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Reframing Engineering in Multilingual and Multidialectal Contexts: The Role of Instructor Identity and Language in Dominican-Haitian Learning Communities (Work in-Progress)

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Abstract

This Work-in-Progress paper examines how engineering thinking is reimagined in multilingual and multidialectal settings through a STEM summer program in two Dominican-Haitian communities in the Dominican Republic. Designed and implemented by a multilingual and multicultural team, the program sought to center the experiences, practices, and knowledge of communities while introducing foundational engineering concepts. Drawing on culturally sustaining pedagogy and positionality theory, this study analyzes how the identities of instructors shaped lesson design and delivery, and how students' engagement with engineering was interpreted through a multimodal and multilingual lens. Data sources included instructor journals, field notes, and community conversations. The thematic analysis highlights (1) the influence of instructors' own definitions of engineering on classroom interactions; (2) the role of heritage language use in building trust; and (3) students' creative engagement with materials, which surfaced localized forms of engineering not always recognized in traditional curricula. This WIP illustrates the role instructors 'identities play in affirming the ways of knowing and doing of students in their communities while expanding notions of who engineers are and how they think. The paper offers early insights for designing equity-driven, linguistically inclusive, and culturally responsive engineering learning experiences in linguistically minoritized communities.

Keywords: multilingual and multidialectal learning, engineering learning, Haitian-Dominican communities, identity, informal learning, elementary, higher education

Introduction

Engineering education has traditionally prioritized technical proficiency and problem-solving frameworks, often neglecting the cultural, linguistic, and socio-political dimensions that shape how engineering is taught, understood, and practiced across communities. Emerging research highlights the benefits of more inclusive educational models that challenge these traditional views of engineering. For example, Boz and colleagues show the transformative impact of community-based engineering (CBE) in Indigenous and rural schools in the United States [1]. Their study found that culturally grounded, locally relevant engineering curricula significantly improved students' identification with engineering, increased aspirations for engineering careers, and fostered a deeper connection between technical skills and community empowerment. These outcomes point to the broader potential of integrating cultural epistemologies into engineering education to enhance both learning and civic engagement.

Dominican-Haitian communities on the island shared by the Dominican Republic (DR) and Haiti offer a compelling context to further explore these dynamics because of the colonial legacies, migration patterns, and systemic inequities that have dominated these nations for centuries and its influence in who gets to access quality STEM education. In transnational communities, with a considerable population of Haitian-Dominicans, students face limited access to quality STEM education. Additionally, the predominance of Spanish as the instructional language sidelines Haitian Creole speakers. This context makes the Dominican Republic a valuable site to examine the educational and social impacts of multicultural and multilingual engineering learning experiences.

Conceptual Frameworks

Guided by culturally sustaining pedagogy and positionality theory, this work expands perceptions of engineering practices and epistemologies. These perspectives informed how the program was designed, how instructors approached their teaching, and how data were interpreted throughout the study.

We started this work with an understanding of the role colonial legacies played and continue to play in shaping education access in the Dominican Republic. We also understand the role of language in learning and the dominance of Western knowledge systems in STEM. In this paper, we use the term "traditional" or "Western" engineering to refer to formal, institutionalized STEM practices rooted Westernize education systems—often emphasizing abstract problem-solving, technical jargon, and standardized design processes. This stands in contrast to the informal, situated forms of engineering observed in rural DR and Haiti, which are shaped by practical constraints, material reuse, and community-driven innovation.

In the Dominican Republic and Haiti, colonial legacies manifest through language hierarchies, systemic inequalities, and limited STEM opportunities for historically marginalized communities. Our research and teaching team draw on Lucena and Alder [2], [3] to critique dominant engineering narratives and reimagine engineering as a socially and culturally situated practice that can empower communities when local knowledge is recognized and valued.

Culturally relevant pedagogy, as articulated by Ladson-Billings, centers students' lived experiences, cultural knowledge, and linguistic practices as essential in the learning process [4]. This framework shaped how lessons were designed to reflect community contexts and encouraged student agency in engineering problem-solving. The project also incorporated principles of culturally sustaining pedagogy, with emphasis maintaining and supporting students' languages—Dominican Spanish and Haitian Creole—as part of a broader commitment to identity affirmation and linguistic inclusion in education [5], [8].

Positionality theory further guided the project by acknowledging that the social, cultural, and educational backgrounds of us as instructors shaped how we engaged with students and make sense of the learning environment. Instructors were encouraged to reflect on how their own experiences, languages, and educational training influenced their teaching decisions. This reflexivity was built into the structure of the program through daily journaling and group debriefs, creating space to challenge assumptions, make pedagogical adjustments, and support more equitable, student-centered practices.

Together, these frameworks provided the foundation for an engineering educational experience rooted in cultural and linguistic responsiveness and critical awareness.

Objectives

This WIP paper seeks to explore how engineering education can be adapted to better support multilingual/multidialectal and multicultural communities by examining the identities of the instructors who designed and facilitated a two-week STEM Summer program in two Dominican-Haitian communities. The study focuses on investigating: (1) how instructors' positionality and background influenced the design and facilitation of engineering lessons in a context shaped by transnational and translingual realities; (2) how instructors' identities—language, culture, training, and lived experiences—shaped their teaching decisions, classroom interactions, and evolving definitions of engineering, and (3) what are the perceptions from instructors of how students engaged with engineering concepts through multimodal and multilingual expression, as documented through instructor observations, journaling, and field notes.

