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Exploring transversal competencies in engineering students through international experiences

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Well-rounded professionals must have competencies that adapt their expertise to contribute to future advancements. Beyond technical prowess, skills such as critical thinking, teamwork, communication, leadership, management, and entrepreneurship are essential for the modern workforce and solving twenty-first-century problems. Lifelong learning is a fundamental educational principle that prepares individuals to acquire knowledge and skills at any stage. With this interest in mind, higher education institutions pursue abroad study programs to involve students in different learning opportunities. Stepping outside familiar environments immerses individuals in new challenges, fostering a rich learning experience that promotes the development of critical competencies shaped by a global perspective. This research analyzes the competencies students developed according to their educational model and during their experience abroad. Data were collected through a 43-question semi-structured interview with 13 undergraduate engineering students experiencing an abroad study program. Participants conducted a personal assessment to reflect on their enhancement of competencies through personal and academic performance. The analyzed competencies correlate to those defined in the Tec21 Educational Model, a model designed by Tecnologico de Monterrey in 2019, in which the participants of this research are enrolled. The model defines seven competencies that every degree must develop: self-knowledge and management, innovative entrepreneurship, social intelligence, ethical and civic engagement, reasoning for complexity, communication, and digital transformation. Results indicate that the participants mainly developed competencies in reasoning for complexity, social intelligence, and communication. Such skills are essential for tackling global challenges, as they demonstrate the ability to generate creative solutions, communicate ideas effectively, and foster meaningful collaboration. Conversely, the competencies of digital transformation and ethical and civic engagement were less developed. These findings suggest areas for improvement within the Tec21 model, emphasizing the need to cultivate individuals aware of their societal impact and proficient in applying technological tools effectively.

KEYWORDS

higher education, internationalization, educational innovation, transversal competencies, future skills, challenge-based education, lifelong learning, continuous education

1 Introduction

The world is constantly changing and evolving. With the rapid pace of technological and social advancements, engineering professionals must develop higher adaptability to keep up with modern challenges (Allain and Rabb, 2023). It is widely acknowledged that conventional educational models, which rely on short-term memorization, are inadequate for preparing graduate students for successful professional practice (Williams, 2015). Therefore, it is crucial to equip students with tools that foster higher levels of cognition and a capacity for lifelong learning. As Williams (2015) emphasized, "Genuinely acquired deep knowledge will be internalized to create personal understanding." When knowledge is deeply ingrained, graduates can develop lifelong learning abilities. This skill is essential to identifying situations in a dynamic world and adapting acquired knowledge to contribute to future advancements (Kruchten, 2015).

Engineers, in particular, must constantly evaluate and develop skills to meet the demands of the twenty-first century (Chadha and Heng, 2024). However, besides technical expertise, graduates across all disciplines need abilities that extend beyond their specific fields (Hansen and Bertel, 2023). Multidisciplinary approaches, especially in engineering, are essential to solving modern-day situations (Allain and Rabb, 2023). In light of global issues and events, engineers must be equipped with more professional skills than they did two decades ago (Chadha and Heng, 2024).

Although technical prowess is needed to form a successful engineer, other professional competencies are required to perform correctly in the workplace and society. These competencies encompass creative and critical thinking, teamwork, effective communication, leadership, project management, and entrepreneurship, all of which are vital to cultivating well-rounded professionals (Allain and Rabb, 2023; Chadha and Heng, 2024).

1.1 Lifelong learning in higher education

Lifelong learning is the ongoing process throughout an individual's lifetime, allowing people to acquire knowledge and develop new skills at any point in their lives (Håkansson Lindqvist et al., 2024). This ability enables learners to adapt to evolving circumstances by restructuring their way of thinking to provide innovative solutions to complex problems (Alt and Raichel, 2022). At the core of the lifelong learning paradigm is enhancing individuals' knowledge and skills through active participation in learning activities. According to Pillay (2002), learners should be positioned at the forefront of the educational journey. Lifelong learning rests upon two key pillars: a vertical one, acknowledging that learning occurs not only in youth but also throughout one's lifetime, and a horizontal one, recognizing that learning happens not only within formal educational institutions like universities but also in workplaces, communities, social settings, and through non-formal individual study (Schuetze and Slowey, 2000).

The importance of lifelong learning for the future is underscored by the UNESCO Institute for Lifelong Learning (2022), as evident in the United Nations 2030 Agenda for Sustainable Development and its Sustainable Development Goals (SDGs). Furthermore, international organizations such as the [The Organization for Economic Cooperation and Development (OECD), 2009] and the Council of Europe endorse lifelong learning as a fundamental educational principle, equipping individuals with the skills necessary to confront evolving challenges and shape a desirable future.

The competencies required for lifelong learning act as the cornerstone for education and work, nurturing a diverse set of skills essential in a rapidly changing world. The COVID-19 pandemic has accelerated shifts in labor market demands, underscoring the urgent need for individuals to swiftly adapt their skills to meet evolving requirements (OECD, 2021). In response, educational institutions were compelled to modify their teaching strategies and curricula to adapt to distance learning, integrating digital tools to sustain the educational process (Songu, 2022). This shift underscored the critical role of lifelong learning, as students were placed at the center of their learning journeys, requiring them to acquire new or enhance existing skills (Deveci, 2022). The analysis of global trends highlights the close relationship between lifelong learning and twenty-first-century competencies (Collins, 2009; Güven, 2021). However, research by Du Toit et al. (2016) reveals a persistent gap between the skills university graduates possess and those demanded by employers, stressing the importance of addressing this disparity.

