frontiers | Frontiers in Education

TYPE Original Research
PUBLISHED 30 May 2025
DOI 10.3389/feduc.2025.1563361

OPEN ACCESS

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RECEIVED 19 January 2025
ACCEPTED 13 May 2025
PUBLISHED 30 May 2025

CITATION
Gutiérrez-Pulido H and Orozco-Rodríguez C (2025) The contribution of professional internships to the academic development of engineering and science students: a case study.
Front. Educ. 10:1563361.
doi: 10.3389/feduc.2025.1563361

The contribution of professional internships to the academic development of engineering and science students: a case study

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Introduction: Professional internships are widely recognized as a mechanism to bridge the gap between academic training and labor-market demands in science and engineering. However, few studies have comprehensively evaluated students' perceptions of how internships contribute to their technical and soft-skill development. This study examines the formative impact of the CUCEI (University Center for Exact Sciences and Engineering) internship program at the University of Guadalajara from the students' perspective.

Methods: A 28-item Likert-type questionnaire covering four dimensions—Overall Satisfaction, Practical Experience, Technical Skills, and Soft Skills—was developed and validated. It was administered online to 589 undergraduate interns (60.4% male; 39.6% female). Reliability was evaluated using Cronbach's alpha (α), and construct validity was examined through exploratory factor analysis; both assessments yielded satisfactory results.

Results: Students reported high levels of satisfaction, and substantial development of practical experience (85–92% agreement). Practice of specific technical skills was more variable (66-79% "Quite a lot/A lot"), while soft-skill development—especially teamwork, adaptability, and feedback reception—was rated positively (88–90%). Additionally, 37.7% extended their internships, and 45% indicated likelihood of continued employment with their host company.

Discussion: Findings confirm that structured internships at CUCEI effectively support student satisfaction and the practical application of academic knowledge, while fostering both technical and interpersonal competencies. Variability in technical-skill opportunities and limited language practice highlight areas for program enhancement. Student feedback underscores the need for deeper industry collaboration and curriculum updates to reinforce hands-on training and global employability.

KEYWORDS

employability, academic development, technical skills, soft skills, professional skills, questionnaire development

1 Introduction

A significant disconnect between the perspectives of higher education institutions and employers regarding graduate preparedness has been documented; while education providers tend to express high confidence in the readiness of their graduates for the workforce, employers remain notably less convinced. This gap stems from differing priorities: universities often emphasize theoretical and academic development, whereas employers seek practical, transferable, and job-specific skills such as teamwork, problem-solving, and leadership. This mismatch has contributed to a growing skills gap that affects both recent graduates and organizations, prompting a search for complementary learning mechanisms to enhance employability and better align academic training with real-world labor market demands (Calonge and Shah, 2016).

In light of this, the relevance of professional internships in higher education, particularly in science and engineering programs, has been widely recognized due to their contribution to the integral development of students (Winberg et al., 2020). These internships complement academic training by offering practical experience and supporting students in acquiring skills relevant to the demands of an increasingly competitive labor market (Green et al., 2010; Peña et al., 2016). Internships not only foster technical proficiency but also contribute to the development of key professional competencies such as communication, teamwork, and problem-solving (Byrne et al., 2020). Previous studies have highlighted that well-structured internship programs enhance students' employability by providing them with opportunities to apply theoretical knowledge in practical contexts (Winberg et al., 2020). However, the effectiveness of these programs can vary significantly based on the quality of supervision, the work environment, and the type of tasks assigned to students (McHenry and Krishnan, 2022). Despite these findings, there is a need for ongoing evaluation of how well internships meet academic and professional development objectives from the students' perspectives.

The evaluation of academic programs and educational experiences plays a crucial role in determining their effectiveness and identifying areas for continuous improvement. Research has emphasized that a systematic approach to assessment helps to ensure that programs align with both academic goals and the demands of the labor market (Winberg et al., 2020). Evaluation processes provide not only valuable feedback for curriculum enhancement but also insights into how well institutions prepare their students to address real-world challenges. This underscores the need to develop robust tools that capture students' experiences comprehensively, particularly in terms of satisfaction, technical proficiency, and the development of transferable skills.

In this context, we aimed to evaluate the formative impact of the internship program at the University Center for Exact Sciences and Engineering (Centro Universitario de Ciencias Exactas e Ingeniería, CUCEI) of the University of Guadalajara. The contribution of internships to the development of students' technical competencies and soft skills has been well documented in the literature. Therefore, our goal was to assess whether the CUCEI internship program effectively fosters these outcomes—at least from the perspective of the students, who are ultimately the primary beneficiaries. We did not seek to evaluate the program's administrative aspects or gather the opinions of employers, acknowledging that such perspectives warrant a different approach. Instead, our focus was on identifying whether an instrument existed to assess students' perceptions of the formative impact of their internship experience, specifically within the field of science and engineering. We found few published studies that addressed this issue directly, and a synthesis of the most relevant literature is presented below.

In a study conducted with students from two universities- in northwestern Mexico—Bórquez-Tamayo et al. (2024) employed a questionnaire to evaluate professional internship programs based on four dimensions: management, development, satisfaction, and usefulness. The instrument was developed using items adapted from questionnaires originally designed for the *prácticum* in teacher education programs (Mayorga Fernández et al., 2017; González-Riaño and Hevia-Artime, 2011), which, although related, differ from professional internships in structure and objectives. While the instrument enabled a general assessment and demonstrated high internal consistency, most items focused on management and development, whereas satisfaction and usefulness were addressed through broad, general questions. This imbalance limits a deeper understanding of the contribution of internships to the development of technical and soft skills.

A comparable study by Arias-Marín et al. (2020) evaluated internships within the Industrial and Environmental Microbiology program at the University of Antioquia, Colombia. The study utilized a rubric to assess three key dimensions: planning, administration and management, and facilitator performance. While it provides valuable insights into the organizational and supervisory aspects of the internship experience, it does not include a direct self-assessment of students' learning outcomes or the competencies they developed during the internship. In a variant of the previous study, Marín-Marín et al. (2021) develop and validate an instrument with three dimensions - planning, administration-management and student performance - however the evaluations were conducted by external facilitators, without incorporating the perspectives of the students themselves.