By addressing these objectives, this paper contributes to the growing discourse on culturally sustaining engineering education, emphasizing the need for equity, sustainability, and inclusion in technical fields. While this study offers rich qualitative insights, its findings are exploratory and limited by the short duration of the program.

Positionality in Engineering Education: Definition and Importance

Positionality refers to how an individual's social, cultural, and professional background inherently shapes their teaching and research—whether or not it is explicitly acknowledged. It includes the ways educators' identities, experiences, and assumptions influence their interactions, interpretations, and pedagogical decisions. In this project, positionality was shaped by intersecting factors including cultural narratives, socioeconomic conditions, language practices, and educational pathways—especially as they relate to the complex histories of the

Dominican Republic and Haiti. These two nations share a legacy marked by colonization, migration, and systemic inequality, all of which directly influence educational access and outcomes.

Understanding these dynamics was essential for the research team as they designed and delivered an engineering education program intended to affirm students' identities and lived experiences. Cultural context emerged as a critical consideration: instructors navigated tensions between honoring local knowledge and introducing new engineering concepts in ways that felt relevant and respectful. Socioeconomic challenges, such as limited access to materials and technology, pushed the team to develop low-cost, scalable strategies grounded in the realities of the communities they served.

Language was another vital layer. The interplay of Spanish, Haitian Creole, and English required instructors to be linguistically flexible and attentive to how language shapes inclusion. The multilingual nature of the program not only improved communication but also validated students' heritage languages—an act of recognition often absent in formal STEM instruction.

Rather than treating culturally responsive/sustaining pedagogy and positionality as static frameworks, the team approached them as evolving processes—requiring continuous reflection, adaptation, and responsiveness to context. This approach echoes Johnson-Ojeda and colleague's findings on inclusive STEM instruction, which emphasize the importance of reflective growth over rigid adherence to prescriptive models [6].

Role in the Project

Reflective practice was central to how the research team engaged with their own positionality and shaped the design and facilitation of the program. Each day, instructors documented their assumptions, challenges, and moments of learning through structured journaling. These reflections revealed how preconceived notions—such as the belief that students in rural communities would have limited exposure to engineering—were challenged by students' ingenuity and resourcefulness. Participants appeared to draw on their lived experiences to design structures inspired by familiar tools, vehicles, and community infrastructure. Instructors interpreted this through students' use of terms like "colmado," and through design elements that mimicked recognizable features (e.g., open storefronts, flat roofs). These patterns, discussed in group reflections and field notes, prompted the team to reconsider what counts as engineering knowledge and who is seen as an engineer.

Group reflection sessions deepened this process. Conversations among instructors surfaced the varied ways that cultural background, linguistic fluency, and prior training influenced how each team member framed and delivered engineering concepts. For example, instructors with U.S.-based educational experiences often defaulted to Western engineering frameworks, while others who had taught in the Dominican Republic brought insights grounded in local epistemologies and student norms. This dialogic exchange supported collaborative instructional adjustments and revealed the value of teaching as a shared, iterative process. Several instructors, who identified as Latin American and Caribbean—including individuals with Dominican and Haitian heritage—drew on their cultural proximity to interpret student analogies and classroom interactions. When needed, local collaborators clarified meanings of certain student references to ensure the research team's analysis reflected community perspectives rather than assumptions.

The team's adaptability was further shaped by their commitment to culturally responsive and sustaining pedagogy. Rather than rigidly adhering to pre-planned lessons, instructors modified and co-created activities with input from students and community members. This flexibility, built trust and affirmed local knowledge, especially when students recognized their languages—Spanish and Creole—as valid and central in the classroom. Language became a medium for both communication and connection, as multilingual teaching allowed students to engage more fully and feel seen in their identities.

Ultimately, reflective practice served not only as a pedagogical strategy but also as a research tool. It allowed instructors to interrogate their own biases, respond meaningfully to student needs, and engage in continuous learning. By centering reflection and positional awareness, the team co-constructed a learning environment where engineering education was grounded in culture, language, and community—offering a model for equity-driven teaching in similarly complex contexts.

Methodology

Project Design

This two-week engineering education program was conducted in two Dominican-Haitian communities to examine how STEM instruction might reflect and respond to local cultural and linguistic diversity. The curriculum was co-developed and facilitated by a multilingual, multicultural team with instruction in Spanish, Haitian Creole, and English. Activities were selected for their accessibility and potential to foster creativity, collaboration, and practical problem-solving. These included LEGO robotics and Play-Doh modeling, which required no prior technical background and encouraged open-ended design.

The activities were intentionally grounded in local contexts. Students were invited to design models based on familiar structures and modes of transportation—such as motoconchos (motorcycle taxis) and colmados (corner stores)—to connect engineering principles to their everyday experiences. Each session incorporated group discussions, which allowed students to articulate their ideas and relate new content to local knowledge and observations (e.g., community construction techniques or environmental challenges). These moments also provided instructors with insight into how students conceptualized engineering and where adaptations were needed.

Lessons were structured to support participation across multiple languages. Visual aids, translated materials, and scaffolded vocabulary supported engagement in Spanish, Creole, and English. This multilingual approach was not only a practical tool for access but also a core feature of the curriculum's commitment to honoring students' heritage languages and fostering inclusive learning spaces.

Additionally, interpretation of students' design choices and classroom engagement was informed by ongoing conversations with community members and parents, who offered context for certain cultural references and helped clarify how specific designs connected to local infrastructure or customs. While the instructional team was not composed of individuals from the exact communities involved, most members were of Latin American or Caribbean heritage, bringing linguistic and regional familiarity that supported culturally responsive interpretation without making unfounded assumptions.

