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Affordances and Challenges in the Transition from Research Internship to Graduate Studies for Colombian Engineering Students in the USA

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I. INTRODUCTION

The study of international migration for educational purposes has been thoroughly examined within developed nations, notably in high-income countries like the United States, Canada, the United Kingdom, and Australia [1], [2], [3]. Over time, researchers have gained a nuanced understanding of how international student status affects various dimensions of academic life, including mental health, psychosocial well-being, cultural adaptation, and feelings of belonging [4], [5]. Qualitative studies have added depth to this picture, highlighting how students undergo personal and identity shifts through their interactions with new social systems, unfamiliar environments, and internal reflections on their past and aspirations for the future. These changes don't happen in isolation but emerge through a complex web of experiences that unfold across different stages and destinations.

Much of the existing scholarship has concentrated on individuals pursuing long-term undergraduate or graduate degrees abroad, often spanning four years or more. Typically, these students come from lower-income nations across Asia, Europe, and Africa. Many also envision permanent settlement in their host countries, prompting thoughtful consideration of their educational choices in light of broader life plans.

However, there's a notable gap in the literature regarding students from South America. Their experiences—shaped by distinctive cultures and Spanish dialects different from those in Mexico—remain vastly underrepresented. Mexico is frequently cited in studies, sometimes inaccurately generalized as representative of all Latin America. In addition, short-term academic stays, particularly those under six months that are neither touristic nor volunteer-based, have received minimal scholarly attention.

The Undergraduate Research Experience Purdue-Colombia (UREP-C) program, launched in 2014, offers valuable insight into this underexplored area. The initiative brings talented Colombian undergraduates to Purdue University to engage in research alongside faculty mentors. This setting not only promotes academic growth but also fosters meaningful cross-cultural exchange. Especially compelling is the lens it provides into the experiences of students from low- to middle-income families traveling outside their home country for the first time. For many, the program is a pivotal moment that reshapes their academic ambitions, sometimes steering them toward pursuing graduate education abroad, informed by personal revelations, evolving expectations, and real-world exposure.

In this context, our research question is: What are the experiences of Colombian undergraduate students during a 6-month research internship at Purdue University, and how do these experiences influence their decision to study abroad?

II. LITERATURE REVIEW

Within the scope of this study, the diverse experiences of international undergraduate students adjusting both psychosocially and socioculturally in the United States are explored. The review of existing literature sheds light on various strategies and obstacles these students navigate while adapting to unfamiliar academic and cultural surroundings. This synthesis is critical for addressing the central research question: how do these dynamics influence students' overall development and adjustment?

One central theme in the literature is the role of intercultural interactions during the formative years at university. These encounters often lay the groundwork for enduring personal and professional relationships [6], [7]. Early on, during orientation, students frequently gravitate toward fellow international peers to form support networks, though this can unintentionally lead to the exclusion of domestic students. Engaging with the local community and participating in host cultural activities helps build essential social capital, which plays a key role in smoother integration [6], [8].

Another central factor involves cultural and linguistic adaptation. A lack of cultural familiarity and limited knowledge about American norms can hinder social and academic inclusion [9], [10]. Participating in multicultural events and embracing their cultural identities boosts students' confidence and fosters a sense of campus belonging [6]. For instance, although South and Central American students often express enthusiasm for cultural exchange, they may feel compelled to downplay their accents to assimilate, which can reinforce feelings of otherness and social disconnect [11].

Emotional well-being also emerges as a significant dimension of the adjustment process. Financial background often shapes how students cope—those from wealthier families generally report lower levels of loneliness [7]. While many students value exposure to global perspectives, encounters with discrimination and economic hardship can negatively affect mental health [11], [12].

When it comes to academics, students often demonstrate creativity and self-advocacy in overcoming hurdles [4], [13], [14], [15]. Although language barriers and differing cultural expectations pose challenges, participation in intensive English programs has enhanced adaptability [16], [17]. In addition, institutional offerings like transition courses and academic support services bolster academic skills and provide platforms for social connection [11].

Lastly, the literature points to the influence of students' prior experiences. Previous travel, family background, and personal expectations all inform their academic goals and shape their role within the university [17]. These experiences often reinforce a value system rooted in cultural identity and academic aspiration [10], [13].

While current research offers a meaningful glimpse into the international student experience, notable gaps remain. Specifically, much of the existing work centers on long-term students from select regions, often overlooking those from South America or participants in short-term academic exchanges. The Undergraduate Research Experience Purdue-Colombia (UREP-C)

stands out as a valuable case to examine students' experiences from low- to middle-income backgrounds on temporary academic placements. Addressing this underexplored area is crucial for broadening the conversation around international education and capturing the full scope of how such experiences shape future educational pathways.

III. THEORETICAL FRAMEWORK

It is vital to consider acculturation theory to address the study's research problem and objectives. It is a key conceptual lens for understanding how individuals from different backgrounds engage with a new host culture. When this intercultural contact is sustained over time, it often changes cultural patterns shaped by the ongoing negotiation between one's heritage and the surrounding environment. The theory provides a structured way to explore how individuals manage these transitions by adopting one of four distinct acculturation strategies: assimilation, integration, separation, or marginalization.

Among these, integration—where individuals maintain their cultural roots while embracing aspects of the host culture—is often linked to developing a bicultural identity, aligning with the aspirations expressed by many participants. Assimilation, by contrast, involves abandoning one's original cultural norms in favor of those of the host. Separation reflects a withdrawal from the host culture, while marginalization denotes disengagement from both cultural spheres. These strategies are shaped by various factors, including personality, social networks, and perceived cultural compatibility [18]. This framework allows the study to examine how participants negotiate their identity while adjusting to academic demands and social settings.