Chan-Pavon et al. (2018) applied a structured questionnaire to a small, self-selected sample of students from the Faculty of Chemical Engineering at the Autonomous University of Yucatán. Section 3 focused on student satisfaction, covering aspects like the work environment and whether students felt heard by their supervisors. Section 4, with five items, explored the application and acquisition of knowledge during internships, though it did not clearly differentiate between technical skills and soft skills. While the findings offer useful insights, the voluntary nature of participation and the limited sample size constrain the generalizability of the results.

In the study by Ramírez-Cruz et al. (2018), an academic satisfaction scale was validated and applied to psychology students at a public university in Mexico. The questionnaire included three dimensions: the facilitator's role, the student's ethical performance, and the didactic strategy. However, the instrument does not include the self-evaluation of learning or skills developed in relation to the discipline, which limits its capacity to assess the formative impact of the internship experience.

In their study, Nogueira et al. (2021) validated a Portuguese version of the Work Experience Questionnaire (WEQ) with engineering students from public universities and polytechnic institutes in Portugal. The instrument includes four dimensions: clear goals (4 items), university support (3 items), workplace support (3 items), and generic competencies (5 items). Although the instrument demonstrated good internal consistency, a notable limitation lies in the recruitment process, as participants were contacted via social media platforms (Facebook and LinkedIn), which may introduce sampling bias and affect the generalizability of the results. Additionally, while the items on generic competencies address relevant aspects of student development, their formulation tends to be declarative and self-attributive—for example, *"The internship developed my ability to solve problems"*—which may limit the depth of reflection and introduce desirability bias in responses. We believe that this type of question would be more effective if oriented toward the kinds of activities students engaged in during the internship, thereby allowing the possibility to infer the development and enhancement of competencies and skills as a consequence of those experiences.

Thus, even though there are studies evaluating professional internship programs, most of the identified instruments have limitations in measuring the development of technical competencies and soft skills from the student's perspective. Almost all focus on management and administration aspects, others on evaluation by third parties (external facilitators), or evaluate academic satisfaction in a general way without delving into the specific learning and skills acquired during the internship. Even those instruments that address generic competencies tend to formulate self-attributive questions, which could generate biases in responses. Consequently, there is a need to design instruments that more accurately and comprehensively assess students' perceptions of the formative impact of internships on the development of their competencies, specifically within the context of Science and Engineering. Considering this, we decided to create our own instrument, drawing inspiration from ideas found in the aforementioned studies.

In sum, the present study aims to address this need by developing and validating a questionnaire that, as will be discussed below, assesses four key dimensions of the internship experience: overall satisfaction, practical experience, technical skills and soft skills. This instrument aims to capture students' perceptions of the contribution of their internships to their professional development.

The objective of this research is to provide insights into the strengths and areas for improvement in the CUCEI internship program. Specifically, this study aims to answer the following questions:

To what extent do students feel satisfied with their internship experience?

How well do internships facilitate the practical application of academic knowledge?

What is the perceived impact of internships on the development of technical and soft skills?

By addressing these questions, this study aims to contribute to the continuous improvement of the CUCEI internship program and provide recommendations for enhancing the alignment between academic curricula and industry demands.

2 Materials and methods

This section is organized into three subsections. First, the Conceptual Model outlines the theoretical and empirical foundations that guided the development of the evaluation framework. Then, the Sample and context describes the characteristics of the participants and the context in which the data was collected. Finally, the Questionnaire Design and Validation details the instrument construction process, including the selection of dimensions, item refinement, and statistical procedures used to confirm the reliability and validity of the questionnaire.

2.1 Conceptual model

When a science or engineering student undertakes their professional internship or enters the job market, they are expected to apply their specific competencies related to their profession, referred to as engineering knowledge according to Winberg et al. (2020). In addition, they are expected to demonstrate general competencies, which encompass skills, abilities and knowledge that all professionals are expected to possess to some extent, such as the ability to learn, make decisions, develop projects, interpersonal skills. The TUNING project, both in Europe and Latin America, defined generic and specific competencies that prepare students for global challenges. In Latin America, TUNING identified 27 generic competencies (González et al., 2004); in Europe 31 (Tuning Academy, 2025). These general competencies, or part of them, are referred to in different ways in different studies or fields, for example they are often called professional competencies or soft skills (Winberg et al., 2020; Byrne et al., 2020). Other publications also identify them as transversal competencies (Corbella and Giuliania, 2024). Professional competencies are also identified as social skills, especially in the field of engineering education (Byrne et al., 2020). In contrast, specific competencies are also called hard skills.

Several studies have highlighted the importance of internships as spaces where students can bridge the gap between academic knowledge and real-world applications. Internships not only foster technical skills but also support the development of soft skills, such as communication, teamwork, and problem-solving (Byrne et al., 2020; Green et al., 2010; Peña et al., 2016).

In the context of professional internships, evaluation efforts have focused on various aspects to measure their contribution to student development. A crucial component of this evaluation is understanding their impact on both technical and interpersonal skill development. Green et al. (2010) conducted an exploratory study to examine how professional internships influence students' perceptions of essential employment traits. The study assessed students' opinions before and after their internship experiences, focusing on changes in the perceived importance of key skills and attributes for employability. Surveys and statistical analyses were used to identify significant variations in students' perceptions. Similarly, Chan-Pavon et al. (2018) assessed internships based on student satisfaction, knowledge application, and professional training contributions. They found that internships positively impacted students' education, though only 41% felt tasks were closely related to their studies. Motivation was highlighted as key to a successful experience.

Ponce-Ceballos et al. (2024) emphasized the importance of professional internships in real contexts to help students meet professional challenges. The authors proposed a four-dimensional model evaluating student engagement, learning outcomes, participation factors, and institutional support. They concluded that internships in real environments enhance knowledge assimilation, practical skill development, and employability. Arias-Marín et al. (2021) developed and validated a rubric to evaluate internships from students' perspectives across three dimensions: Internship Programming, Administration and Management, and Student Support. The study highlighted internships as essential for professional growth, emphasizing the positive influence of the work environment, company management, and facilitator support on goal achievement. These findings align with those of McHenry and Krishnan (2022), who emphasized that structured professional practice frameworks improve the balance between academic knowledge and workplace expectations.