Data Collection

Multiple qualitative data sources were used to capture instructional dynamics and student engagement throughout the program. Each instructor completed daily journals in response to open-ended prompts about their observations, assumptions, challenges, and adaptations. These entries offered insight into instructors' evolving perceptions of engineering, language, and their own positionality in the classroom. Community members and local youth volunteers also helped interpret student references during activities, explaining the significance of certain structures (e.g., colmados) or practices (e.g., building orientation for rainwater runoff). This collaboration helped the research team avoid misinterpreting culturally specific design choices.

In addition, selected instructors took field notes during classroom activities, focusing on students' use of materials, peer collaboration, and expressive behaviors—including gesture, sketching, and code-switching—as forms of engineering reasoning. Rather than relying solely on verbal explanations, instructors paid attention to how students communicated ideas across languages and modalities.

Informal conversations were also held with students, parents, and community members before and after sessions. While not formally transcribed, these interactions informed instructors' understanding of how the program aligned with local expectations and supported learning. Community feedback helped refine lesson content and strategies in real time and ensured that instruction remained relevant to the educational and cultural context of each location.

Data Analysis

Data analysis was grounded in iterative, collaborative reflection. Rather than applying a pre-established coding scheme, the research team engaged in thematic analysis through regular debrief meetings held during and after the program. These discussions involved reading selected journal entries and field notes aloud, responding to reflective prompts, and collectively identifying recurring themes and moments of significance.

Themes were derived inductively, with guiding questions such as: "How did your identity shape today's teaching?", "What did students communicate about how they view engineering?", and "In what ways did language support or complicate learning today?" Researchers used consensus-building and collaborative interpretation to refine and name emerging themes. This reflective dialogue allowed the team to explore the intersections of identity, language, and pedagogy without imposing external frameworks.

To support the trustworthiness of the analysis, interpretations were compared across instructors, sites, and roles. Where differences in interpretation emerged, they were used generatively to explore multiple meanings and contextual nuances. This included acknowledging how instructors' cultural and linguistic backgrounds influenced what they noticed and how they interpreted classroom moments.

Rather than presenting reflection as supplementary to analysis, the team treated it as central to the research process. This approach aligned with the study's emphasis on positionality and contextual sensitivity, prioritizing lived experiences over rigid objectivity. The themes that emerged—such as reframing engineering identity, language as a tool for inclusion, and localized, multimodal expressions of engineering thinking—were not imposed a priori, but grounded in the collaborative sense-making practices of the research team.

Results and Discussion

This section presents the central findings from our study, organized around key themes that emerged through instructor journaling, field notes, and reflective conversations among the research team. These findings illustrate how the team's identities and pedagogical choices intersected with the multilingual and multidialectal context of the program and how students' engineering thinking emerged through multimodal and locally grounded expressions.

Instructor Identity and the Reframing of Engineering

One of the strongest throughlines in the data was the shift in how instructors perceived engineering—and their own legitimacy within it—throughout the program. For many, their understanding of what it meant to "be" an engineer evolved in response to the students' expansive and community-rooted design work.

Luis, for example, was raised and educated in Venezuela's public school system before moving to the United States to study computer science. In Venezuela, he noted, engineering was portrayed as a narrow, elite field centered around large-scale infrastructure, and he never saw himself reflected in that image. Even when he began studying robotics in the U.S., he found that engineering continued to be defined by U.S.-centric design frameworks that prioritize formal instruction and standardized outcomes over lived experience and local ingenuity. "I wasn't in an engineering department—I was in Arts and Sciences," he explained. "So, I kept thinking I wasn't a real engineer." However, through the process of leading lessons, prototyping alongside students, and responding to their designs, Luis had a breakthrough: "Being an engineer is not just about having a diploma; it's about how you break down a system, understand it, and build something new."

Clara, who had a background in science education rather than engineering, also wrestled with impostor syndrome at the start. "I've taught science, not robotics," she shared. "My only engineering experience was teaching workshops to kids." Yet she was struck by how the students naturally defined engineering as something deeply tied to creativity and everyday problem-solving. "They weren't limited by the idea that engineering is about building bridges or coding apps. They saw it as figuring things out with the resources you have. That really changed how I saw my own role—as someone helping make that visible."

In both cases, the act of teaching and observing students not only redefined engineering but helped instructors feel more grounded in their roles. Their shifting self-perceptions speak to the transformative power of teaching as a site for identity exploration and growth.

Language as Inclusion and Connection

Language emerged as a powerful axis of both challenge and transformation throughout the program. With Spanish, Haitian Creole, and English circulating fluidly among participants and instructors, multilingualism became both a logistical reality and a pedagogical resource.

For many instructors, it was the first time teaching STEM content in a multilingual classroom. Taisha, a Haitian-American fluent in Creole and English, initially assumed she would rely mostly on Spanish in a setting where Dominican norms often dominate. She said, “I kept thinking, ‘How can I expect them to speak Creole in a room full of Dominicans?’” But her assumption was quickly challenged when students began calling to her in Creole. “Some of the students would shout in Creole to get my attention. It became this beautiful way of building trust. It told me, ‘We see you. You see us.’” This moment reframed Creole not as a private language to be hidden, but as a bridge for connection and affirmation.

Luis offered another linguistic perspective. He was educated primarily in Spanish, but learned most of his robotics and computer science vocabulary in English after moving to the U.S. “So when I tried to explain those ideas in Spanish, it didn’t always come out right,” he said. Teaching in Spanish forced him to rethink how he conceptualized technical ideas—a process that deepened his own understanding. “I had to find the language to make these concepts real for them and for me.”