Through higher education, students can engage in programs tailored to cultivate lifelong learning skills (Håkansson Lindqvist et al., 2024), while institutions may also offer continuing education initiatives to complement academic pursuits and reinforce various competencies (Güven, 2021; Håkansson Lindqvist et al., 2024). Curricula and academic content should be designed to facilitate student engagement in enriching learning experiences and provide avenues for ongoing development and training throughout their careers and lifetimes (Soares and Dias, 2019). As higher education institutions adapt to meet these needs, new approaches are needed to close the gap between the skills graduates possess and those demanded by the workforce.

1.2 Tec21 educational model

In 2019, Tecnologico de Monterrey (Tec) introduced the Tec21 Educational Model (TEM) to address lifelong learning challenges. The base of this initiative was designed to foster undergraduate students with a range of disciplinary and transversal competencies (Olivares et al., 2021). As defined by the TEM, competency is a conscious integration of knowledge, abilities, attitudes, and values to overcome structured and uncertain situations involving mental processes of higher order (Instituto Tecnológico y de Estudios Superiores de Monterrey, 2018). Disciplinary competencies are dependent on the career in which the student is enrolled, encompassing the knowledge and abilities necessary for the specific field. On the other hand, transversal competencies are defined as the skills that must be developed in every undergraduate program, regardless of the career of choice (Instituto Tecnológico y de Estudios Superiores de Monterrey, 2018).

The TEM seeks to enhance seven transversal competencies: (1) self-knowledge and management, (2) innovative entrepreneurship,

(3) social intelligence, (4) ethical and civic engagement, (5) reasoning for complexity, (6) communication, and (7) digital transformation (Tapia Gardner, 2021). Each of these competencies is defined by Tecnologico de Monterrey, as observed in Figure 1.

Amidst the challenges posed by the COVID-19 pandemic, one notable silver lining was the accelerated adoption of digitalized teaching methods. Numerous studies underscore the significance of internationalization at home (Thier et al., 2024; Rivas and Espinoza, 2023), mainly through the increasingly popular Collaborative Online International Learning (COIL) methodology (Simões and Sangiamchit, 2023). Furthermore, among the competencies extensively studied are intercultural competencies (Wolff and Borzikowsky, 2018; Diego-Lázaro et al., 2020; Meaux et al., 2021), global citizenship (Thier et al., 2024; Aktas et al., 2017), professional competencies (Marques et al., 2014; Witkowsky and Mendez, 2018; Meaux et al., 2021), and language literacy (Van Maele et al., 2016; Gruber et al., 2023). However, recent literature on soft skills or transversal competencies within internationalization experiences appears scarce (Sisavath, 2021; Brennan et al., 2023). Hence, this study serves as a potential pioneering effort in this area.

To foster students' different learning experiences and enrich academic opportunities, students in the TEM can participate in international programs in the semester before graduating. Participants reside in a foreign country for an entire academic semester while enrolled at a host university abroad during this period. By interacting with people from different backgrounds and experiencing living independently for the first time, students can reflect on their capabilities, areas for improvement, and personal growth.

1.3 Internationalization in higher education

Internationalization in higher education entails actively integrating international and intercultural dimensions into all aspects of academia, including teaching, research, and services (Knight, 2004; Kosmützky and Putty, 2016). This approach has been pivotal in higher education policy for the past three decades (de Wit, 2020) and is recognized as crucial for its advancement in the twenty-first century (Klopper, 2020). It is best understood as a dynamic and proactive response by universities to enhance intercultural relations across borders (De Wit, 1999). Commonly associated phenomena with internationalization include heightened knowledge transfer, physical mobility, international collaboration, and education and research within a global context (Tight, 2021).

Individual mobility represents the foremost aspect of internationalization, defined as the physical movement of students, faculty, and staff to engage in learning, research, and collaborative endeavors (Buckner et al., 2022). Promoting opportunities to study abroad during short periods has been one approach of higher education institutions (HEI) to implement highly valuable experiences to develop lifelong learning competencies.

The significant rise in student numbers over the last decade underscores the importance that many universities have placed on internationalization as a fundamental aspect of their growth (Ge, 2022). As per the 5th Global Survey on Internationalization of Higher Education conducted by the International Association of Universities (IAU), over 90% of institutions include internationalization in their mission or strategic plans (Marinoni and de Wit, 2019).