Acculturation theory's attention to social networks and cultural fit is particularly relevant in community building and adaptation within diverse institutional settings like Purdue University. The presence of host families, supportive mentors, and peer groups plays a pivotal role in smoothing the integration process. Participants' efforts to learn the language, build friendships, and engage with the broader community illustrate how they attempt to forge a sense of belonging while holding onto their cultural heritage.

To further explore participants' academic development and personal transformation, the concept of Funds of Identity [20] offers essential insights. This framework centers on the socially rooted resources, ranging from cultural to institutional, that individuals use to define themselves and adapt to new contexts. These dimensions provide a nuanced lens to understand how participants actively shape their identities during their internships. Given the short-term nature of their experience, identity emerges as fluid and responsive, influenced by continuous interaction with unfamiliar academic and cultural systems [21].

For South American students, many of whom are navigating international education for the first time, adapting to different academic expectations, mastering technical English, and participating in multicultural environments becomes a complex but formative journey. Language serves as both a hurdle and a bridge—participants rely on past learning while acquiring new skills to express themselves effectively in this new setting.

The concept of Funds of Identity also sheds light on the emotional foundations students rely on, such as family and cultural connections, which help them maintain balance amid uncertainty. Though physically distant, these ties remain emotionally central and act as anchors. However, balancing these relationships with academic pressures and time differences often creates tension between adapting to a new life and preserving cultural continuity.

Importantly, the identity resources students draw upon are not fixed. They evolve as students confront and adapt to the demands of their temporary academic stay. These shifts often lead to deeper self-awareness, with participants beginning to see new educational possibilities, such as pursuing graduate studies, as attainable, thanks to their success in managing their internships' social, linguistic, and academic dimensions. The intensity and brevity of the experience make it a transformative moment, one that can influence future academic decisions in profound ways.

By integrating Acculturation Theory and Funds of Identity, this study offers a layered understanding of the interplay between students' challenges and the internal and external resources they mobilize. Together, these frameworks capture the complexity of adaptation and the agency and resilience that shape students' experiences and growth during their time in the United States.

IV. METHODS

A. Methodology

The methodology of this study is rooted in phenomenology, a qualitative approach designed to explore and understand lived experiences within a specific context [22]. Its primary aim is to examine how Colombian undergraduate engineering students navigate a six-month research internship at Purdue University. By prioritizing participants' subjective interpretations and meanings, phenomenology facilitates an in-depth understanding of their academic, social, and cultural encounters, offering insights into their experiences within a short-term international program.

This approach emphasizes the holistic exploration of lived experiences, enabling the analysis of interconnected aspects of participants' lives [23]. It aligns with the study's focus on academic, linguistic, and social integration and the decision-making processes for pursuing graduate studies. By centering on individual perspectives, phenomenology provides a methodological framework that prioritizes depth and context, ensuring the findings authentically reflect participants' unique experiences.

A cornerstone of this methodology is bracketing, or epoché, where researchers set aside preconceived notions to base interpretations solely on participants' accounts [24]. This enhances the credibility and reliability of the findings, allowing for a detailed exploration of identity transformations, acculturation, and academic challenges. These elements collectively offer a comprehensive understanding of the cultural and educational adaptation dynamics experienced by the participants.

In-depth interviews are the primary data collection method, reflecting phenomenology's emphasis on subjective experiences [22]. These interviews provide an open platform for participants to articulate their thoughts, feelings, and perceptions, fostering a nuanced

understanding of their academic and social lives. The semi-structured format ensures flexibility, accommodating participants' diverse backgrounds, motivations, and expectations, and capturing the multifaceted nature of their journeys.

The study adopts a longitudinal design, with three rounds of interviews conducted during the internship's first, third, and sixth months. This design traces the evolution of participants' experiences, highlighting the dynamic processes of adaptation, identity negotiation, and coping mechanisms within the host context [23]. By documenting these changes over time, the study aligns with the interpretive paradigm's recognition of knowledge's socially constructed and context-dependent nature.

Epistemologically, the study operates within an interpretive paradigm, rejecting universal truths and embracing the subjective construction of reality [24]. This paradigm underscores the importance of exploring participants' perspectives to understand their adaptation and integration into new academic and cultural environments. It also challenges traditional concerns about generalizability in qualitative research, emphasizing the value of deep, context-dependent insights into specific populations and circumstances.

Rather than seeking to generalize findings, the study aims to generate a nuanced understanding of the experiences of Colombian students at Purdue University [22]. These insights inform strategies for improving international students' recruitment, retention, and support, particularly from Colombia and South America, by addressing factors that influence their adaptation, integration, and well-being.

By focusing on a specific group's lived experiences, the study offers actionable knowledge for enhancing the inclusiveness and quality of educational programs. It highlights the importance of understanding these students' unique challenges and opportunities, fostering cultural competence, and designing tailored interventions. The study contributes to broader efforts to support diverse international student populations in achieving academic and personal success [23].

While this study relies solely on participants' self-reported narratives, this is consistent with the phenomenological research tradition, which centers on participants' lived experiences and subjective meanings. While valuable in mixed-methods research, triangulation through additional sources such as mentor evaluations or academic records is not essential in phenomenological studies, where the aim is depth over breadth, and interpretation is grounded in participants' own voices. Bracketing was employed throughout the data collection and analysis phases to enhance the credibility of the findings. The study's longitudinal design, with three interviews per participant over six months, further reinforces its trustworthiness by allowing consistency checks and developmental insight.