Mia, whose family is Dominican but who was raised in an English-speaking context, described teaching in Spanish as a moment of profound identity affirmation. “I’ve never spoken Spanish this consistently for this long,” she said. “But it felt so natural. No one questioned my fluency or my ‘Dominicanness.’ I felt fully accepted.” She also noted how translating lesson materials required her to slow down and reconsider how to best explain key ideas: “It made me a better instructor because I had to really understand what I was saying.”

Clara, whose primary fluency was in Creole, described how language negotiation unfolded in the classroom. In small group settings, she witnessed what she called “language engineering"—students would fluidly shift between Spanish and Creole to co-construct meaning. She recalled, “One student might start a sentence in Creole, and another would finish the idea in Spanish. They were building knowledge together, using everything they had.”

These reflections collectively show that language was not just a tool for instruction—it was a medium of identity, connection, and creativity. The multilingual structure of the program affirmed heritage languages, created space for linguistic flexibility, and invited students and instructors alike to expand how they engaged with engineering concepts.

Multimodal and Localized Engineering Thinking

Although the program did not include formal student interviews, the research team’s field notes and reflections captured vivid examples of students engaging with engineering through design, storytelling, sketching, and gesture. These multimodal forms of expression were critical for understanding how students thought and communicated about engineering in multilingual and resource-constrained settings.

Clara, who observed students closely during Play-Doh and LEGO robotics activities, shared: "A group of students built a motoconcho—a motorcycle taxi that's everywhere in the DR. Another group built a colmado [small corner store]." These choices, she explained, seemed to reflect the students' everyday experiences and the structures they interacted with regularly. "They weren't just imaginative projects—they were reflections of their world," she added. In one instance, a student explained, "Our roof needs to be flat because of the rainwater," referencing design decisions that appeared to draw on local construction practices. Clara inferred these connections based on students' verbal descriptions and the ways they linked design choices to challenges in their environment.

Luis also noticed how students took ownership of their projects in ways he hadn't anticipated. "They weren't asking for help—they were discussing ideas with each other, repurposing pieces, testing things out," he said. "Even when they couldn't explain in technical terms, you could see the process. They'd sketch things, point to reference images, act things out with their hands."

Mia described how some students used a mix of Spanish, English, and Creole to work through design challenges. "There was this constant switching between languages—but it wasn't confusing. It actually helped them explain their ideas more clearly. One student said, 'The wheel goes aquí, porque it needs to turn rápido.'" These examples underscore how students drew on their full linguistic and cultural repertoires to engage in engineering thinking.

Traditional engineering assessments might have overlooked these moments because they didn't fit neatly into written reports or formal presentations. But in this context, engineering was embodied, multimodal, and grounded in community knowledge.

Instructor Adaptation and Reflective Practice

The dynamic nature of the program demanded that instructors continually adapt their lesson plans and pedagogical strategies based on student response, language use, and cultural relevance. This flexibility was only possible because of the team's strong commitment to reflective practice.

Luis shared how he initially removed the coding component from his robotics lesson, assuming students wouldn't be ready for it. "I thought, 'Let's just build—I don't want to overwhelm them,'" he said. "But after seeing their creativity, I realized I had underestimated them. They were ready for more." This realization prompted him to reintroduce open-ended problem-solving into the second site.

Taisha reflected on how she had to shift from delivering structured lessons to facilitating open dialogue. "I went from lecture mode to question mode," she said. "It wasn't about me teaching them something new—it was about creating space for what they already knew." Her approach was shaped by the insight that students often came in with relevant knowledge, even if they didn't yet have the words for it in a technical language.

Mia noted that the iterative nature of lesson planning—especially in Spanish—sharpened her ability to teach with clarity. "When I translated my slides, I had to rethink every phrase. I couldn't just copy-paste. That forced me to clarify the concepts for myself, too." Her lesson on sustainable building materials was adapted to incorporate familiar local examples, like palm leaf roofing and cement block structures.

These experiences underscore that inclusive teaching is not static—it is an active, reflexive process of listening, adjusting, and growing in response to students and context. Reflection wasn't just a post-activity exercise—it was integral to the instructors' evolving definitions of good teaching and good engineering education.

Positionality Dimension: Research Motivation and Approach

The research team, composed of individuals with Latin American, Caribbean, and Haitian heritage, was deeply invested in exploring how cultural and linguistic diversity influences engineering education. While the team was not originally from the specific communities served, several instructors had prior experience living, studying, or teaching in similar Caribbean and Latin American contexts. This proximity offered a shared regional and linguistic grounding that informed their interactions, while reflective practices and input from local community members were used to avoid misinterpretation and prevent overgeneralization. These cultural exchanges played a crucial role in helping the team understand what students were referencing or drawing upon in their engineering work.

Language was a key factor in the team's motivations. Several members were particularly interested in the role of language in STEM education, comparing the ways engineering is taught and understood in English, Creole, and Spanish. The researchers sought to examine how linguistic flexibility impacted student engagement and comprehension, particularly in a setting where Haitian and Dominican cultures intersected. Their cultural backgrounds also shaped their understanding of education systems and learning environments. The Dominican Republic, with its historically complex relationship between Dominican and Haitian populations, provided a rich environment to explore how students from Haitian backgrounds engage with engineering concepts. Researchers were drawn to this project not only for its pedagogical impact but also because it provided an opportunity to reflect on their own identities and biases in teaching STEM subjects.