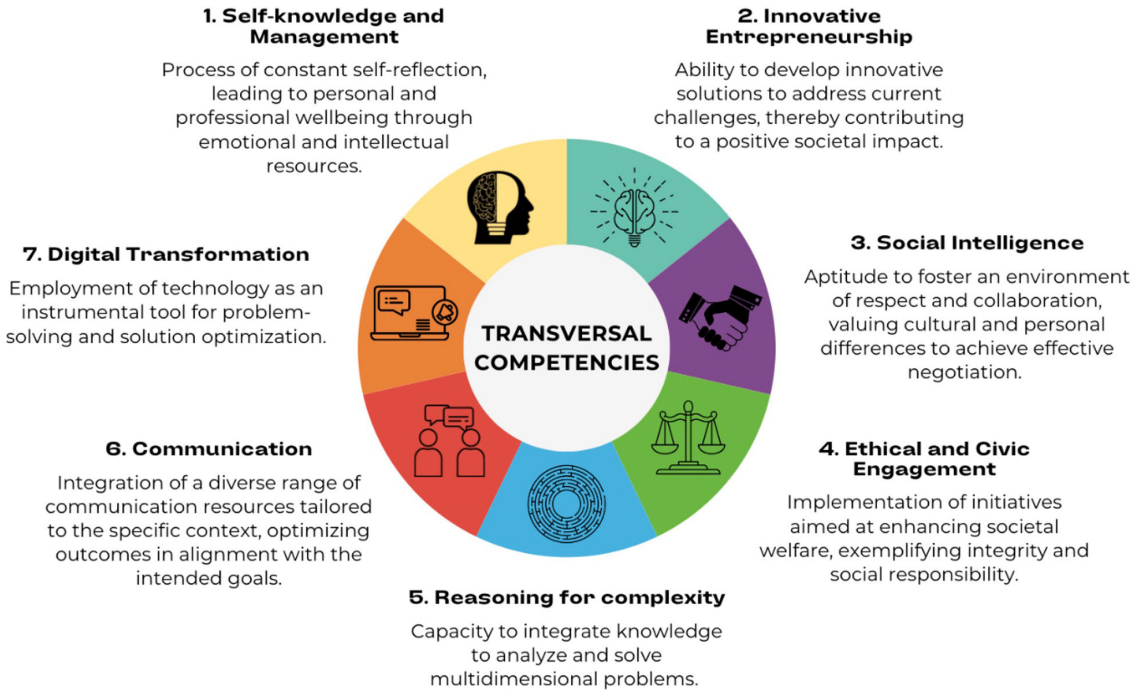

FIGURE 1
Seven transversal competencies as defined by the Tec21 Educational Model.

Internationalization practices cultivate an enriched learning environment, allowing faculty and students to step beyond their familiar contexts and develop a global perspective (Drake et al., 2015). These experiences facilitate encounters, interactions, and experimentation, solidifying learning within intrapersonal and interpersonal realms. Moreover, they encourage participants to develop cultural sensitivity and tolerance competencies (Braskamp et al., 2009), gaining insights into diverse values, behaviors, and interactions (Datar et al., 2010). Additional notable benefits include fortifying international collaboration, enhancing capacity, and enhancing teaching and learning quality (Buckner et al., 2022).

1.4 Internationalization after COVID-19

The COVID-19 pandemic caused significant disruption to internationalization projects, particularly evident in the measures and policies implemented to curb the virus's spread, such as border closures that hindered international mobility (Mok et al., 2021). In response to the global health crisis, universities have had to adapt and innovate, embracing virtual mobility through information technologies (Romero León and Lafont Castillo, 2022). HEI implemented "internationalization at home" projects, which allowed for online collaboration with foreign universities, surging a possibility of internationalization that surpassed the limitations of the pandemic (Chans et al., 2023). However, as we transition back to in-person education, reflecting on the lessons learned during this period and prioritizing face-to-face interactions whenever possible while maintaining the flexibility and innovation gained during the pandemic is essential.

2 Objective

This research seeks to evaluate the enhancement of students' competencies through an educational model tailored with a challenge-based approach. Additionally, the aim is to analyze students' outlooks on their personal and academic growth by comparing the experiences at their home institution and the international university in which they enrolled.

The following questions guided the research:

1. What are Tecnologico de Monterrey students' perceptions regarding the competencies they have developed throughout their academic journey via the TEM framework?
2. How do students perceive the competencies they acquired while studying abroad at foreign universities?

The data presented analyze the significance of preparing engineering professionals with competencies that adapt to a rapidly evolving field. An educational model based on the development of competencies can be tailored to continuing education, as it supplies the skills necessary to respond to the problems and demands of the modern world.

3 Methodology

3.1 Study design and data collection

The study employed a qualitative methodology to investigate students' perceptions of the competencies cultivated during their international endeavors. This cross-sectional study was conducted in November and December 2022 with thirteen engineering undergraduates from Tecnologico de Monterrey who participated in international study programs.

Participants were selected through convenience sampling, as they were enrolled in the 5-week capstone course, Immersion Week 18, as part of their semester's culmination. This course prompts students to reflect on their academic journey thus far, chart a course for the upcoming semester, and reflect on their experiences. The convenience sampling approach ensured that all participants shared relevant contextual experiences, aligning with the study's focus on the competencies gained along their Tec21 experience and during their time abroad.

Data were gathered through semi-structured interviews performed remotely through video conference using Zoom during the last month of their program abroad. Participants were encouraged to provide honest responses. Each interview session lasted between 45 and 60 min and was conducted in Spanish, the researchers' and participants' native language. By sharing his contact number and email address, the researcher invited the participants to reach out if they desired access to the research results. Interviews were video recorded with previous consent to review further and transcribed verbatim. All recordings were checked against transcripts to verify clarity and accuracy.

3.2 Procedure

The researcher asked each student to respond to 43 questions regarding their perspectives on the internationalization experience. The questions focused on personal and academic performance or their perceptions of the TEM as observed in a different university and educational model. Other questions were designed to inquire about the progress and development of the seven transversal competencies while comparing knowledge, skills, attitudes, and values with their international peers.

3.3 Analysis

The qualitative analysis employed two distinct methods: thematic and text mining (Figure 2), for methodological triangulation of our findings, ensuring the credibility, objectivity, and validity of the results. While thematic analysis requires active researcher involvement in data interpretation, text mining minimizes researcher bias by relying on algorithms.

In the thematic analysis, interview questions were categorized into specific and general types based on their objectives. A coding framework was established, clearly defining categories for each of