B. Data Sources and Collection

The participants in this study were undergraduate students from the Bogotá and Medellín campuses of the National University of Colombia, engaged in a 6-month research internship at Purdue University through the UREP-C program. Their selection was based on the specificity of their experiences as Colombian undergraduate engineering students participating in a short-term research internship, representing a distinctive group that facilitates focused exploration.

After obtaining IRB approval, the researcher utilized the existing infrastructure of the UREP-C program for recruitment. The UREP-C Program Coordinator sent personalized email invitations to current participants in Fall 2023. These invitations detailed the study's objectives, potential benefits, and risks. During the first interview, the researcher presented an informed consent document, explaining participants' rights, potential risks, and benefits, emphasizing the voluntary nature of participation. This ensured that students were empowered to make an informed decision about their involvement.

A total of 10 participants were recruited for the study, representing a diverse range of perspectives. This number provided a balance between depth and breadth, allowing for comprehensive exploration while ensuring representation across both campuses, various majors, and genders.

Interview sessions were conducted in a private office to ensure confidentiality and privacy. This setting safeguarded participants' personal information and fostered an atmosphere conducive to open and sincere discussions. Care was taken to prevent unauthorized access or inadvertent eavesdropping, ensuring participants' comfort throughout the process.

The study adopted a longitudinal design, featuring three rounds of interviews conducted during the internship's first, third, and sixth months. A total of 30 interviews were conducted, each lasting approximately one hour. This design traced the evolution of participants' experiences, highlighting their adaptation, identity negotiation, and coping mechanisms within the host context. It also aligned with the interpretive paradigm's commitment to context-dependent and socially constructed knowledge, recognizing the fluid and dynamic nature of human experiences.

C. Data Analysis

All interviews were transcribed, translated from Spanish to English, and reviewed to ensure clarity and accuracy. The transcripts were imported into NVivo software for systematic organization and coding, allowing for a structured and iterative analysis to identify key themes and patterns.

The initial coding round focused on participants' adaptation to the U.S.-based academic and social context. Specific attention was given to language adaptation, ties to Colombia, social-community relationships, and academic and research achievements. These areas were critical as the internship marked the participants' first significant experience in an English-dominant environment where the language of instruction and institutional power was English.

Table 1. Participants and demographics

Pseudonym	Age	City	Major	Intentions to pursue graduate studies
Karina	22	Bogotá	Chemical engineering	No
Mariana	22	Bogotá	Biomedical engineering	No
Martina	23	Medellín	Geological engineering	No
Alberto	21	Bogotá	Industrial engineering	Yes
Andrea	23	Medellín	Environmental engineering	Yes

Dora	22	Medellín	Biological engineering	Yes
Elena	23	Bogotá	Biomedical engineering	Yes
Elvia	23	Medellín	Geological engineering	Yes
Luciano	21	Bogotá	Civil engineering	Yes
Marcela	24	Medellín	Chemical engineering	Yes

A second coding round organized the data into broader conceptual categories aligned with the study's theoretical framework. These categories included identity foundations such as socially distributed resources, historically accumulated experiences, and culturally developed identities. This step provided a deeper understanding of how participants' experiences were shaped by and contributed to their evolving social and academic identities within the host environment.

The third and final coding round refined the analysis by categorizing data into challenges, opportunities, and achievements themes. This round adopted a longitudinal perspective, comparing initial, intermediate, and final interview findings to trace changes over time. An additional layer of analysis was included to differentiate participants who expressed intentions to pursue graduate studies in the U.S. at the end of the internship from those who openly stated they did not plan to return. This distinction revealed variations in their trajectories and adaptation strategies.

The final round aimed to capture the complexities of participants' experiences, including the barriers they encountered, the opportunities they leveraged, and the milestones they reached during the internship, offering a comprehensive view of their transformation across academic, social, and cultural dimensions.

V. FINDINGS

A. Engineering education

Participants' engagement with engineering education during their six-month research internships revealed complex and dynamic processes shaped by academic unfamiliarity, linguistic constraints, and the cultural codes of engineering research in a U.S. context. While the general structure of challenges aligned with prior literature on international student adjustment [4], [10], the specificity of engineering created distinct hurdles and learning opportunities not adequately addressed in studies focused on general academic adaptation.

Upon arrival, participants confronted the disciplinary challenge of translating their theoretical knowledge into practical research competencies within labs that assumed a level of autonomy and initiative not commonly emphasized in Colombian undergraduate engineering curricula. Several reported surprise at the expectation that they contribute meaningfully to lab conversations and research planning from the outset, despite having limited prior exposure to the methodologies or topics. María Camila, for example, described how "I had heard of biosensors, but I had never worked with them. Suddenly, I was expected to help calibrate and design systems I didn't fully understand yet." This sudden immersion demanded the rapid development of engineering-specific competencies, particularly in digital tools like MATLAB, SolidWorks, and Origin, and domain-specific knowledge in thermofluid systems, signal processing, or seismic modeling. Students like Lucas reported that their learning was "a lot by necessity; I had to figure

out how to run simulations even though no one gave me step-by-step instructions." Such experiences align with Esteban-Guitart and Moll's [21] emphasis on identity transformation through contextual demands, illustrating how technical demands in host institutions catalyze the activation and expansion of students' Funds of Identity.