Furthermore, research by Winberg et al. (2020), and Lowe et al. (2024) underscores the importance of embedding students in real-world environments to foster situated learning and the transfer of theoretical knowledge to professional contexts. Lowe et al. (2024) compared engineering students' perceptions of the development of professional and technical competencies and found that students often perceive professional competencies (e.g., communication and teamwork) as being better developed in workplace settings, whereas technical competencies are often best refined within academic environments. This underscores the complementary roles of universities and companies in professional training and reinforces the need for comprehensive evaluation instruments.

Finally, it is crucial to recognize that professional internships contribute to the generation, extension, and deepening of new knowledge and skills for both personal and professional development. According to Winberg et al. (2020) and Byrne et al. (2020), these competencies can be categorized into two main groups: technical skills, which involve the application of specialized knowledge grounded in scientific and mathematical principles, and soft skills, which include collaboration, leadership, communication, and adaptability. Engineering problem-solving, for instance, requires not only mastery of technical knowledge but also the ability to collaborate effectively in diverse professional contexts (McHenry and Krishnan, 2022; Ponce-Ceballos et al., 2024).

The aim is not to conduct an exhaustive assessment of the technical and soft skills that CUCEI students develop during their internships, but rather to evaluate whether they were placed in a work context that enabled the development of some of these competencies, thereby contributing to the educational and employability benefits widely documented in the literature. Figure 1 presents the conceptual model we propose, which synthesizes key elements identified in the preceding discussion as relevant for evaluating the formative effectiveness of internship programs from the perspective of undergraduate science and engineering students. The model is structured around four interconnected dimensions: Overall Satisfaction, Practical Experience, Technical Skills Development, and Soft Skills Development— each of which is discussed in more detail below. The model assumes a dynamic interrelation among these dimensions: strong satisfaction can enhance students' motivation to engage deeply with practical and technical activities, while positive experiences in applying academic knowledge and developing skills can reinforce students' overall satisfaction. Thus, the dimensions are not isolated but mutually reinforcing, collectively contributing to a comprehensive evaluation of the internship's formative impact.

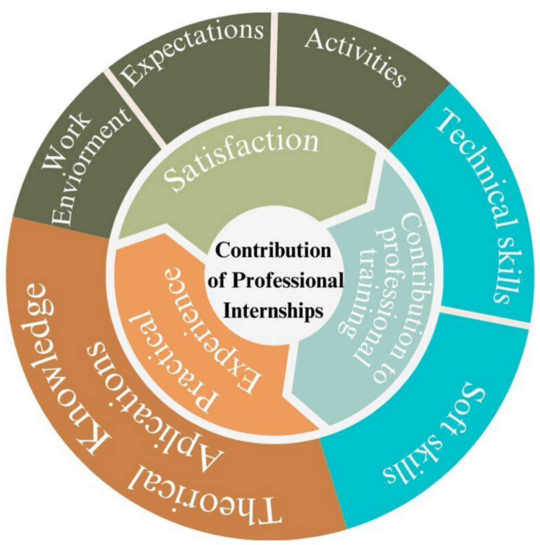

FIGURE 1
Conceptual model for evaluating the formative effectiveness of professional internships from the perspective of students in undergraduate science and engineering programs.

2.2 Sample and context

Every year, approximately 1,500 students from CUCEI, which offers 18 undergraduate programs in science and engineering, begin their professional internships. These internships are a mandatory component in 14 of those programs and are carried out in collaboration with over 600 companies that provide specialized training aligned with various professional fields. To enhance the efficiency of internship program management, the university center implemented a comprehensive digital system in early 2024. This platform was designed to streamline processes ranging from establishing agreements with host organizations to assigning students and managing their final reports. As part of this initiative, the need to evaluate the internship program emerged, prompting the development of a tailored questionnaire.

The questionnaire was completed online by 589 students from CUCEI, with 60.4% men and 39.4% women, as part of their final internship report between July and December 2024. Responses were collected from students across 17 academic programs, with the majority representing Industrial Engineering, Pharmaceutical Chemistry, Chemical Engineering, and Civil Engineering. The demographic distribution indicated that 95% of respondents were between 21 and 25 years old, with 60% specifically between 22 and 23 years old. Additionally, 70.3% reported having completed more than 85% of the academic credits for their respective careers.

2.3 Questionnaire design and validation

Following the recommendations of the literature, the questionnaire was elaborated and validated in three phases (Bolarinwa, 2015; Broder et al., 2007; Gutiérrez Pulido et al., 2014).

2.3.1 Dimension selection

In the literature review presented in the introduction and at the beginning of this section, several studies have discussed the benefits of professional internships, as well as key features of some instruments designed to assess this type of educational experience. Based on these findings and our own experience, we propose that the questionnaire for evaluating professional internships be structured around four dimensions: overall satisfaction, practical experience, technical skills, and interpersonal skills. Below, we provide a brief definition of each dimension, along with references that highlight its relevance.

Overall Satisfaction. This dimension refers to the extent to which students perceive that their expectations were met during the internship experience. This includes the alignment between the internship and their academic training, the quality of the organizational environment, and the support received from supervisors and coworkers. As emphasized by Chan-Pavon et al. (2018) and Bórquez-Tamayo et al. (2024), elements such as mentorship, motivation, and a structured work environment play a crucial role in enhancing student satisfaction and engagement. This dimension is foundational, as it shapes students' overall perceptions of the internship's value and can significantly influence their motivation to participate actively in practical and learning activities.

Practical Experience captures the extent to which students were able to apply the theoretical knowledge acquired during their academic training to real-world professional contexts. This dimension assesses not only the opportunity to engage in authentic tasks and challenges but also the degree to which these experiences reinforced the relevance of their academic preparation. A strong practical component can enhance students' overall satisfaction by validating their educational background and fostering deeper engagement with internship activities. The importance of this dimension has been highlighted in various studies: Ponce-Ceballos et al. (2024) stress the value of situated learning environments for promoting knowledge transfer, while Winberg et al. (2020) and Green et al. (2010) emphasize the role of contextualized practice in bridging the gap between academic learning and professional application.