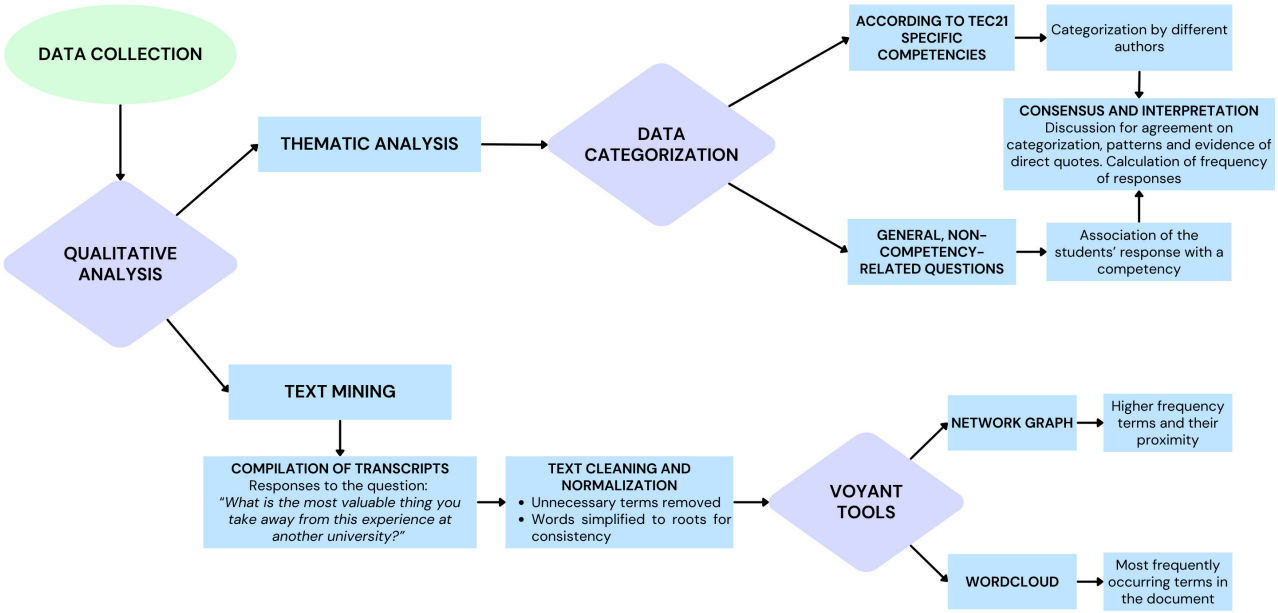

FIGURE 2
Flowchart illustrating the methodology employed through thematic analysis and text mining.

the Tec21 competencies and their criteria on the evidence of their development or proficiency to guide the analysis. Raters underwent a training process to ensure a consistent understanding of the coding framework and to minimize subjective interpretation. A pilot test was conducted with a subset of the data, allowing for the resolution of any initial doubts and the refinement of the coding scheme.

The specific interview questions were designed to evaluate the development level for each of the seven competencies. Data were organized into tables summarizing students' responses, highlighting recurring themes. For instance, the question, "*How do you perceive your innovative entrepreneurship skills compared to those of your peers in the subjects you are studying (specifically in terms of being proactive and innovative)?*" was aligned with the innovative entrepreneurship competency. Responses to this question were categorized based on students' perceived skill levels relative to their peers, with options such as lower, higher, equal, not perceived, or unable to demonstrate.

Additionally, Supplementary Tables were generated to analyze broader questions exploring the presence of competencies in students' experiences. These general questions included (1) perceptions of differences with new classmates, (2) advantages or disadvantages of working within a challenge-based model, and (3) perceived differences in abilities, attitudes, or values. Responses were classified according to their alignment with one or more competencies defined by the Tec21 model (Figure 1).

Before writing the results, two authors contrasted their coding decisions in depth until consensus was achieved. This collaborative approach ensured alignment in the themes' interpretation, enhancing the findings' reliability and trustworthiness. Direct quotes from the interview transcripts were selected and included to illustrate specific instances of competency development.

Voyant Tools was employed as a text mining technique software to analyze the transcriptions of the responses to the question, "*What is the most valuable thing you take away from this experience at another university*?" This tool facilitates visual and analytical representations of the most relevant aspects of the *corpus*. The transcribed responses from each participant were compiled into a document for a revision process, where unnecessary terms that did not aid in text analysis were eliminated. Additionally, words were simplified to their roots to ensure consistency throughout the text. In this research, two visual aids offered by the software were utilized: a word cloud, which highlights frequently used words, and a network graph, which illustrates connections among key terms and their commonly associated words.

3.4 Ethical considerations

This study followed the principles of the Declaration of Helsinki (World Medical Association, 2013) and the Belmont Report (National Commission for the Protection of Human Subjects of Biomedical Behavioral Research, 1979). All procedures were conducted in strict accordance with the applicable guidelines and regulations. All students were explicitly informed of the voluntary nature of their participation, the confidentiality of their responses, the absence of any incentives for participation, and their right to withdraw voluntarily at any point.

The research methodology exclusively utilized online interview measurements, avoiding sensitive content for participants. Furthermore, the study abstained from collecting biological samples or implementing experimental interventions. As a result, these precautions categorize the study as low risk.

4 Results and discussion

The 13 participants involved in this study were enrolled in an international program for a single academic semester. All individuals were Mexican students from Tecnologico de Monterrey (Tec), comprising eight women and five men, aged between 21 and 22. They were in their seventh semester of engineering studies. Eleven participants resided in European countries such as Spain, Germany, Sweden, the United Kingdom, and the Netherlands. The remaining two stayed in Latin American countries, specifically Argentina and Chile. Each student attended a different institution based on location, with two enrolled in private universities (Students 1 and 2) and the others in public institutions. Their international experience occurred a few months after Tec initiated international travel allowance, notwithstanding Mexico's ongoing COVID-19 health emergency (Secretaría de Salud, 2023).

The sample used in this study aligns with Guest et al.'s (2006) framework, as it meets the criteria of a homogeneous group, where shared perceptions and experiences are examined through semi-structured interviews. A systematic analysis (Guest et al., 2006) demonstrated that a sample of at least 12 interviews is sufficient to reach data saturation, with critical themes often emerging as early as the sixth interview.

Students 1, 2, 5, 7, 8, 9, and 13 opted to enroll in classes outside their designated academic field at Tec. As observed in Table 1, Students 1, 2, 7, and 8 selected courses in the business field, while the rest opted for subjects such as finance, industrial design, and smart city management. Additionally, Students 4 and 8 enrolled in classes that were part of Master's programs. Students 3 and 12 participated in classes intended for international students, not integrating with local students.