Participants were not typically enrolled in formal coursework. Their acquisition of technical knowledge was thus dependent on informal learning structures: advisor interactions, self-directed study, and peer mentorship. This independence produced both growth and anxiety. Elizabeth noted, "I was working on two different projects. My advisor would give me goals, but not how to get there. It took me weeks to feel like I had any control over my actions." This absence of scaffolding mirrored American expectations of research maturity but clashed with the guided instruction more common in Colombian undergraduate settings. Consequently, students' ability to adapt was linked to their capacity to interpret unspoken expectations and seek knowledge beyond formal channels.

The technical language of engineering—ranging from precise jargon to structured academic discourse—posed another persistent obstacle. While many participants had intermediate or high levels of English comprehension, few had practiced scientific writing or oral communication in academic contexts. In lab meetings and research symposia, participants struggled to formulate questions, articulate findings, and receive feedback clearly. For some, particularly those who reported limited writing instruction in English before the internship, even crafting a coherent paragraph posed a challenge. María Paula reflected, "It's not just knowing what you want to say—it's figuring out how to say it the way scientists here say it. You can have the idea, but if you don't say it right, it sounds like you don't know what you're doing." The evolution of technical language proficiency was closely tied to participants' interactions with mentors and peers. Students who engaged with culturally diverse teams, such as those in labs where English was the lingua franca among Indian, Chinese, and European members, reported greater progress in listening comprehension and adaptive communication strategies [68†María Paula ESP].

Engineering culture also shaped how communication unfolded. Participants quickly learned that American lab environments valued conciseness, directness, and self-confidence in discourse—values that diverged from the deferential or dialogical styles some brought with them. Katerin recounted, "In Colombia, I would wait for the professor to lead. If I don't speak up, nobody knows I'm even working on something." This tacit expectation to self-advocate created emotional strain but also fostered growth. By the third round of interviews, many had internalized these norms. Diana noted, "Now I come into meetings prepared to say: this is what I did, this is what didn't work, here's my next step. At the start, I waited to be asked."

Mentorship emerged as a decisive factor in shaping students' ability to manage these challenges. Consistent with the literature on international students' adaptation [11], students with accessible, engaged mentors reported more confidence in navigating technical challenges and participating in academic culture. However, access to such mentorship varied. Lucas and María Paula indicated that they often went days without substantial advisor interaction, prompting them to rely on doctoral students or online resources to solve technical issues. "Sometimes I just googled my way through a protocol," said Lucas. In contrast, Diana described her advisor as "demanding but always willing to listen," emphasizing how structured feedback helped her "see where my

thinking was off and correct it." Informal mentorship—particularly from PhD students—was a common and often underrecognized support structure. Elizabeth credited one such mentor: "He would explain things in a way that made sense and didn't make me feel stupid. That was key."

The quality and availability of mentorship shaped students' academic self-perception and future aspirations. Participants with positive mentorship experiences were more likely to express interest in graduate studies, identifying the internship as a springboard for academic identity development. These students sought intellectual feedback, practiced presenting their ideas, and viewed critique as a learning process. By contrast, those with minimal guidance often saw mentorship in utilitarian terms—important for completing tasks, but not necessarily for shaping long-term goals. This contrast reinforces the reviewer's point that mentorship, when framed as a formative academic relationship rather than simple supervision, can catalyze deeper transformations in self-concept.

Participants also confronted collaboration structures that differed markedly from their prior experiences. Many had not worked in teams where roles were fluid, feedback cycles were continuous, and cultural negotiation was embedded in technical work. Some thrived under these conditions. Manuela described how "working with people from Nigeria and China wasn't just about the science. It was about learning how they think, how they solve problems." Others struggled. María Camila reflected on a lab where most communication occurred in Mandarin: "Even if I wanted to collaborate, I couldn't join the conversations. It made me feel invisible." These divergent experiences illustrate how lab culture operates as a multilayered space of power, belonging, and knowledge exchange, where language proficiency, cultural awareness, and initiative converge.

Overall, the engineering education experience was shaped by disciplinary content and the interplay of communication styles, institutional expectations, and social positionings within the lab. Students gradually moved from tentative observers to more confident contributors, but this transition was uneven and contingent. The distinction between those pursuing graduate studies and those focused on professional careers was especially salient in how they perceived and utilized these experiences. The former framed technical challenges as preparation for research careers, while the latter often emphasized immediate skill acquisition and professional applicability in Colombia.

These trajectories underscore the importance of acknowledging the specificities of disciplinary acculturation. Engineering is not a neutral backdrop but a socially and linguistically charged context where knowledge is constructed, identities are negotiated, and futures are imagined. Integrating Berry's [18] acculturation strategies, students pursuing graduate paths exhibited integrative approaches, adopting U.S. academic norms while maintaining cultural ties. Those more professionally oriented leaned toward separation or selective assimilation, prioritizing technical gains without full cultural incorporation. Through this lens, the engineering internship becomes more than a training experience—it is a crucible for identity transformation, professional visioning, and reconfiguring what it means to be an engineer across borders.

B. Language difficulties

Language barriers emerged as one of the most pervasive and complex challenges faced by the participants throughout their six-month research internship, exerting a significant influence not only on their academic integration but specifically on their participation in engineering research. While many students arrived with at least an intermediate level of English proficiency, the technical nature of their work and the communicative expectations of U.S. academic culture exposed gaps in general fluency and discipline-specific discourse competence. These linguistic constraints did not operate in isolation; rather, they intersected with disciplinary expectations, lab culture, and mentorship structures that directly affected students' ability to contribute meaningfully to their projects and, ultimately, their sense of legitimacy within the engineering space.