Technical Skills refers to the acquisition and application of specific competences and abilities that enable students to perform specialized tasks, operate professional tools and software, conduct analyses, and implement technical standards relevant to their fields of study. This dimension is both a direct outcome of practical experience and a key contributor to the perceived professional value of the internship. The importance of developing technical competencies through internships is well documented. For instance, Byrne et al. (2020) and McHenry and Krishnan (2022) highlight how internships enhance students' capabilities in areas such as data analysis, the use of specialized equipment, and the application of industry-relevant standards and procedures.

Soft Skills encompasses a broad range of interpersonal and intrapersonal competencies, including teamwork, communication, adaptability, emotional regulation, stress management, and the ability to receive and incorporate feedback. These skills, grounded in knowledge, attitudes, and behaviors, are not specific to any single profession but are essential for functioning effectively across diverse work environments. Soft skills enable individuals to collaborate, build relationships, and respond constructively to challenges. Their importance for employability is well documented in the literature (Winberg et al., 2020; Byrne et al., 2020; Lowe et al., 2024), with particular emphasis on how well-structured internship experiences support the development of adaptive behaviors and feedback integration through ongoing interpersonal interactions.

2.3.2 Item refinement

Based on the intended content to be evaluated within each of the four dimensions used to structure the instrument, and following a review of other relevant questionnaires, an initial pool of 78 items was developed. With the participation of the authors and two additional colleagues, this preliminary list was refined and reduced to a second version comprising 55 items: 13 related to overall satisfaction, 9 to practical experience, 13 to technical skills, 10 to soft skills, and 10 to additional aspects, including open-ended questions intended to capture and expand on students' learning experiences. At this stage, demographic items had not yet been included.

Subsequently, the 18 program coordinators were invited to review each group of items and select four to five that they considered most useful for assessing the corresponding dimension. They were also encouraged to suggest new items or modify the wording of existing ones. Responses were received from 14 coordinators. Based on the items most frequently selected by the coordinators, the final version of the questionnaire was constructed and is presented in Table 1, organized according to the four dimensions. This final version also includes five demographic items and eight items addressing additional aspects, including three open-ended questions listed at the end of the following section. The final instrument consists of 41 items, a number we consider appropriate, as it is well established that excessively long questionnaires can negatively affect the quality of the data collected.

2.3.3 Validation of the questionnaire

The validation of the questionnaire was carried out by means of a series of statistical analyses, considering the aforementioned data, in order to obtain information on reliability, internal consistency and construct validity.

To evaluate the reliability of the questionnaire, we conducted a reliability analysis based on Cronbach's alpha using the psych package (Revelle, 2025). First, for the entire sample of 589 students, we recoded the responses from 28 Likert-type items with numerical values ranging from 1 to 5, based on the frequency or degree of agreement observed in each case (see Table 1). The raw alpha was $\alpha = 0.92$, indicating very high internal consistency; the standardized alpha based on the correlations was 0.93, confirming the reliability (Bolarinwa, 2015; Revelle, 2025). Guttman's lambda 6 reliability was 0.95, further supporting the robustness of the scale. The average inter-item correlation was 0.330, suggesting moderate relationships between items. With psych package we performed an item-level analysis by removing each item and quantifying α. In this analysis, the α value remains stable (~0.92), suggesting that no single item drastically affects overall reliability.

To analyze the consistency of the questionnaire, a multivariate factor analysis of the coded variables was performed. Five underlying factors with eigenvalues greater than 1.0 were obtained, explaining 59.4% of the total variability. We then investigated whether these factors were related to the four dimensions from which the questionnaire was constructed. When we analyzed the factor loadings after applying varimax rotation, we found that the first factor is clearly associated with the items of the practical experience dimension. Factor two is associated with the items corresponding to the technical skills development dimension, while factor three is aligned with the items of the general satisfaction dimension. Factors four and five best replicate the interpersonal skills development items. This association between the five underlying factors and the items corresponding to the four conceptual dimensions of the instrument supports the design of the questionnaire (Bolarinwa, 2015; Broder et al., 2007; Gutiérrez Pulido et al., 2014).

The high reliability and alignment of the items with the conceptual dimensions suggest that the questionnaire is a robust instrument for evaluating professional internships. By capturing students' perceptions across multiple dimensions, the questionnaire provides a comprehensive assessment of the strengths and weaknesses of the CUCEI internship program.

Given the nature of this study, data were collected through a structured self-report questionnaire designed to capture student perceptions, which is an effective way to collect data from large samples. However, their main limitation lies in the subjectivity of responses, as participants may be influenced by social desirability bias or by their interpretation of the questions. In our case, all students must complete the questionnaire in order to access the system for the official completion of their internship. While this ensures full participation, it may also introduce response bias, as students may feel compelled to give favorable responses or engage with the instrument superficially.

3 Results

The main results of the data analysis are presented below, with the aim of identifying the contribution of professional internships to the academic development of engineering and science students. Table 1 provides a summary of student responses grouped into four dimensions (satisfaction, practical experience, technical skills, and soft skill). For each item, the percentage of responses for the highest values is presented, along with the mean, standard deviation, skewness and kurtosis. These results are then explored and discussed according to the four dimensions of the questionnaire. Additionally, a subsection presents the findings derived from three open-ended questions.

3.1 Overall satisfaction dimension and generalities

Seven items were included in the instrument with the intention of evaluating the general satisfaction of the students with the performance of the internship (see Table 1 and Figure 2). The responses indicate a very high level of satisfaction with the internship experience. Items in this dimension consistently show mean values between 4.4 and 4.8 (on a 1–5 scale), with standard deviations below 0.85, suggesting strong consensus among students. Over 88% of respondents selected "Almost Always" or "Always" for all items (Figure 2), highlighting positive perceptions regarding supervisor support, the work environment, task relevance, and overall fulfillment of expectations. Undoubtedly, having an adequate environment and good support is the first step for the professional internship to reach its formative potential. Similar results have been observed in other studies, such as Chan-Pavón et al. (2018), who found that mentorship significantly increased students' motivation to complete their internships successfully.

The perception of good organizational processes within the company (reported by 90% of students) reinforces the idea that a structured work environment supports effective professional learning, providing students with clear workflows and expectations. Additionally, the high percentage of students who felt their contributions were acknowledged (94%) highlights the participatory nature of their internships, fostering a sense of belonging and motivation.