This study evaluated how students recognize and develop the seven transversal competencies during their semester abroad. Participants engaged in constructing a personalized assessment, enabling them to gain fresh insights into the competencies fostered throughout 3 years of their educational journey, as well as those areas requiring additional refinement.

The transversal competencies emphasized by Tec closely mirror the eight key competencies for lifelong learning endorsed by the Council of the European Union (European, Commission Directorate-General for Education Youth Sport and Culture, 2019). These competencies are fundamental for individuals to attain personal fulfillment, maintain a healthy and sustainable lifestyle, enhance employability, actively engage as citizens, and contribute meaningfully to society.

The results revealed that participants identified three highly developed competencies during their careers (Table 2): reasoning for complexity, social intelligence, and communication. However, the students did not report improving these competencies during their international experience; instead, they noted applying what they had already learned. This insight was based on the reflections provided in the three general questions categorized to give a broad perception of competencies:

- *What differences do you notice between your level of preparation and that of your new classmates?*
- *What advantages or disadvantages have you gained from working with challenges in Tec's educational model?*
- *What differences do you perceive between your skills and those of your new classmates?*

Regarding reasoning for complexity, five students identified challenge-based education in the TEM as a beneficial method to implement theoretical concepts in real-life problems (Table 2). During the projects proposed in the courses held at Tec, students found a connection with the professional environment, which motivated them to strive for optimal solutions to the presented challenges. This form of experiential learning incentivized students to aim for higher grades and encouraged them to immerse themselves deeply in the subject, often exceeding expectations. By engaging with the topics this way, students gained a profound understanding, recognizing that problem-solving can be approached through various strategies with no definitive answer (Alt and Raichel, 2022). This mindset empowered them to explore innovative solutions through creative thinking, extending theoretical knowledge beyond the confines of the classroom.

Reasoning for complexity was not explicitly perceived as developed during the international experience (Table 2). Patiño et al. (2023) noted that these skills are primarily trained through problem-based and case-based learning. These approaches foster a student-centered environment, empowering learners to derive insights from seeking solutions.

When reflecting on their experiences at foreign universities, students observed a pronounced emphasis on theoretical aspects in classes, with assessments primarily centered around exams, indicative of a traditional educational approach. Consequently, they identified a notable disparity: while their counterparts exhibited a deeper comprehension of the theory, they possessed a more hands-on, practice-oriented background. For instance, three students observed that their peers often tended to rely on short-term memorization rather than pursuing genuine comprehension of the subject matter. Conversely, they endeavored to grasp and internalize the concepts to facilitate their practical application.

Focusing on social intelligence, students were asked about their collaborative work and the effectiveness of their interactions with their classmates. Five participants responded that when paired with international classmates, they encountered an ineffective environment for teamwork that hindered the collaborative process. They mentioned that their new classmates often had an individualistic attitude, complicating interactions and affecting the final delivery.

This attitude was highlighted by student number nine, who provided insight into her perspective on collaborative work during her internationalization experience:

> *"Here, people aren't 100% committed to a team. [...] We're back to the individualism [...]; working in a team bothers them, it annoys them, so they don't know how to communicate; they don't know what it is like to agree to work collaboratively."*

Five students acknowledged that teamwork is always part of every project at Tec, enhancing the social skills necessary to work with a diverse group (Table 2). This principle can be exemplified by

TABLE 1 Students' degrees taken at Tec compared to the classes during their international studies.

Student	Gender	Engineering degree	Country	Courses taken at their foreign university
1	Male	Industrial and systems	Argentina	Business administration and economics
2	Male	Industrial and systems	Germany	Business
3	Male	Mechatronics	Netherlands	Information technology
4	Female	Industrial and systems	Germany	No information provided
5	Female	Mechatronics	Spain	Information technology and subjects related to smart city management
6	Female	Industrial and systems	Spain	Organizational industrial engineering and one course in business administration
7	Male	Industrial and systems	Germany	Business and industrial engineering
8	Female	Industrial and systems	Sweden	Product development, finance, and industrial engineering
9	Female	Industrial and systems	England	Event organization
10	Male	Industrial and systems	Germany	Industrial engineering
11	Female	Industrial and systems	Spain	Production and logistics
12	Female	Mechatronics	Austria	Business Administration
13	Female	Industrial and systems	Chile	Industrial Design

TABLE 2 Categorization of competencies developed through undergraduate studies and during their international experience.

Competency	Along previous undergraduate studies	During international experience
Reasoning for complexity	Challenge-based education as a beneficial method to implement theoretical concepts in real-life problems	Not perceived
Social intelligence	Effective collaborative work	Not perceived
	Easy interactions with classmates	
Communication	Confidence during class presentations	Not perceived
	Effective communication of ideas	
Self-knowledge and management	Ability to work in short periods	Independent living
	Identification of stressful academic situations	
Innovative entrepreneurship	Further research required	
Ethical and civic engagement	Further research required	
Digital transformation	Further research required	

the answer given by student 10 when asked about the differences perceived between his preparation and that of his new classmates:

> *"As they are very closed-off and not used to working in teams, when I arrived from Tec, where all my work was in teamwork, it was very easy for me to work with them because there are things that I know I can help them with, and it facilitates our work."*

In this address, although collaboration was not explicitly perceived as developed during the international experience (Table 2), further analysis demonstrates that participants valued interacting with people from different backgrounds (see Figure 3). Therefore, they likely had the opportunity to enhance other critical aspects of social intelligence.