Participants repeatedly described difficulty understanding and using engineering-specific terminology, particularly during the first months. This technical language, often embedded in lab meetings, procedural documents, and software interfaces, exceeded the scope of the general English instruction they had received prior to arrival. María Camila explained: “When they said impedance, signal-noise ratio, or thermal dissipation, I knew what it meant in Spanish. But I would freeze in English because I couldn’t follow how they connected the ideas.” This unfamiliarity created comprehension challenges and a sense of exclusion in fast-paced, expert-driven conversations where there was little room to ask for clarification without risking judgment. Lucas echoed this sentiment, stating: “It wasn’t just vocabulary. It was how they spoke—fast, with assumptions. I often left meetings not fully understanding what I was supposed to do.”

The impact of these language gaps was particularly acute in moments requiring active participation, such as proposing solutions during troubleshooting sessions, writing up results for research posters, or defending choices in experimental design. Several participants reported that the inability to express themselves clearly in these contexts led to hesitancy, silence, or withdrawal from group discussions. Elizabeth observed, “Even when I had something to say, I wasn’t sure I had the words to say it right. I didn’t want to sound stupid in front of the PhDs.” This hesitancy sometimes contributed to supervisors perceiving students as passive or disengaged, a dynamic that compounded students’ feelings of invisibility or underestimation. The resulting loop, where limited linguistic confidence led to reduced participation, reinforcing perceptions of inadequacy, highlighted how language proficiency directly shaped access to intellectual exchange within the engineering research environment.

However, the data also reveal that language challenges were not static. Over time, students developed adaptive strategies that expanded their technical communication capabilities. By month three, many had begun to understand the terminology and the discursive conventions of engineering communication, such as hedging claims, sequencing findings, or contextualizing results, through repeated exposure and practice. Diana noted: “At first, I just listened. But by the third month, I started preparing phrases before meetings. I knew I had to say ‘based on our preliminary results’ or ‘we observed a trend.’ That gave me confidence.” This shift toward greater discursive awareness reflects what Esteban-Guitart and Moll [21] describe as expanding Funds of Identity through situated practice, where language proficiency becomes a cognitive and cultural resource.

The cultural dimension of language also emerged clearly in students' reflections. Several participants articulated how their accent, tone, and hesitancy were perceived by others, sometimes reinforcing implicit hierarchies within the lab. María Paula recalled: "Sometimes I felt I had to prove twice that I knew what I was doing, because of my accent. People would slow their speech or explain basic things, making me feel small." Others, like Angelly, used their awareness of cultural communication styles to their advantage, adopting concise and assertive phrasing modeled by American peers: "I learned to say things like 'I recommend this approach' instead of 'maybe we could try.' It made a difference." These shifts reflect Berry's [18] integration strategy, where students adapt to host norms while retaining awareness of their own cultural voice.

Language barriers were particularly salient in writing, especially when students were tasked with producing abstracts, posters, or lab reports. Few had experience composing technical texts in English; several admitted relying on tools such as Grammarly or translating content from Spanish drafts. Eloísa described the writing process as "more about survival than expression," while Elizabeth said: "I would write the sentence in Spanish in my head, translate it, then fix the grammar. It took forever." While these strategies enabled completion of tasks, they also underscored the cognitive load and temporal demands that linguistic adaptation imposed on students. Moreover, students often struggled to improve beyond basic correctness without structured feedback, missing opportunities to refine rhetorical clarity or precision. This barrier was particularly relevant for those aspiring to graduate studies, who identified scientific writing as a current limitation and a critical future competency.

Differences in how participants approached and experienced these linguistic challenges were closely tied to their future academic intentions. Students interested in pursuing graduate studies generally viewed language acquisition as essential to their academic identity formation. Despite initial discomfort, they actively sought feedback, practiced presentations, and engaged in extended discussions. Lucas reflected, "Even if it was hard, I kept talking. I knew this was part of becoming the researcher I want to be." By contrast, those not intending to pursue graduate studies tended to prioritize intelligibility over fluency or formality, often framing English as a tool rather than a disciplinary discourse. Mariana explained, "I needed people to understand my process, my results. That's what mattered. I wasn't trying to sound native." These distinctions align with participants' divergent Funds of Identity, with the former group investing in linguistic capital tied to academic aspirations and the latter leveraging practical communication as sufficient for professional relevance.

The intersection of language and collaboration was also critical. In labs where English was a second language for most team members, such as those dominated by Mandarin or Hindi speakers, participants reported an additional layer of complexity: decoding unfamiliar accents and managing cross-cultural pragmatics. While these environments occasionally hindered communication, they created solidarities across linguistic boundaries. Manuela noted, "We all had accents, so we were patient with each other. That helped a lot." This shared experience fostered empathy and highlighted the relational potential of language learning when framed as mutual accommodation rather than unilateral adaptation.

Ultimately, the role of language barriers in shaping participants' engineering research experience cannot be disentangled from broader questions of access, authority, and legitimacy. Linguistic proficiency was not simply a matter of vocabulary, but a conduit for epistemic participation, determining who could ask questions, offer critiques, and be recognized as a credible knower within the lab. As such, the evolution of students' language use over time reflected deeper shifts in their academic identity and sense of belonging. For many, this transformation was uneven and ongoing, shaped by their goals, social contexts, and access to mentorship. However, across profiles, the data make clear that language was both a barrier and a catalyst—a challenge to overcome and a medium through which students came to see themselves as contributors to global engineering knowledge.

