineering Modules Developed

Module Titles

Discovering Hidden Figures in Engineering and Your Own Global Voice	Cultural Humility in Engineering: Designing with Global Partners
Empathy in Engineering – Advancing Interpersonal and Stakeholder Communication	Interventions to Develop Intercultural Communicative Competence to Impact Study Abroad
Raising Your Cultural IQ	Effectively Engaging with Underserved Communities in the Co-Creation of Humanitarian Engineering Projects
Cross-Cultural Competency in Engineering	Powerful Communication Strategies for Engineers New to the Field
Powering the iShack: Embedding Global Communication and Entrepreneurial Thinking	Introduction to Culturally Aware Argumentation in Engineering
The Engineer as Storyteller: Using Narrative to Inspire Innovation	Bridging Intercultural and Interdiscp. Communications in Faculty-Led Programs
Global Communication through Nature-Inspired Podcast Creation	Designing Communication Like an Engineer
Writing for the World: Building and Sharing Engineering Knowledge on Wikipedia	

Phase 3: Faculty Dissemination

Following the development of the modules, the project team offered faculty workshops to introduce them and support implementation. Seventy-five faculty participated in four workshops. Post-workshop surveys indicated high ratings for clarity ($M = 4.62$, $SD = 0.48$), relevance ($M = 4.71$, $SD = 0.45$), usefulness ($M = 4.67$, $SD = 0.39$), and adoption intent ($M = 4.43$, $SD = 0.61$). Perceived usefulness correlated strongly with adoption intent ($r = .71$, $p < .001$).

These findings suggest that faculty participants viewed the modules as understandable, relevant, and feasible for integration into existing courses. Because adoption intent is not the same as documented long-term implementation, these results are interpreted as early evidence of faculty interest and perceived usability.

Phase 4: Student Pilot Implementation

Student pilot implementation provided early insight into how selected modules functioned in classroom contexts. One hundred eight students participated in pilot activities, with a 91% response rate on post-activity surveys. Students reported improved understanding of global communication ($M = 4.52$, $SD = 0.58$) and increased communication confidence ($M = 4.36$, $SD = 0.66$). Perceived relevance correlated significantly with communication confidence ($r = .62$, $p < .01$).

Structured reflection rubrics yielded a mean score of 3.9 out of 5 ($SD = 0.72$), indicating moderate integration of perspective-taking and adaptation to the audience. For example, students were assessed on their ability to tailor technical explanations for culturally diverse stakeholder audiences within applied engineering scenarios. These findings should be interpreted as preliminary indicators of engagement and perceived learning. They do not establish long-term intercultural competence or demonstrate behavioral change. However, they suggest that students recognized the relevance of global communication and began to connect communication practices to engineering identity and professional preparation.

Discussion

The findings of this project suggest that a structured, theory-informed curricular development process can generate scalable instructional resources aligned with faculty-identified global communication priorities in engineering education. Rather than evaluating a single intervention in isolation, this initiative examined a development-and-dissemination model in which theoretical framing, faculty expertise, instructional design, and evidence from early implementation were intentionally aligned.

One of the most notable findings is the alignment between competencies prioritized in the faculty needs assessment and the content embedded within the developed modules. Faculty consistently identified adaptive communication, conflict resolution, empathy, stakeholder engagement, and digital collaboration as essential for early-career engineers. These priorities were operationalized in modules that emphasize culturally aware argumentation, humanitarian co-creation, storytelling for engineering leadership, and communication framed as a design process. This alignment strengthens the project's internal coherence and suggests that the modules were responsive to articulated professional demands rather than developed solely on theoretical grounds. The relationship between perceived usefulness and faculty adoption intent ($r = .71$, $p < .001$) further underscores the importance of practical usability in faculty-facing curricular innovations. Adoption decisions in higher education are often influenced by perceived feasibility, relevance, and alignment with disciplinary expectations. The high ratings for clarity and relevance, combined with the strong relationship between usefulness and adoption intent, suggest that faculty recognized the modules as applicable within existing curricular structures. This finding is especially important for international engineering education, where scalable approaches are needed for institutions that may not have the resources to support large-scale study abroad or immersive international programs.

Student outcomes, while primarily perception-based, provide additional insight into early-stage impact. Students reported increased understanding of global communication and improved

communication confidence. The statistically significant association between perceived relevance and communication confidence suggests that when students see global communication instruction as professionally meaningful, they may be more likely to report growth in self-efficacy. Although self-reported confidence does not equate to demonstrated mastery, shifts in self-concept may be an important early step in the development of professional identity. The reflection rubric scores offer preliminary evidence that students engaged with perspective-taking and audience adaptation in applied tasks. However, these data should be interpreted cautiously. The project did not include longitudinal tracking, validated intercultural competence instruments, or performance-based assessments across multiple implementation settings. As such, the findings are best understood as early indicators of student engagement and perceived growth rather than definitive evidence of sustained competency development. The qualitative findings further illuminate how students were beginning to reconceptualize communication within engineering practice. Student reflections frequently described the activities as "eye-opening" and emphasized recognition that technical correctness alone does not guarantee shared understanding. This shift from transmission-based communication toward more relational and contextualized communication mirrors the theoretical commitments underlying the modules. In this sense, the student reflections suggest that the curricular activities made the importance of intercultural communication visible and relevant to learners.