Positionality Dimension: Methodology

The research team had the liberty to design and test the lessons during the planning stage of the Engineering learning experience. Each iteration in the design process led to more choices about the way to communicate and practice new content in the classroom. The researchers reflected on which decisions were more relevant to their work and delved into the reasoning behind. Luis has experience working with students from Venezuela's public education system, and he expected to see similar levels of literacy with emerging technologies in the Dominican Republic. He opted to focus his lesson on the building process of the robots and leave aside the coding section, as he imagined how the lesson would go in his home country. Moreover, Luis noted how students interacted with the pieces during the first location and decided to adapt his lesson to provide more liberty in the creation process. Luis' background drives him to develop more hands-on activities as they are more engaging in his local context.

Mia's priority was to include materials that relate to the student's environment and that could be easily replaced to replicate the activity. This decision materialized after gaining some insights from the experience in piloting some of the lessons in an urban school in the Northeast, as she noted students often imitate buildings, weathers and landscapes from their surroundings. Therefore, sustainability was an important pillar of her methodology planning.

Drawing from research on effective STEM pedagogy, including findings that highlight the significant impact of active learning on student performance and retention, the instructional team intentionally designed the program to include hands-on experiences that mirrored the engineering process [7]. Mia's decisions were influence by her emphasis on sustainability and the goal of developing lessons that could be repeated beyond our presence. After reviewing outcomes from the first week, Luis decided to consider a range of problem-solving focused activities to engage in practice with students. These changes were informed by reflections from their prior teaching experiences, where they saw the need for a program that fostered creativity and engineering ingenuity.

Positionality Dimension: Ontology

The research team has diverse backgrounds, from undergraduates in different majors to doctorate students with unique research areas. Thus, the observations went according to the interests of each person, revealing a large range of interesting topics. A project with multiple layers as this one requires diversity in the observations made, ranging from interactions with new materials, to the way students approach learning in multiple languages

Clara was very intrigued by the way students would interact with new materials, with the LEGO pieces and the Play-Doh. From her experience as a Caribbean person, she argues that people from the region were could creatively repurpose any material. Her emphasis on the interactions led to entertaining observations about the student's journey of understanding and using mechanic pieces.

Current efforts to review the collected data motivated Taisha, Luis and Mia to be intrigued by the interactions between the participants. Luis is interested in the way students repurpose materials to serve different functions, while Taisha observes that the social dynamics in small groups are often based on collaboration. These areas of interest have driven them to notice the interactions within small groups during the design and implementation process of the lessons. Mia's curiosity about the role of language in multicultural settings has led her to explore verbal and non-verbal ways of communication between community members.

Positionality Dimension: Researcher-as-instrument

Empowering students to see themselves as engineers was a core goal of the program. However, the research team's perceptions of engineering initially differed from the expansive definitions students embraced.

Luis initially did not see himself as an engineer because he was enrolled in a faculty of arts and sciences rather than a traditional engineering program. His initial concept of engineering was tied strictly to formal design and building processes. However, through teaching, prototyping, and lesson development, he began to recognize that engineering is about problem-solving, breaking down systems, and reconstructing them creatively.

Luis: "Being an engineer is not just about having a diploma; it's about how you break down a system, understand it, and build something new."

The experience in the Dominican Republic, particularly conversations about informal engineering practices, made him rethink the definition of engineering. He reflected on how daily problem-solving and resourcefulness in underserved communities were engineering-like processes, even if they did not fit the conventional Westernized model of engineering education.

Mia reflected on how speaking Spanish throughout the program strengthened her connection to her identity. Being able to communicate her story and engineering lessons in Spanish allowed her to feel more connected with students and more confident in herself.

Mia: "Speaking Spanish for such a long time was enriching, and no one questioned my fluency. My identity was not up for debate—it was simply accepted."

She also recognized how lesson planning in English, then translating, helped refine her teaching. The process of translating STEM concepts into Spanish forced her to rethink technical vocabulary and adapt lessons in a way that made more sense for a Spanish-speaking audience.

Taisha emphasized the importance of reinforcing students' existing knowledge rather than rewriting it. She noted, "As much as we can tell them that their education doesn't stop here, we need to show them that they are already thinking like engineers." This approach helped students recognize their own problem-solving skills, fostering confidence and a sense of ownership over their learning.

Clara, who initially felt like an impostor due to her background in science education rather than traditional engineering, was struck by the students' broad definitions of what it means to be an engineer. "They weren't limited by the traditional image of an engineer as someone who builds homes or works with machines. Instead, they saw engineering as the ability to figure things out and create solutions." This realization reinforced the importance of presenting engineering as an accessible and diverse field, shaped by curiosity and adaptability.

Considerations in Program Implementation

The implementation of the program revealed several critical factors that contributed to its success, particularly cultural relevance, linguistic flexibility, and student agency. Researchers faced and adapted to multiple challenges, which shaped the program's delivery and impact.

Challenges and Adaptations in Teaching Approaches

Luis had several preconceived notions about students' ability to grasp complex STEM concepts due to his experiences with public education in Venezuela, where educational resources had deteriorated. Before arriving, he assumed that students in the Dominican Republic, particularly in rural and suburban areas, might not have been exposed to advanced robotics or computer science. This led him to initially remove coding from the lesson, focusing solely on building mechanics. However, after seeing how students interacted with LEGO robotics, he reconsidered his approach and reflected that a more open-ended, hands-on learning process—rather than strict instructions—would have been more beneficial. He compared this to his experience in an urban school in the Northeast, where the primary focus was on coding rather than physical design.