Communication competency was specifically observed when students were asked to identify the differences perceived in their abilities compared with those of their new classmates. Five students expressed confidence during class presentations, conveying a sense of assurance in their understanding of the subject matter (Table 2). In contrast, the participants declared that their peers seemed nervous in front of the classroom and did not seem prepared enough to express themselves fluidly. Tec students could also effectively communicate their ideas within their teams while guiding the conversation to ensure that every contribution was heard (Table 2). This ability to communicate ideas can be evidenced by the answer given by the 10th participant:

> *"Tec has given me more ability to relate and express my ideas regarding projects because here, people do not have as much ability to speak in public. For example, when presenting a presentation for a project, I see that they do lack a little of that. Also, in terms of the material they use for oral presentations, they tend to be basic and simplistic. At Tec, we elaborate it to make it more attractive and professional."*

In contrast, this competency was not explicitly perceived as developed during the international experience (Table 2).

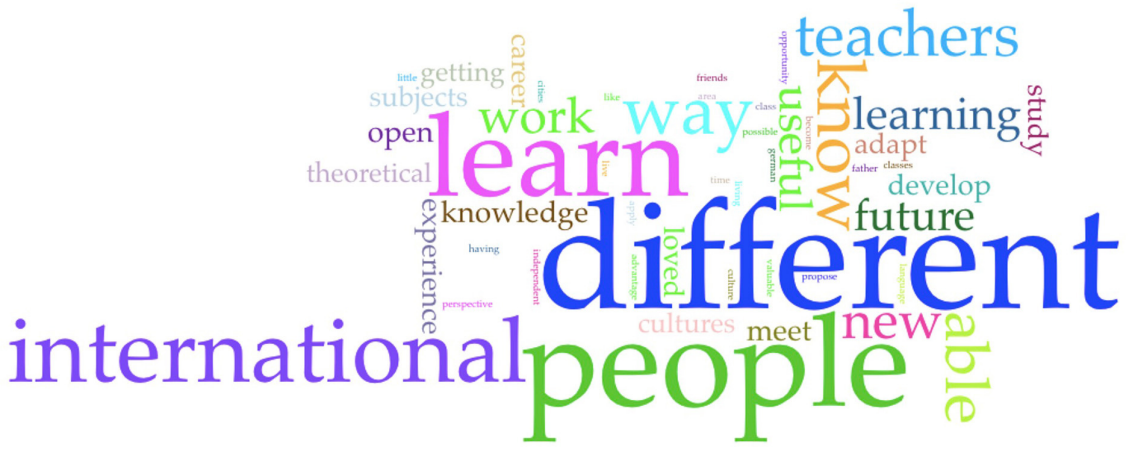

FIGURE 3
Word cloud of participants' most valuable aspects taken from their international experience.

Concerning self-knowledge and management, five students reported that the TEM's 5-week course structure improved their ability to work in short periods, emphasizing an advancement in time management skills (Table 2). These challenge-based courses prompted students to deliver high-quality assignments in shorter periods. Students must evaluate effective work distribution among teammates and create optimal structures for collaborative work to ensure time is used wisely. Nevertheless, it was also noted that Tec students required an adjustment period when transitioning to international universities, where they had to shift their management skills to accommodate a semester-long course structure.

However, when asked to describe the level of stress they had experienced, seven students noted that they had significantly higher stress levels at Tec compared to their new university, where the stress was minimal (Table 2). The two contributing factors mentioned by students were a high workload and a lack of free time. Academic pressure from test preparation, learning significant concepts in a short period, ongoing study, realization and preparation of evaluated activities, and excessive work outside school hours have been reported as one of the most recurrent stressors in higher education (Yang et al., 2021; Vega Martínez et al., 2022). High levels of academic stress can lead to a deterioration of wellbeing (Chow et al., 2018), which has been linked to depression, anxiety, ill health, and poor academic performance (Deng et al., 2022). Students shared a feeling of relief, referring to the lower workload in the foreign university. This allowed them to make time for themselves and to enjoy different experiences beyond the academic field. These findings can be correlated with those obtained by Muro et al. (2022) who discovered that exchange students at a university in Barcelona exhibited higher sociability, activity level, and susceptibility to boredom than local students. Nevertheless, two participants acknowledged the value of the high-stress environment at Tec, noting that it had equipped them with valuable skills in working under pressure and managing stressful situations. They found these skills beneficial for their daily lives and future professional endeavors.

When discussing self-knowledge, participants noted that it was a skill developed further during the international program (Table 2). Five students revealed that this experience marked their first foray into independent living. Consequently, they had to learn how to balance academic responsibilities and social engagements to overcome autonomy challenges. This also entailed regulating proper habits, such as maintaining a healthy diet and keeping a tidy living space. Although stress levels were initially high due to the demands of independent living, most students adapted to their new lifestyle after a brief adjustment period. Participants viewed this transition as a valuable learning experience, where they identified the strengths that propelled them forward while simultaneously recognizing areas for growth.

The competency of innovative entrepreneurship yielded diverse outcomes among Tec participants. While five students perceived themselves as possessing higher innovation skills than their international peers, three expressed lower confidence in their innovation abilities within specific subjects, and four reported no noticeable difference. Additionally, two participants mentioned constraints in demonstrating their innovation skills during their courses abroad, limiting the analysis scope. One participant noted that projects at the foreign university were excessively structured, impeding their ability to propose alternative solutions or methodologies. Participants also observed that only some of their peers demonstrated exceptional entrepreneurship. Therefore, it is premature to conclude whether TEM is responsible for developing this competency.

Nevertheless, outcomes of this competency can also be correlated with those identified in reasoning for complexity. As illustrated in Figure 1, innovative entrepreneurship aims to deliver creative solutions to surrounding problems (Tapia Gardner, 2021). Challenge-based education enables students to analyze real-life scenarios and determine the optimal pathway to a solution. Student 3 highlighted the advantages he perceived in working through a challenged-based model:

> *"To think beyond what is explained to us. There are different ways to solve the projects."*

As the student described, "thinking beyond" demonstrates that working through challenges fosters innovation and creative thinking.