C. Social and community relationships

At first, many expressed insecurity and difficulty connecting with native speakers due to language and cultural barriers. However, as they progressed, they developed strategies to overcome these obstacles, such as participating in activities organized by the university, interacting at multicultural events, or seeking emotional support from closer groups, such as other international students or Latino communities. This learning process was key to strengthening their ability to establish meaningful connections and feel part of a broader community.

The group that expressed their intention to pursue graduate studies in the United States showed a greater effort to integrate into the academic and multicultural community, which allowed them to build valuable networks for their professional and personal development. Andrea, for example, highlighted how her interactions in the laboratory were transformed into opportunities for both technical and social learning: "Talking with my classmates about our cultures while we worked helped me feel like I was not only learning about science, but also about the world." These experiences demonstrate how the resources available at Purdue, such as organized activities and access to local communities, facilitated these participants' integration into the social context.

On the other hand, the group that did not plan to continue graduate studies in the United States maintained a more selective approach to their social interactions, prioritizing relationships that offered them emotional support and resonated with their own cultural identities. Martina, for example, expressed that although she made an effort to participate in social events, she found greater comfort in relating to Latino peers: "Talking to people who understood my language and my culture was a relief. I didn't need to explain everything, it just flowed." This group used their interactions to reinforce their sense of belonging to their cultural community while selectively adopting elements of the American environment.

Those with backgrounds in international programs or multicultural contexts adapted more quickly and frequently sought out interactions that enriched their experience. Furthermore, cultural identities were crucial in how participants perceived and managed their relationships. For some, maintaining a connection to their language and culture was essential to feeling comfortable in a foreign environment. In contrast, others saw multicultural interactions as an opportunity to redefine aspects of their personal and professional identity.

Beyond being a space for technical and scientific work, the laboratory environment became a microcosm of cultural and professional negotiation, where participants had to balance adaptation and self-preservation. While some embraced the challenge of integrating into a diverse academic setting, others struggled with the unspoken social hierarchies and implicit expectations that shaped interactions in the lab. For many, the initial weeks were marked by a silent observation period, where they carefully assessed who to approach, how to ask for help, and when to assert their ideas without seeming intrusive. Those who adapted most successfully learned to decode the unwritten rules of academic engagement, such as when to challenge a senior researcher's perspective, request feedback without appearing unprepared, and the subtle dynamics of turn-taking in discussions. However, this adaptation was not always seamless—some faced microaggressions, unconscious biases, or the frustration of being overlooked in conversations dominated by more confident speakers. The tension between integration and self-assertion was particularly pronounced for those who wished to pursue graduate studies, as they recognized that professional success depended on technical skills and their ability to navigate and influence social and intellectual networks within the lab. Conversely, those who did not plan to continue in academia approached these interactions more pragmatically, seeking collaboration when necessary but prioritizing environments that provided emotional security. In this way, the lab experience was not merely about conducting research—it became a training ground for cultural agility, professional resilience, and the strategic management of identity in highly structured academic spaces.

D. Connections in Colombia

Participants showed remarkable learning in adjusting their expectations regarding the frequency and depth of interactions with their families, partners, and friends in Colombia. Initially, several participants expressed feelings of isolation and homesickness, particularly during the first weeks of their stay, when the novelty of the environment exacerbated their disconnection from family ties. However, towards the end of their experiences, many highlighted how they established routines to stay in touch, which allowed them to feel the emotional support necessary to face the challenges of everyday life. Acculturation in this context did not imply a disconnection from their roots, but rather a reconfiguration of their ties, learning to balance the demands of their life at Purdue with their family and social identity in Colombia.

In the group that intends to continue graduate studies in the United States, greater proactivity was evident in establishing sustainable communication systems with their loved ones. Elena, for example, noted that although she initially felt overwhelmed by the distance, she found solace in weekly video calls with her mother: "Talking to my mom every Sunday reminded me that even though she was far away, she was always with me. That connection gave me the strength to keep going." This group also highlighted how their families offered them emotional support, celebrated their achievements, and motivated them to continue pursuing their goals. These experiences reflect how technological resources became crucial to maintaining strong and meaningful relationships, even in a context of high academic demands.

On the other hand, the group that does not plan to pursue graduate studies in the United States showed a stronger connection with their family and social environment in Colombia, prioritizing the preservation of these ties as an essential part of their identity. Manuela explained that her family was a fundamental pillar during her stay: "Every time I spoke to my dad, he reminded me

how important it was to come home and share what I was learning. That helped me stay connected to who I am." This group tended to use their relationships in Colombia as an emotional anchor, reinforcing their sense of belonging and connection to their roots.

VI. DISCUSSION

A. Discussions

The findings from this study on the research internship at Purdue reveal how the interaction between lived experience and available resources shaped participants' distinct processes of adaptation and identity development. Through the lens of Berry's acculturation theory [18], two predominant strategies emerged: integration and separation. Participants who aspired to pursue graduate studies in the United States tended toward integration, adopting academic and communicative norms from the host context while maintaining strong ties to their cultural roots. This group benefited from key institutional resources, including access to academic mentorship, multicultural environments, and technical tools that facilitated their insertion into the international scientific community. Their acculturation was evident in their ability to participate in technical discussions, engage in diverse social networks, and sustain a bicultural identity aligned with their academic aspirations. However, this strategy was not without emotional tension, as they faced the challenge of maintaining relationships with their families and home communities while striving to succeed in a demanding academic setting.