Mia prioritized using locally available materials so that students could replicate their projects beyond the classroom. This decision was influenced by her experience teaching in an urban school in the Northeast, where students often designed structures reflecting their immediate environment. However, she later realized that starting with too simple materials might have underestimated students' capabilities. She reflected on how students' designs incorporated recognizable aspects of their communities, reinforcing the importance of letting students take ownership of their engineering process rather than limiting them based on perceived accessibility of resources.

Taisha: Initially underestimated how many students were Creole speakers. Although there was prepared content in Creole, she realized she was not as well-prepared to deliver lessons in Creole herself. This forced her to pivot toward a conversational, question-based approach that allowed her to gauge students' understanding before introducing concepts. The challenge of juggling three languages—Spanish, English, and Creole—was initially confusing, but as the weeks progressed, she found that once students grasped the topic and the goal, the learning process became smoother. She also adjusted her teaching approach in the second week after realizing that students already had a stronger science background than she had assumed. Instead of re-teaching foundational knowledge, she focused on supporting their existing understanding, reinforcing their confidence in STEM learning.

Taisha: "Being more conversational rather than teaching a rigid lesson helped create a smoother learning experience."

Linguistic and Cultural Dynamics in the Classroom

Taisha reflected on why she initially underestimated the number of Creole speakers. She had previously attended church with Haitian students raised in the Dominican Republic, where they felt pressure to assimilate linguistically and culturally into Dominican society, often distancing themselves from Creole in public settings.

Taisha: "I can't expect them to speak Creole in a room full of Dominicans."

She noted tensions when Creole was introduced, especially when Clara greeted the students in Creole. Some students hesitated before responding, questioning whether to reply in Spanish or Creole. However, by the second week, students began using Creole more freely, sometimes even deliberately speaking it to gain instructors' attention.

Additionally, the presence of multiple languages—Spanish, English, and Creole—created moments of linguistic negotiation. Clara noted how students navigated language fluidly in group work, using both Spanish and Creole to co-construct ideas—an observation she also described earlier as "language engineering." However, tensions arose when Creole was used in predominantly Dominican settings, with some students hesitating to speak it openly. Taisha reflected on how her initial assumption—that most Haitian students would prefer Spanish in academic settings—was challenged by their preference for Creole in certain discussions. This highlighted the need for a more adaptive linguistic strategy to foster an inclusive learning environment.

Question #1: What considerations (decisions from challenges you faced) did you consider while implementing STEM teaching ideas specific to the local community context?

Luis:

Luis initially held preconceived notions about how students would engage with the lessons, particularly in LEGO Robotics, as he assumed it might be their first time interacting with such materials. His concerns stemmed from his experience with Venezuela's public education system, where he had seen limited access to emerging technologies and a deterioration of STEM instruction to the point where some subjects were no longer being taught at all.

Before arriving in the Dominican Republic, Luis compared the educational landscape to that of Venezuela, assuming that students in suburban and rural areas would have minimal exposure to robotics and computer science. Based on this, he structured his lesson to focus on the mechanical aspects of building the robot rather than the coding and programming components. He believed this approach would make the lesson more accessible and engaging for students with little prior exposure to these technologies.

However, his assumptions were challenged during the program. He observed that students were naturally drawn to building and modifying designs based on their environment, often imitating familiar objects rather than following step-by-step instructions. This realization led him to reflect that the lesson should have emphasized creativity and problem-solving rather than simplifying the content based on perceived limitations.

Mia:

Mia prioritized using materials that students could easily find in their surroundings to ensure they could replicate the lessons beyond the classroom. She integrated elements from the local community, such as terrain types for construction projects and structures that reflected familiar environments rather than skyscrapers, making the lessons more relevant to the students' lived experiences. However, she later reflected that starting with simpler and more relatable materials may have underestimated the students' abilities. As the lessons progressed, she observed that the students were capable of more complex problem-solving and creative adaptations than initially anticipated.

Taisha:

Taisha initially underestimated how many students were Creole speakers and, although content was available in Creole, she wished she had better prepare herself to communicate in the language. She recognized that teaching students in Creole was not just about language accessibility but also about affirming that it is completely valid to teach and learn in Creole. At first, navigating three languages—Spanish, English, and Creole—was challenging, and she found that students had varying levels of comfort with different languages depending on the context. To overcome these challenges, she shifted to a more conversational approach, using questions to gauge students' understanding and comfort levels, which allowed for a smoother and more inclusive learning experience.

By the second week, after observing that students already had a stronger background in science than anticipated, she adjusted her approach to focus on supporting their knowledge rather than rewriting it. This shift helped reinforce student agency and confidence in their own learning.

Taisha was initially concerned about how her Spanish would be received in the Dominican Republic, but she found that the team and community members were welcoming and encouraging, making it easier for her to engage in Spanish and feel more confident in her interactions.

Clara:

Clara was particularly intrigued by the materials and the considerations Mia made when selecting them. She was eager to see how students would engage with the materials, as she had observed that Caribbean people have a remarkable ability to repurpose and create art from any material. She noticed that many of the children were using LEGOs and playdough for the first time and watching them experiment and make discoveries was one of the most exciting aspects of the learning process.

Language posed a significant challenge for Clara, as she could primarily communicate in Creole, while many students naturally switched between Spanish and Creole in their discussions. This language negotiation process was fascinating to observe, as students often mixed words and phrases from both languages to collaboratively construct meaning. While explaining technical concepts was difficult at times, she found that students intuitively helped bridge gaps in understanding by contributing in whichever language made the most sense at the moment. This collective, multilingual knowledge-building process reinforced the value of linguistic diversity in STEM education highlighting how students leveraged their full linguistic repertoire to engage with engineering concepts.