The module suite itself represents a substantive contribution. Within a design-based research orientation, the artifacts developed are not ancillary outputs but central outcomes of the project. The breadth of the fifteen modules reveals a field-level understanding that global communication competence in engineering is multifaceted and sociotechnical. It encompasses empathy, cultural humility, persuasive reasoning, multimodal communication, stakeholder engagement, and ethical co-creation. The inclusion of public-facing genres such as podcasting and Wikipedia authorship reflects recognition that engineers must communicate across technical and nontechnical audiences in increasingly visible global spaces.

From a theoretical standpoint, the findings support integrating intercultural communication theory with situated and experiential learning principles. Communication competence is most effectively developed when embedded in authentic engineering contexts rather than treated as abstract instruction. This reinforces the importance of positioning communication not as a separate "soft skill" module but as an integral part of engineering design, collaboration, and leadership. At the same time, the limitations of this work should remain visible. This was a practitioner-oriented curricular development effort supported by early-stage evaluation. The study relied heavily on short-term, perception-based survey data, which limits claims about causality, transfer, or long-term behavioral change. Faculty participants may have been predisposed toward communication-focused innovation, potentially inflating measures of adoption intent. Student pilot implementation was limited in scope and does not support broad generalization across institutional types or global contexts. These limitations are not weaknesses to obscure; rather, they appropriately define the current stage of the work and provide a foundation for future research.

Nevertheless, the project offers several implications for international engineering education. First, faculty-driven module development grounded in articulated professional needs can produce scalable curricular resources. Second, alignment between theory and practice can strengthen both

faculty adoption and student engagement. Third, global communication competency should be framed as a sociotechnical dimension of professional engineering identity rather than as an auxiliary communication skill. Future research should build from this practitioner foundation by incorporating pre–post assessments, scenario-based performance measures, longitudinal tracking of student artifacts, and cross-institutional comparisons. Overall, this effort demonstrates that structured, theory-informed curricular design, paired with faculty development and early empirical feedback, can generate meaningful innovation in global engineering communication education. While further validation is required, the intervention provides a replicable framework and a set of practical design principles that contribute to the ongoing internationalization of engineering education.

Conclusion and Next Steps

The globalization of engineering practice demands a reframing of communication as a culturally situated, sociotechnical professional competency rather than a peripheral skill. This paper presents a theory-grounded, faculty-driven, and practitioner-oriented model for integrating global communication competency into engineering education. By aligning intercultural communication theory, situated learning, and experiential pedagogy with faculty-identified professional needs, the project produced a scalable suite of instructional modules and a dissemination model that demonstrates coherence across theory, design, and implementation.

Findings indicate strong alignment between faculty-identified priorities and the developed modules, as well as high intent to adopt and positive student learning indicators. While the evidence remains largely perception-based and short-term, statistically significant relationships between perceived relevance and communication confidence suggest meaningful engagement. The design-based orientation of the project further positions the instructional artifacts themselves as contributions, revealing a cross-institutional understanding that global communication competency encompasses empathy, cultural humility, adaptive argumentation, stakeholder engagement, multimodal communication, and structured intercultural intervention. Importantly, this initiative advances the internationalization of engineering education not merely by adding global content, but by embedding intercultural meaning-making within core engineering practice. Rather than treating global competence as a study-abroad outcome or elective enrichment, the project integrates it into mainstream curricular structures accessible across institutional types. In doing so, it offers a practical model for engineering educators seeking to operationalize global engineering preparation within existing programs.

The next phase of this work will address more detailed academic research questions related to intercultural competency development, instructional design, and assessment. Future research will extend the DBR cycle through the development and administration of a new instrument titled “Expert Perspectives on Intercultural Competency and Video-Based Instructional Resources in Engineering Education.” This survey will be administered to international engineering educators and practitioners with expertise in intercultural communication, global engineering practice, or engineering education. The instrument will include Likert-scale and open-ended items designed to capture expert perspectives on (1) the definition and core dimensions of intercultural competency in engineering, (2) its relative importance across international professional contexts, and (3) the instructional role of video-based resources in supporting intercultural learning.

This next phase responds directly to insights from the current project. Several developed modules incorporate multimodal instructional approaches, yet systematic examination of video as a scaffold for modeling intercultural interaction remains limited. The forthcoming survey will therefore inform refinement of instructional design, including development of expert-modeled video segments illustrating intercultural dialogue, stakeholder negotiation, and cross-cultural engineering collaboration. Subsequent iterations will incorporate pre–post measures, scenario-based performance tasks, and cross-institutional implementation to strengthen evidence of demonstrated competency development. Expanding the work across national contexts will also allow examination of cultural variability in both instructional reception and competency interpretation. Through continued iterative refinement and international collaboration, this initiative seeks to contribute not only instructional modules but transferable design principles for embedding global communication competency into engineering education at scale.

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