In contrast, participants without plans to pursue further academic studies adopted strategies closer to separation. While actively engaged in their research responsibilities, their interaction with the host culture remained mostly functional or instrumental, with no significant internalization of American academic values or practices. Their emotional and symbolic connection to Colombia remained central, and they experienced the research internship as a temporary opportunity for professional growth rather than a transformative entry point into global academic life. This strategy was not indicative of rejection but rather a deliberate preservation of cultural continuity while making practical use of the resources available.

From the perspective of Funds of Identity [20], the study illustrates how students mobilized diverse resources—linguistic, academic, cultural, and emotional—to define and adapt their identities during the internship. Those aiming for graduate school drew heavily on academic and linguistic identity funds. They leveraged prior research experience, intermediate or advanced English skills, and autonomous learning dispositions to engage effectively in highly technical and multicultural settings. In these cases, English was re-signified—not merely as a communication tool but as a constitutive element of their emerging academic identity. Language use became a professional practice, internalized not without effort, but with a clear orientation toward mastery of technical and scientific discourse. For these students, linguistic and cultural difficulties were not merely obstacles but formative challenges that shaped their sense of agency and competence.

In contrast, students who did not envision an international academic trajectory activated different identity resources. Their narratives emphasized emotional ties to their roots, the importance of maintaining familial connections, and the intention to return to Colombia equipped with skills applicable to the local context. English was used functionally, prioritizing intelligibility rather

than fluency or discursive sophistication. Their social support networks were often anchored in Spanish-speaking or Latinx communities, providing emotional containment and cultural resonance. In these cases, professional identity did not expand toward a global orientation but was reinforced through a localized lens, affirming their role as development agents within Colombia.

Self-Determination Theory (SDT) further enriches this analysis. Graduate-oriented participants demonstrated progressive development of the three pillars of SDT: competence (e.g., mastering technical tools and scientific English), autonomy (e.g., navigating lab environments independently), and relatedness (e.g., forming meaningful relationships with mentors and integrating into multicultural academic spaces). Meanwhile, participants with a local professional orientation also displayed autonomy in their efforts to preserve cultural identity and pursue goals aligned with personal values. Their sense of relatedness was expressed through strong connections with peers and family in Colombia, which helped them navigate the internship without feeling pressured to alter their core identity.

The findings show that identity construction and acculturation are not linear or uniform processes. They are mediated by individual aspirations, prior experiences, and the nature of the student's engagement with their new environment. Institutional structures, research group culture, cultural diversity within labs, and access to mentoring all operated as enabling or filtering mechanisms depending on the student's orientation. Those with previous international experience or strong academic preparation managed the demands of identity negotiation more fluidly, whether through integration or separation. For others, the internship served more as a space for exploration than transformation, often reaffirming their belonging to the local context.

The short duration of the program further intensified this negotiation process. Students faced a compressed period of cultural, linguistic, and professional adaptation in six months. Every small decision—whether to speak up in a lab meeting, how to structure an English-language report, how to request help without seeming unprepared, or whether to attend a lab event or call home—became a site of negotiation. These decisions were not just about adaptation; they were moments of self-definition.

B. Limitations

This study presents several limitations, rooted primarily in its design and scope, which shape how its findings should be interpreted and applied. The research focused on a specific population: ten undergraduate engineering students from Colombia participating in a short-term research internship at Purdue University. While small, this sample was intentionally selected based on the principles of phenomenological inquiry, where depth of engagement and longitudinal exploration take precedence over breadth or representativeness. The three rounds of interviews provided rich, temporal insights into participants' evolving experiences, allowing for developmental analysis of language acquisition, academic adaptation, and identity transformation. As such, the study does not aim for statistical generalizability but rather for *analytical generalization* and *transferability*. Readers may assess how these insights apply to comparable populations, such as Global South students, STEM interns, or short-term mobility participants, based on the contextual and theoretical richness provided.

The absence of triangulated data sources—such as mentor evaluations, academic records, or participant observations—may be a limitation when evaluated from a positivist or mixed-methods lens. However, in phenomenological research, where the goal is to understand *lived experience from the participant's perspective*, using self-reported data is appropriate and central. Bracketing techniques were employed throughout data collection and analysis to mitigate researcher bias, and the longitudinal design enabled consistency checks across interviews. Still, future research could expand the data corpus to include mentor perspectives or co-analysis of students' research products (e.g., lab reports, presentations) to complement the emic account presented here.

Another limitation lies in the specificity of the context. The experiences documented reflect the unique academic and cultural ecology of Purdue University and the structure of the UREP-C program. While this environment offers valuable insights into short-term STEM mobility, it may differ significantly from other U.S. institutions or experiences in non-engineering fields. Nonetheless, the processes of navigating disciplinary language, lab culture, and mentorship structures identified in this study are not exclusive to Purdue and may resonate across similar research settings. Likewise, the engineering lens brings distinct challenges, such as mastery of technical jargon, adaptation to self-directed lab work, and competence performance in a linguistically and culturally demanding environment, which may extend to other technical or applied fields.

A further limitation is the variability in participants' pre-existing resources. Differences in English proficiency, academic preparation, and prior research experience shaped how students responded to the host environment. While the study recognizes the role of these background factors, it did not systematically compare them across participants due to the small sample. Future studies may benefit from clustering participants based on prior international exposure, language training, or socio-academic trajectory to better understand how these variables influence acculturation strategies and post-internship aspirations.