Assessing the strengthening of ethical and civic engagement competency is limited by the nature of the international programs (see Table 2) in which participants were enrolled, as these programs did not prioritize social work or community service. The absence of activities focused on this subject hindered students' competency development. When participants were questioned about perceived differences in values compared to their international classmates, four students commented that their classmates seemed more reserved, making them appear less empathetic and tolerant. However, this disparity can be attributed to cultural differences, where a reserved demeanor does not necessarily indicate a lack of respect or tolerance but rather a different cultural expression. Although isolated incidents of perceived lack of empathy or respect toward international students and other classmates were noted, they did not represent most of their international peers. These findings contrast with Luo and Jamieson-Drake's (2015) conclusions, demonstrating that studying abroad led to a deeper understanding of moral and ethical dilemmas.

While not explicitly observed, there is potential for students to enhance this competency through their experiences in internationalization. Jon and Fry (2021) conducted a study exploring the impact of study abroad programs in higher education, investigating how participants contributed to local and global engagement. Their research addressed whether these contributions to the worldwide community stemmed from their experiences abroad. The findings revealed that internationalization significantly heightened participants' involvement in civic engagement, social entrepreneurship, and proactive measures to tackle global issues such as climate change and inequality. This outcome underscores the pivotal role of internationalization in cultivating individuals aware of local and global challenges and motivated to take tangible steps toward societal contribution.

Similarly, Millora (2011) demonstrated how internationalization significantly fostered civic and global engagement among U.S. students immersed in international education. Participants exhibited heightened awareness and empathy toward global issues and increased interest in addressing these challenges.

During the interviews, only one question directly addressed digital transformation. The question focused on the technological tools implemented at their new university, mainly using Learning Management Systems. Unfortunately, this line of inquiry failed to provide adequate insight into enhancing the competency. However, one student noted that he felt more prepared than his new classmates to use MATLAB, applying his previous knowledge of software in engineering to economics. Another student shared that she integrated technology into everything she did, employing digital tools like Excel. At the same time, her classmates relied on traditional methods such as pen and paper and lacked proficiency in Excel. It can be argued that digital skills have become a second language for a generation immersed in technology from a young age (Koumachi, 2019). As digital natives, they effortlessly navigate technological tools, integrating them seamlessly into their daily lives (Gulsecen et al., 2015). This innate familiarity with technology may lead participants to view digital transformation competency as inherent, requiring no further guidance (Tóth et al., 2022). Furthermore, participants may perceive their digital skills as instinctual rather than a competency consciously developed through the TEM.

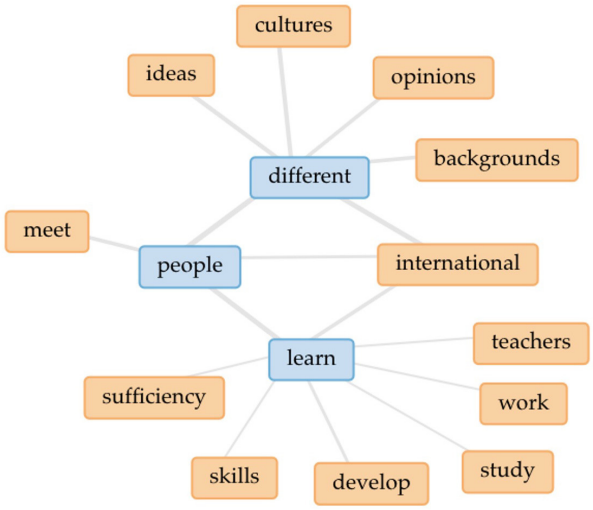

FIGURE 4
Web diagram of most frequent links found in students' valuable aspects taken from the international experience.

To finalize the interview, students were asked: *What is the most valuable thing you take away from this experience at another university?* This final question prompted students to reflect on the lessons learned while living in a foreign country. Their responses provided valuable insights into the most significant and enlightening experiences gained through internationalization.

After examining the transcriptions, we employed Voyant Tools software to visually represent the most prevalent ideas in the responses. Figure 3 illustrates the most recurrent terms with font sizes adjusted to reflect their frequency. The analysis revealed that the most frequent words were *different*, *people, learn,* and *international*. These terms highlight students' significant value in experiencing different learning environments and cultures.

Figure 4 demonstrates how keywords (blue) are frequently observed in proximity to other terms (orange). It reveals that the students' reflections on their international experience are centered around learning, interactions with people, diversity, and the international context. These central nodes are interconnected, forming a cohesive network that underscores the multifaceted nature of the internationalization experience in higher education.

The network of words suggests that students value the opportunity to meet diverse people, learn new skills, and develop a global outlook. These experiences are crucial for fostering a well-rounded education that prepares students for the complexities of a globalized world. The visual representation underscores the importance of internationalization in higher education and its

impact on student's personal and academic development. This evidence complements the thematic analysis, underlining that the international experience by itself, beyond the perception of the students inside the classrooms, clearly offers them the opportunity to strengthen their communication and social intelligence competencies.