Question #2: How did the researcher team's perception of their own identity as engineers influence interactions with students?

Luis:

Luis initially did not consider himself an engineer, as he was enrolled in the arts and sciences faculty, and his understanding of engineering was primarily linked to formal design and construction work. However, his perspective began to shift during the process of developing and teaching lessons. The experience of prototyping, building a robot, and structuring an educational experience revealed to him that engineering is not solely about working with machines or infrastructure but also about problem-solving, iteration, and adaptation. He began to recognize that the engineering mindset was present in the way he taught, received feedback, and adjusted lessons based on student engagement.

While working in the Dominican Republic, Luis had a realization: being an engineer is not about holding a diploma but about a way of thinking—breaking down systems, understanding them, and constructing something new from that understanding. Observing students engage in resourceful, hands-on problem-solving pushed him to reconsider the formal definitions of engineering he once held. Conversations about informal engineering practices—the ways in which communities innovate, repair, and repurpose materials in everyday life—expanded his perception of what engineering truly entails. This shift helped him connect more deeply with the students, as he saw them already engaging in engineering thought processes, even if they did not formally label it as such.

Mia:

Mia found that speaking Spanish throughout the program deepened her connection to her identity. Being able to communicate fluently with students allowed her to share not only technical knowledge but also her personal experiences and cultural background, fostering a stronger sense of belonging. Engaging in conversations and teaching in Spanish reinforced her sense of cultural pride, as she felt fully embraced by the students and the community.

Initially, Mia had planned her lessons in English, drawing from her experience in an urban school in the Northeast, where she had previously taught. However, during the process of translating materials into Spanish, she began to reflect more on word choice and instructional strategies, leading her to adapt and refine her teaching approach. This shift helped her recognize the importance of linguistic accessibility and how language shapes the learning experience.

Working with students also led Mia to a deeper personal reflection. Speaking Spanish for an extended period was not just about facilitating instruction—it became an affirmation of her identity. She noted that in this "so Dominican" environment, filled with warmth, kindness, and cultural familiarity, no one questioned her language fluency or heritage. This sense of acceptance and immersion allowed her to fully embrace her identity, reinforcing the idea that language is a powerful tool for both education and self-affirmation.

Taisha:

Taisha's perspective on engineering was clear from the beginning—she immediately saw herself and the team as engineers, a belief that shocked her when other team members expressed doubts about their own engineering identities. To her, engineering is not just a title or degree, but an action—a process of problem-solving, designing, and collaborating. She emphasized that beyond technical skills, engineering also requires soft skills like teamwork, adaptability, and creativity, all of which the team actively demonstrated throughout the program.

One of Taisha's key pedagogical insights was the importance of creating a conversation rather than a rigid lesson structure. By the second week, she noticed that teamwork among instructors played a crucial role in helping students grasp concepts more effectively. Instead of approaching lessons as one-way instruction, the team worked together to foster a collaborative learning environment, where students could ask questions, share their perspectives, and contribute their own knowledge. This approach leveled the power dynamic and reinforced the idea that students were already knowledgeable and capable of contributing to discussions in meaningful ways.

Taisha also recognized the significance of reinforcing students' existing knowledge rather than rewriting it. She firmly believed that students were already thinking like engineers, even if they did not initially realize it. She explained, "As much as we can tell them that their education doesn't stop here, we have to show them that they are already thinking like engineers." By affirming the problem-solving skills and resourcefulness students already possessed, she sought to empower them to see their potential and build confidence in their abilities.

A particularly impactful moment for Taisha was when students asked how they could get to the university where she is attending college. This question revealed a deep curiosity and aspiration among the students, and she saw it as an opportunity to emphasize that the team was not there to "take them away from home" but rather to add to what they already had. Her approach centered on showing students that they already possessed the knowledge and skills necessary for engineering—they simply needed to apply it in different contexts.

Taisha also experienced personal growth through this process. While she had always envisioned herself as an engineer, she had not previously imagined herself as an engineering educator. Being in this role and seeing the impact of her teaching on students shifted her perspective, demonstrating to her that engineering education is just as much about guidance, encouragement, and empowerment as it is about technical expertise.

Clara:

Clara's experience in the program challenged and expanded her understanding of what it means to be an engineer, both for herself and for the students. She observed that students approached engineering with a much broader and more inclusive perspective than the research team initially had. While the team began with a relatively narrow definition of engineering—often tied to traditional roles like building homes or working with machines—students saw engineering as problem-solving, creativity, and making sense of the world around them. This shift in perspective helped Clara redefine her own relationship with engineering.

Despite her background in science education, Clara initially struggled with feeling like an impostor in an engineering space. She explained, "I am not an engineer, and I am an impostor because I do have a science background, but my engineering experience is teaching engineering workshops for children." Unlike many of her peers, she did not have experience in coding, CAD, or traditional engineering design, which made her question whether she truly belonged in an engineering setting. However, she found herself deeply fascinated by the way engineers think and problem-solve, which is what ultimately motivated her to pursue engineering education.

Over time, Clara began to see the value of her role as an educator in engineering spaces. She realized that pedagogical expertise is just as important as technical expertise when it comes to fostering engineering thinking in students. She noted that wearing the "teacher hat" was just as valuable as the "engineer hat", because it allowed her to guide students in discovering engineering principles, even if she was not the one designing or building herself. This insight helped her feel more at home in an engineering environment, as she recognized that her ability to facilitate learning and engagement was a critical part of the engineering education process.