Lastly, the study does not address long-term outcomes. Although the findings suggest that the internship played a pivotal role in shaping participants' academic and professional identities, they do not reveal whether students eventually pursued graduate studies, changed career paths, or maintained international ties. Longitudinal follow-up would offer valuable insight into how short-term academic mobility translates into long-term educational or professional decisions, particularly in the Global South context.

C. Recommendations

The findings of this study point to several actionable strategies that host and sending institutions can implement to improve the short-term academic mobility experiences of international students, particularly those from underrepresented regions such as South America. Rather than offering broad, generic recommendations, we propose interventions targeted at specific areas of challenge that emerged from participants' narratives: language barriers, lab integration, and the dynamics of mentorship.

First, institutions should invest in discipline-specific language preparation programs tailored for incoming research interns. These programs should go beyond general English instruction to include targeted modules in technical vocabulary, research writing, and laboratory discourse practices. A pre-arrival online course or an early-semester workshop series could introduce students to the structure of lab meetings, expectations around scientific argumentation, and common technical genres such as abstracts and posters. Such programs should also demystify the pragmatics of engineering English—how to frame uncertainty, express disagreement, or pose questions, which participants like María Paula and Diana only acquired through months of trial and error. Drawing on Berry's [18] notion of integration, such linguistic preparation supports students' ability to adopt host language norms while retaining confidence in their communicative identities. Furthermore, including multilingual glossaries or bilingual technical materials may facilitate early-stage comprehension and allow for faster lab onboarding.

Second, research labs hosting international interns should adopt mentorship protocols for short-term, cross-cultural exchanges. Findings suggest that informal mentorship from PhD students played a decisive role in students' academic adaptation, yet this support was uneven and often accidental. Institutions should formalize this by assigning trained peer mentors—doctoral students or postdocs who can provide academic scaffolding and cultural orientation. Mentors should receive guidance on supporting students from linguistically and culturally diverse backgrounds, emphasizing explaining implicit expectations, offering feedback in accessible language, and promoting autonomy rather than dependence. This mentorship model aligns with Esteban-Guitart and Moll's [21] Funds of Identity, recognizing that students' learning is maximized when supported by distributed social and institutional resources.

Third, labs should adopt culturally responsive collaboration practices. Students often described lab cultures as highly hierarchical and fast-paced, with implicit codes that favored assertiveness, speed, and familiarity with dominant norms. These structures marginalized students who were still adjusting to English or were unfamiliar with academic hierarchies. In response, labs can implement small but meaningful changes such as setting communication norms during onboarding, including rotation-based turn-taking in meetings, and encouraging written follow-ups to verbal discussions. Lab heads can also normalize questions and hesitation in research dialogues, legitimizing students' voices in transition. For students leaning toward integration, these structures provide a safe environment to rehearse their professional identities; for others oriented toward separation or selective assimilation, they lower participation stakes while still promoting access.

Fourth, institutions should design bridging programs that link pre-departure preparation with post-return reintegration. Participants reported that many challenges could have been mitigated by more realistic expectations and prior exposure to U.S. lab cultures. Sending institutions could prepare students through mock lab scenarios, interdisciplinary research projects, or English-for-specific-purposes courses grounded in real internship materials. Upon return, structured reflection activities—such as re-entry workshops or debriefing seminars—can help students translate their international learning into academic and professional capital at home. These mechanisms allow students to process the identity shifts they experienced, reinforce their Funds of Identity, and articulate their growth to future academic or professional audiences.

Finally, host institutions must move beyond viewing international interns as temporary visitors and instead see them as co-constructors of knowledge in transnational research spaces. This requires shifting from a deficit view, focusing on fixing students' limitations, to an asset-based approach that values the diverse perspectives and skills students bring. One way to operationalize this is to create platforms where interns can present their projects in mixed-audience symposia, including domestic and international faculty and students. Such events validate participants' contributions, allow for feedback across cultural lines, and encourage the development of cross-linguistic communication strategies.

D. Future directions

Future research should explore how students' identity trajectories unfold beyond the short-term mobility experience by employing longitudinal follow-up studies that extend one to three years after program completion. These studies could examine whether participants who initially expressed interest in graduate studies abroad follow those plans and how their academic identities evolve upon reintegration into their home countries or transition into global academia. This line of inquiry would contribute to understanding the long-term affordances and constraints of short-term academic mobility, particularly regarding career decision-making, epistemic self-confidence, and academic capital accumulation in students from the Global South. Mixed-methods designs could integrate post-internship interviews with institutional data (e.g., admissions, publication records, or graduate enrollment) to triangulate self-reported outcomes and expand the analytic scope beyond individual narratives.

Future studies should also further theorize how identity and adaptation processes vary across disciplinary and sociolinguistic contexts. For example, research might compare how engineering, natural sciences, and humanities students experience lab culture, technical communication, and mentorship differently across host institutions with distinct expectations and support structures. Additionally, attention should be paid to how language ideology and communicative hierarchies shape participation in multilingual academic spaces—an issue that was particularly salient in labs where English was a second language for most team members. Comparative studies that include students from other Latin American countries and those who study in countries other than the U.S. could illuminate how regional, linguistic, and cultural factors mediate the interplay between acculturation and identity. Such work would enhance the transferability of these findings and inform the design of context-sensitive, equity-oriented interventions across international education programs.

VII. REFERENCES

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