As evidenced by the figures and corroborated by the transcriptions, the findings underscore the profound significance of experiencing life in a different country and interacting with many people from diverse cultures and nationalities. A notable theme across responses was the invaluable opportunity to interact with people from around the globe, learning from their diverse perspectives and encountering many cultures. Ten students echoed this sentiment, emphasizing the enriching experience of meeting individuals from various backgrounds. Participants 7, 8, and 12 exemplify this sentiment in their responses, articulating the most valuable aspect they took away from the experience:

Participant 7:

> *"To see how work is done here, how the country, well this country that I am in, Germany, operates, or how they envision the future [...] also to meet people from all over the world, who have a different point of view than yours or a different way of living."*

Participant 8:

> *"The environment in which they [international classmates] work, the people you meet, what you learn, how you perceive how people are managed, how everyone is open to international people."*

Participant 12:

> *"I believe I greatly benefited from meeting people from numerous countries; I really enjoyed sharing from other cultures and learning how to communicate effectively with them. [...] I like having teachers from other countries, as I haven't had teachers from other countries before. So, seeing another perspective of how they think, not just the teacher, but from another field and country."*

This multicultural connection fosters the development of social intelligence among students (Tran and Pham, 2016). Varied ideas and perspectives create an environment where students can learn from one another and exchange viewpoints. Consequently, a foundation of mutual respect is established, welcoming and appreciating diversity, thus encouraging students to remain receptive to exploring new approaches (Braskamp et al., 2009).

Furthermore, participants highlighted the empowering aspect of the flexibility in their coursework during their internationalization experience. The opportunity to study at a different university exposed students to new theoretical concepts through coursework abroad. Notably, the program where the participants were enrolled offered the flexibility to explore fields beyond their engineering degree. This freedom to choose courses in business, economics, management, computer science, or industrial design or to delve deeper into areas of interest related to their degree empowered students to shape their learning journey with stress on multidisciplinary. Students remarked that these courses equipped them with concepts relevant to their daily lives and career aspirations, emphasizing their value as learning experiences.

Our findings evidence the steps the Tec21 educational model has taken to achieve valuable competencies relevant for graduates to be incorporated into the labor market and effectively contribute to a better global society. It also points out that competency-based education and its benefits on competencies like reasoning for complexity, communication, and social intelligence are not fully spread in universities worldwide. This last affirmation must be taken with caution since it does not mean that hosting universities are not addressing these competencies better or more effectively, as discussed in the following section.

4.1 Limitations

While the presented results offer valuable insights into assessing students' competency development, it is essential to acknowledge the study's limited sample size. With only 13 participants, the ideas presented may not fully represent the perspectives of all students and can only offer a general overview. For future research endeavors, conducting more interviews would enable a more comprehensive analysis, incorporating a broader range of different viewpoints.

The authors also acknowledge the reliance on self-reported data and potential biases due to researchers' rank and positionality. However, conducting more profound research to evaluate each competency with validated instruments was beyond the scope of this exploratory approach.

Additionally, diversifying the sample is essential, as the current research solely focused on students from one private Mexican university who had experienced internationalization. Expanding the study to include universities across Mexico and Latin America would provide a more comprehensive understanding of how internationalization influences students' ongoing education in various contexts.

Furthermore, the participants in this study were exclusively from a single campus and pursued only engineering careers in mechatronics and industrial engineering. Incorporating multiple campuses of either the same institution or from different ones would offer broader insights into competency development through a challenge-based model. Likewise, including non-engineering programs would offer insights into competency growth across diverse fields of study and throughout different career paths.

5 Conclusions

Education extends beyond the confines of a classroom, persisting throughout one's life and embracing diverse pathways beyond formal schooling. Higher education institutions are a fundamental pillar in the upbringing of professionals, established as lifelong learners. These institutions must transition to models that cultivate lifelong learning, as it is a guide that will provide graduates with sufficient tools to keep up with a rapidly changing environment. As knowledge continually evolves, graduates must be able to keep pace with technological and scientific advancements. This ensures that their education remains relevant and does not become outdated.

This research explores how a competency-based educational model prepares students for future challenges and professional success. Results from Research Question 1 highlight that challenge-based learning effectively develops key competencies by engaging students in solving real-world problems from multiple perspectives. Effective communication and a confident attitude, alongside collaborative teamwork, were essential for producing high-quality results in this approach.

For Research Question 2, international experiences were found to enhance or reinforce competencies developed during higher education, fostering multicultural understanding, communication, and collaboration.

A competency-based model can clearly benefit from international experiences by enhancing many skills beyond those inside a local higher education institution. It also offers a great opportunity to assess students' competency development; it can guide curriculum adjustments and continually improve educational models, ensuring students are prepared to face twenty-first-century challenges with a multidisciplinary and innovative approach.

Data availability statement

The datasets presented in this article are not readily available because, through the informed consent signed by the participants, no information can be shared to third parties. Requests to access the datasets should be directed to claudia.camacho@tec.mx.

Ethics statement

This study followed the principles of the Declaration of Helsinki (World Medical Association, 2013) and the Belmont Report (National Commission for the Protection of Human Subjects of Biomedical Behavioral Research, 1979). All procedures were conducted in strict accordance with the applicable guidelines and regulations. All students were explicitly informed of the voluntary nature of their participation, the confidentiality of their responses, the absence of any incentives for participation, and their right to withdraw voluntarily at any point. The research methodology exclusively utilized online interview measurements, avoiding sensitive content for participants. Furthermore, the study abstained from collecting biological samples or implementing experimental interventions. As a result, these precautions categorize the study as low risk. The study adhered to local legislation and institutional requirements. Participants provided written informed consent to participate in the research.

Author contributions

GC: Conceptualization, Formal analysis, Funding acquisition, Methodology, Project administration, Visualization, Writing – original draft, Writing – review & editing. AV-A: Data curation, Formal analysis, Investigation, Methodology, Visualization, Writing – original draft, Writing – review & editing. SS-M: Data curation, Formal analysis, Visualization, Writing – review & editing. PC: Funding acquisition, Writing – review & editing. CC-Z: Conceptualization, Formal analysis, Funding acquisition, Methodology, Project administration, Supervision, Visualization, Writing – original draft, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted without commercial or financial relationships that could create a conflict of interest.

Publisher's note

Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/feduc.2024.1457796/full#supplementary-material

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