Clara also reflected on how her own experiences with STEM education had been shaped by cultural and linguistic contexts. She had never learned STEM outside of the U.S. and English-speaking environments, even though many of her peers and students came from multilingual backgrounds. This led her to assume that children in different places would have the same tendencies toward learning STEM, a perspective she later realized could be limiting. As she engaged with students, she started making note of the specific things that interested them—whether it was familiar materials, cultural references, or personal experiences—and sought to incorporate those elements into her teaching.

Through these experiences, Clara gained a newfound appreciation for how engineering education can be adapted to different cultural and linguistic contexts. She left the program with a stronger belief in the importance of diverse perspectives in engineering and a greater confidence in her role as an educator within this field.

Limitations

This study acknowledges several limitations that may impact the generalizability and scope of its findings. First, the short duration of the program—one week—restricted the ability to assess long-term outcomes, such as sustained student interest in engineering or the development of advanced technical skills. Future research should consider longitudinal studies to evaluate the lasting impact of culturally responsive engineering education initiatives.

Second, while the program aimed to integrate community input, the limited timeframe constrained the extent to which community members could be fully involved in co-creating the curriculum. Although informal interviews and discussions provided valuable insights, a more extensive participatory design process would likely yield deeper alignment with local needs and priorities.

Finally, the positionality of the researchers may have introduced biases into the study. As external facilitators, their perspectives were inevitably shaped by their own cultural and professional backgrounds, which could have influenced both their interactions with students and their interpretations of the data. Reflexive practices, such as journaling and group discussions, were employed to mitigate these biases, but further research involving local educators as co-researchers could enhance the authenticity and relevance of the findings.

By addressing these limitations, future iterations of the program can build upon the insights gained from this study to create more robust, inclusive, and impactful engineering education experiences.

Conclusion

This study underscores the transformative potential of integrating cultural, linguistic, and socio-political considerations into engineering education. Building trust with communities emerged as a foundational element of effective STEM education, fostering environments where students felt empowered to engage deeply with engineering concepts. By drawing upon their lived experiences and cultural assets, students appeared to connect theoretical knowledge with practical, locally relevant applications, as evidenced through their design choices and verbal explanations.

The findings also highlight the importance of embracing fluid and expansive definitions of engineering. Moving beyond rigid, institutionalized frameworks, this approach allowed for the inclusion of informal and community-based problem-solving practices. Such a perspective bridges the gap between technical competencies and real-world challenges, reframing engineering as a discipline that is accessible, inclusive, and reflective of diverse lived experiences. This reframing not only benefited students but also encouraged instructors to reconsider their own roles and identities within the field of engineering.

The implications of this work extend beyond the immediate context of the study. By emphasizing the role of positionality in teaching, it provides a lens for educators to critically evaluate their own practices and adapt them to better serve diverse communities. Moreover, the study suggests the potential of culturally and linguistically learning experiences on educational outcomes and student engagement.

Looking ahead, this research opens promising pathways for further exploration. Longitudinal studies can help assess how culturally responsive engineering initiatives influence students' academic and professional trajectories. Future programs should deepen collaboration with local communities and educators, co-designing activities that are contextually grounded and sustainable. By refining and expanding these approaches, this work aims to inspire a paradigm shift in engineering education—one that values diversity, prioritizes equity, and uses culturally responsive practices to meet the evolving needs of a globalized world.

References

[1] Boz, T., Hammack, R., Lux, N., & Gannon, P. (2024). "Technology-rich Engineering Experiences in Indigenous and Rural Schools" *International Journal of Education in Mathematics, Science and Technology,* 12(4), 1090–1108. https://doi.org/10.46328/ijemst.4129

[2] Lucena, J. (2005). "Defending the nation: U.S. policymaking to create scientists and engineers from Sputnik to the 'War Against Terrorism". *University Press of America.* pp. 12–15, 28–32

[3] Alder, K. (1997). "Engineering the revolution: Arms and enlightenment in France"*, 1763-1815. University of Chicago Press*. Chapters 2, 4.

[4] Ladson-Billings, G. (1995). "Toward a theory of culturally relevant pedagogy." *American Educational Research Journal*, *32*(3), 465–491. https://doi.org/10.3102/00028312032003465

[5] Paris, D., & Alim, H. S. (2014). "What are we seeking to sustain through culturally sustaining pedagogy? A loving critique forward." *Harvard Educational Review*, 84(1), 85–100. https://doi.org/10.17763/haer.84.1.982l873k2ht16m77

[6] Johnson-Ojeda, V., Hill, L. B., Shin, S., York, A. M., & Frey, R. F. (2025). "Measuring STEM instructors' learning of and growth in inclusive teaching: Development and evaluation of the STEM faculty inclusive teaching survey (FITS)." *CBE—Life Sciences Education,* 24(1). https://doi.org/10.1187/cbe.24-01-0016

[7] Freeman, S., Eddy, S. L., McDonough, M., Smith, M. K., Okoroafor, N., Jordt, H., & Wenderoth, M. P. (2014). "Active learning increases student performance in science, engineering, and mathematics." *Proceedings of the National Academy of Sciences,* 111(23), 8410-8415. https://doi.org/10.1073/pnas.1319030111

[8] Gay, G. (2010). *Culturally responsive teaching: Theory, research, and practice* (2nd ed.). Teachers College Press. Chapters 3, 4.

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