Although it is important to note that 12% of the students did not choose the options "Almost always" and "Always" to the item: "The idea and expectations I had about the internship were fulfilled," the high percentages in Figure 2 and the corresponds mean are striking. This is largely due to the frequent "Always" responses for these items, ranging from 57% (item 5) to 87% (item 6). This strongly suggests that a significant majority of students are satisfied with their professional internship experiences. One possible explanation for this satisfaction is CUCEI's established network of 600 companies within the region's productive ecosystem that have formal agreements to host interns. The demand for CUCEI interns exceeds the supply, leading companies to actively recruit students and develop well-structured internship programs with efforts to provide greater financial support, as we will discuss further. This situation contrasts with internship programs at other educational institutions, where students must independently seek out companies to accept them as interns.

Three additional items assessed overall internship outcomes: program extension, financial compensation, and likelihood of continued employment. The internship lasts 300 h, which they cover in a period of 15 to 25 weeks, since they go to the company part-time, which allows the students to simultaneously take other courses. It was found that 37.7% of the cases responded that the company extended the period of professional internship (see Table 2). The extension must be at least another period of 300 h.

There was a strong relationship between the extension of the internship period and the payment, i.e., the higher the payment, the greater the possibility of extending the internship period (see Table 2). The significance of this relationship was verified by means of a contingency table analysis (Agresti and Kateri, 2011) and the value of the chi-square statistic was 136.69, df = 3, p-value < 2.2e-16.

Although companies are not required to provide financial compensation or support to interns, it is recommended. Students were asked if they had received any payment, with four response options (see Table 2). And 67.7% answered the last three options, which consider a payment per fortnight greater than 500 Mexican pesos. And 33.1% answered the option of receiving more than 2000 Mexican pesos per fortnight (approximately 100 US dollars).

They were also asked "How likely is it that you will stay to work in the company where you did your internship?" 45.0% selected the options: Likely, Very likely and Sure. Also, with a positive association with payment (Chi-square statistics = 36.57, df = 5, p-value = 7.302e-07).

The preceding data reinforces the idea that many of the companies participating in CUCEI's internship program utilize it as a recruitment strategy to meet their human resource needs in science and engineering fields. This speaks to the program's strength, as will also be demonstrated by the analysis of the following dimensions.

As mentioned above to improve the efficiency of the management of the internship program, CUCEI implemented a comprehensive digital system in early 2024. To evaluate the system, students were asked how they felt about the operation of this platform for the registration and follow-up of internships; 84% chose the options good or excellent.

3.2 Practical experience dimension

The dimension of practical experience, assessed through five items, reflects students' perceptions of the applicability of their academic training in real-world contexts during their internships. The results suggest that internships contributed to students' satisfaction, practical learning, and the perceived relevance of their academic training for professional tasks, with mean scores ranging from 4.3 to 4.6. In all cases, the percentage of "Agree" or "Strongly Agree" responses exceeded 85%, indicating that the majority of students were able to apply and integrate their academic knowledge, which likely enhanced their understanding of the concepts and tools acquired throughout their studies (see Table 1 and Figure 3). The relatively low standard deviations (ranging from 0.67 to 0.78) suggest consistent perceptions among respondents.

Figure 3 shows the items and the percentage of students who answered the options with the higher agreements. The fact that 92% of students found their tasks relevant to their academic training

 10.3389/feduc.2025.1563361

TABLE 1 Summary of student responses by dimension: satisfaction, practical experience, technical skills, and soft skills.

Satisfaction: How often did the events associated with the following statements occur (Options: Never, Almost never, Occasionally, Almost always or Always).	Frequency of "Almost always" and "Always" responses	Mean	Standard deviation	Skew-ness	Kur-tosis
1. They took my opinions and the work I developed into account.	94	4.7	0.63	−2.25	5.39
2. My immediate supervisor motivated me to learn and improve my tasks.	95	4.8	0.59	−2.85	9.01
3. The idea and expectations I had about the professional internship were fulfilled.	88	4.5	0.83	−1.82	3.55
4. The work environment in the company was good.	94	4.7	0.61	−2.30	6.28
5. The company had good organization in its activities and processes.	90	4.4	0.76	−1.50	2.53
6. When I faced any difficulty or doubt, there were company personnel who offered me advice and support.	96	4.8	0.56	−3.57	14.41
7. I felt satisfied with what I accomplished during the internship.	95	4.7	0.64	−2.54	7.06
Practical experience. In relation to your internship, please indicate your degree of agreement with the following statements (Strongly Disagree, Disagree, Neither Agree or Disagree, Agree, Strongly Agree)	**Frequency of "Agree" and "Strongly Agree" responses**	**Mean**	**Standard deviation**	**Skew-ness**	**Kur-tosis**
1. I applied the knowledge acquired in my career to solve important problems.	91	4.5	0.71	−1.29	1.63
2. The activities and projects in which I participated were related to my career.	92	4.5	0.68	−1.45	1.73
3. The internship helped me to better understand the concepts and tools I studied during my studies.	92	4.6	0.70	−1.72	3.31
4. My academic training adequately prepared me for my internships	85	4.3	0.78	−1.01	0.91
5. I was able to relate the knowledge acquired in different subjects to my internships.	93	4.5	0.67	−1.25	1.87
Technical skills. Please indicate to what extent during your internship you developed or participated in the following activities (Not at all, A little, Enough, Quite a lot, A lot).	**Frequency of "Quite a lot" and "A lot" responses**	**Mean**	**Standard deviation**	**Skew-ness**	**Kur-tosis**
1. Develop actions to improve and optimize processes	77	4.1	0.97	−1.01	0.42
2. Apply techniques, methods and tools of my career	79	4.3	0.89	−0.93	−0.09
3. Perform data analysis of the operation of processes	73	4.1	1.11	−1.01	0.02
4. Develop tests or experiments to find solutions to problems	71	4.0	1.12	−0.90	−0.04
5. Analyze and apply different types of standards	75	4.1	1.06	−1.07	0.30
6. Use specialized technology of the area (software, equipment, machinery, etc.)	77	4.2	1.00	−1.15	0.54
7. Identify risks on the job and take preventive actions.	74	4.1	1.07	−1.09	0.46
8. Receive technical training during my internship	77	4.2	0.98	−1.04	0.08
9. Participate in the development or improvement of an information system.	66	3.9	1.17	−0.76	−0.42

(Continued)

TABLE 1 (Continued)

Soft skills (same question and options as for technical skills)	Frequency of "Quite a lot" and "A lot" responses	Mean	Standard deviation	Skew-ness	Kur-tosis
1. Work in a team with other colleagues or employees, with favorable results.	90	4.6	0.75	−1.81	3.32
2. Make presentations of ideas, analyses or proposals	68	3.9	1.17	−0.82	−0.33
3. Practice a second language	27	2.7	1.31	0.36	−0.94
4. Preparing reports and briefings	74	4.1	1.09	−1.07	0.21
5. Managing stress and emotions related to the activities in which I participated.	75	4.1	0.94	−0.87	0.19
6. Receiving feedback that helped me to do a better job.	88	4.4	0.77	−1.37	1.61
7. Participating in activities that involved having to adapt to certain situations in order to better accomplish the tasks assigned to me	89	4.4	0.76	−1.36	1.81

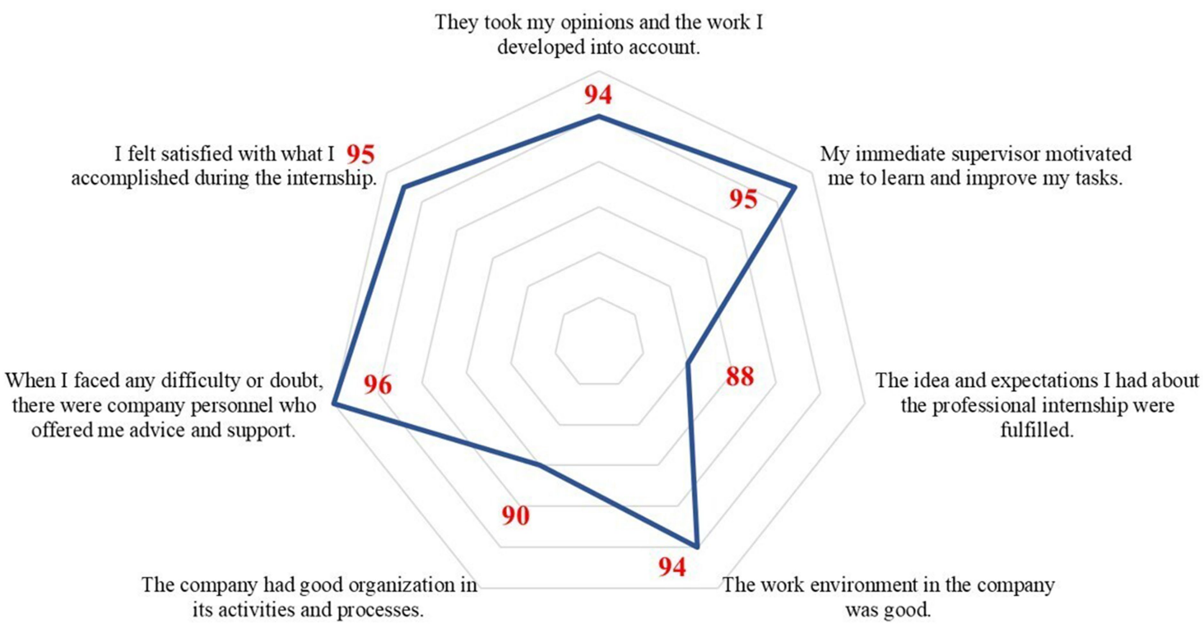

FIGURE 2
Percentage of responses selecting "Always" or "Almost Always" for the overall satisfaction items.

TABLE 2 Distribution of responses by remuneration level and whether the internship extended beyond a single academic period.

	Payment per fortnight (mexican pesos)				
Extended the internship	None, or less than 500	Yes, between 501 and 2000	Yes, between 2001 and 4,000	Yes, more than 4,000	Total
No	29.2	22.1	9.3	1.7	62.3
Yes	3.1	12.6	16.5	5.6	37.7
Total	32.3	34.6	25.8	7.3	100.0

underscores the effectiveness of internships as a bridge between academic learning and professional internship. Although 85% of students reported feeling adequately prepared, this percentage is relatively lower compared to other items.

The results in Figure 3 show that the CUCEI students surveyed valued positively what the internships provided in practical experience dimension. This aligns with findings from Ponce-Ceballos et al. (2024), which emphasize the value of situated learning environments

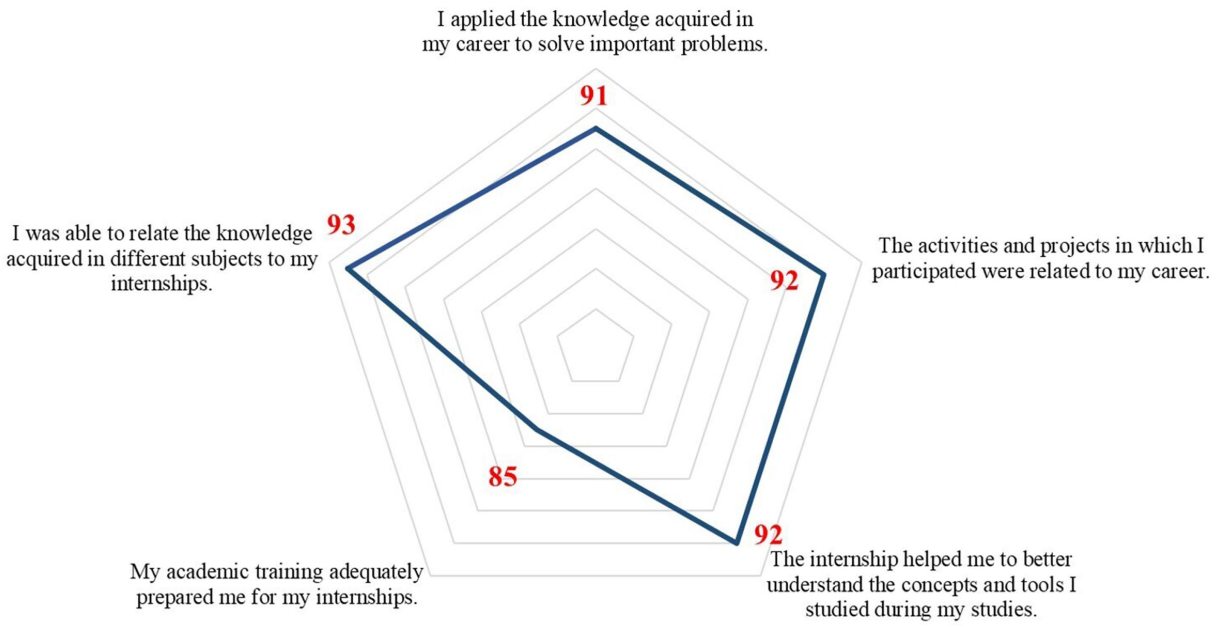

FIGURE 3
Percentage of responses selecting "Agree" or "Strongly Agree" for the practical experience items.

in fostering the application of academic knowledge to real-world tasks. However, this contrasts with Lowe et al. (2024), who reported that technical skills were often perceived as being better developed in academic settings. For example, studies suggest that practical experience enhances cross-disciplinary learning when embedded in structured workplace settings (Winberg et al., 2020).

3.3 Technical skills dimension

The dimension addressing the development of technical skills through internships revealed more moderate outcomes compared to the other areas evaluated. While mean scores ranged from 3.9 to 4.3, they were accompanied by relatively high standard deviations—in some cases exceeding 1.1—which points to considerable variability in student experiences. The proportion of students who selected "Quite a lot" or "A lot" was lower than in other dimensions, generally ranging between 66 and 79% (see Table 1 and Figure 4). This suggests that opportunities to develop technical competencies were not equally available to all students. This is to be expected, because a student does not have to participate in all the activities contemplated in the items of this dimension.

Nevertheless, some areas showed better results. For instance, 79% of students reported applying techniques and tools from their academic training, and 77% indicated receiving technical training or working with specialized technology. Previous research has highlighted the role of internships in strengthening technical competencies within engineering education (Byrne et al., 2020; McHenry and Krishnan, 2022). Moreover, the fact that 73% of students reported developing data analysis skills during their internships underscores the relevance of experiential learning for one of the most sought-after competencies in today's job market.

3.4 Soft skills dimension

The final dimension analyzed was the contribution of internships to the development of soft skills. In general, students positively valued their growth in interpersonal and adaptive competencies, with mean scores ranging from 2.7 to 4.6. The highest-rated items were those related to teamwork, adaptability, and receiving feedback, all of which received high frequencies of "Quite a lot" or "A lot" responses—between 88 and 90%—and mean values above 4.4 (see Table 1 and Figure 5). These results reinforce the notion that internships offer consistent opportunities for collaboration and personal development. The nearly unanimous agreement (90% or higher) on teamwork and feedback highlights the role of supportive professional environments in facilitating meaningful learning, particularly through mentorship and social integration.

However, the data also reveal greater variability in the development of other soft skills. The use of a second language, for example, received the lowest mean score (2.7) and the highest standard deviation (SD = 1.31), indicating that opportunities to practice language skills were limited and unevenly distributed among students. Likewise, the development of presentation skills, although rated more favorably (mean = 3.9), was not as prevalent as other soft skill areas, with 68% of students reporting high levels of participation. These findings suggest that not all internships provided structured experiences for cultivating communication competencies, which are increasingly valued in professional settings.

Overall, these results align with previous research emphasizing the critical role of soft skills in enhancing employability, and they reaffirm the importance of feedback mechanisms and adaptive behavior as key outcomes of well-designed internship programs (Winberg et al., 2020; Byrne et al., 2020; Lowe et al., 2024).

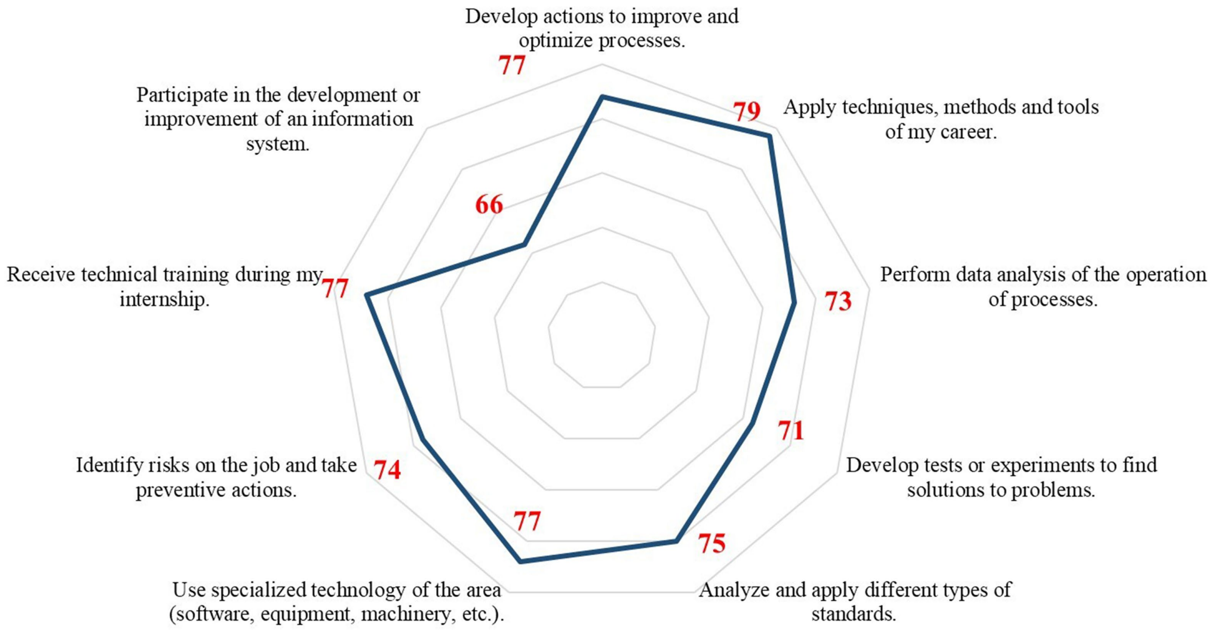

FIGURE 4
Percentage of responses selecting "Quite a lot" or "A lot" for the technical skills items.

FIGURE 5
Percentage of responses selecting "Quite a lot"or "A lot" for the soft skills items.

3.5 Learnings

At the end of the questionnaire, three open-ended questions were asked with the intention of expanding the details of the students' perception of the knowledge acquired, the equipment handled and whether they had suggestions for improving the curriculum of their career. The results are presented below.

3.5.1 What new knowledge did you acquire which is related to your career during your internship?

Most of the students gave detailed answers to this question, which is a positive fact for the evaluation of the instrument and the impact of the professional internships. Only eight of the 589 cases were null responses or indicated that they had learned nothing or almost nothing. A code was made in R to count the words in the responses, eliminating articles, connectors and, in general, what are known as stopwords. The average number of words in the responses was 15.7. With the support of *ChatGPT*, a *Python* script was generated to perform a frequency analysis of words and key phrases, as well as to group responses into categories. The results obtained are presented below.

- Handling (94 mentions): Includes the operation of equipment, tools, or technical systems.
- Processes (79 mentions): Knowledge and application of technical and operational processes.
- Equipment (71 mentions): Use and operation of specialized equipment (laboratories, industrial).
- Analysis (65 mentions): Skills in technical or data analysis related to the career.
- Quality (59 mentions): Knowledge of standards and quality control.
- Standards (45 mentions): Learning of technical regulations relevant to the sector.
- Control (34 mentions): Management or supervision of technical processes.
- Laboratory (33 mentions): work in laboratory environments, experimentation and associated techniques.
- Software (32 mentions): Use of specific digital tools for the career.
- Tools (31 mentions): Implementation of technical or methodological tools.
- Techniques (25 mentions): Mastery of practical techniques related to the professional field.
- Optimization (7 mentions): improvements in technical processes or systems.

The term "processes" (79 mentions) covers both specific operational processes and quality management procedures, reflecting both technical and administrative learning. This list of 12 key words and their descriptors clearly indicate that the students were confronted with real productive technical environments, which is the central purpose of the internship.

3.5.2 What were the main specialized equipment you learned to use in the company during your internship?

Approximately 90% of the students responded to this question, specifying the specialized equipment they used during their internships. The following table, also generated using a *Python* script developed with the support of *ChatGPT*, presents a general classification of these tools (Table 3).

In software tools, general and specific mentions are made, such as Autocad, SAP and Excel. In equipment, HPLC (liquid chromatography), ammeters, balances, agitators, analysis systems (Alinity, Cel Dyn Rubi) are mentioned.

TABLE 3 General classification of tools that students reported using during their internships.

Category	Count
Software tools	117
Laboratory equipment	95
General equipment	66
Measurement tools	27

The answers obtained from this question and the previous one are an important complement to the information obtained through different items of the questionnaire, particularly those of the practical and technical experience dimensions. They also serve as a basis for why the students, in general terms, feel satisfied with the experience obtained in their internship.

3.5.3 Do you have any suggestions for improvement in the curriculum of your career to adapt it more to the labor needs of graduates?

In this question, 72% of the students gave some suggestions. In many of them, the suggestions were broad. The average number of words in these responses was 11.6. The summary of the suggestions obtained, also generated using a *Python* script developed with the support of *ChatGPT*, is presented below.

1. Subjects (Topics) – Requests for changes or additions in specific courses (95 mentions).
2. More Practical Experience – Increased requests for practice-oriented activities (51 mentions).
3. Industry Collaboration – Inclusion of more collaboration or exposure to companies and industry (33 mentions).
4. Curriculum Updates – Suggestions for updating the course structure and content to stay relevant to market demands.
5. Software and Tools – Emphasis on training in relevant tools (e.g., Excel) to meet job expectations (mentions of Excel: 29).

The qualitative responses provided further insights into curriculum enhancement. Many students suggested increasing hands-on activities and collaboration with industry partners, consistent with Peña et al. (2016), who advocated for the inclusion of practical courses aligned with labor market needs. Respondents also emphasized the need for more training in software reinforcing McHenry and Krishnan (2022) assertion that technological proficiency is essential for professional readiness. This finding aligns with Peña et al. (2016), who highlighted the need to strengthen practical content through increased collaboration with industry. Furthermore, addressing these curriculum gaps aligns with research on adaptive learning strategies that support real-world preparation.

4 Discussion and conclusions

4.1 Impact on professional development

The findings indicate that internships contributed to students' professional development. In general, students reported that the objectives of the internship were met. They have been able to transfer what they have learned at the university to the world of work, which in turn has allowed them to develop new skills and knowledge.

One of the main findings of this study is the level of satisfaction expressed by students regarding their internships. These levels are supported by positive perceptions of the items of the other dimensions. Similar findings from Arias-Marín et al. (2021) underscore that effective company management and mentoring are pivotal for positive student perceptions.

The organization and follow-up of activities during their professional internships significantly enhanced their ability to achieve their objectives. Rodríguez-Díaz et al. (2022) mention that the success of professional internships depends on effective management that includes planning, organizing, implementing and evaluating the process, ensuring that students face the challenges of the current work environment.

The results indicate that internships may play a key role in early professional integration. 37.7% of students extended their internship, 30.4% received significant financial compensation, and 45.0% expressed a strong intention to remain at their host company. These figures reflect the potential of internships to foster long-term employment opportunities and strengthen the link between academic training and the labor market.

For the 27 of the 28 questionnaire items, mean scores range from 3.9 to 4.8 on a 1–5 scale, with standard deviations between 0.56 and 1.17, indicating limited dispersion around high values. Skewness coefficients are negative (−0.76 to −3.57) and 23 of the kurtosis coefficients are positive (0.06 to 14.41), reflecting leptokurtic distributions skewed toward the "A lot" or "Always" categories. This pattern can be attributed in part to a ceiling effect common in satisfaction surveys when most respondents report positive experiences (Chyung et al., 2020). Moreover, the mandatory nature of the internships and the institutional framework—over 600 formally affiliated companies and a unified digital tracking system—tend to standardize the quality of placements, thereby reducing variability. Finally, treating ordinal Likert data as interval-level may further compress variability, yielding lower standard deviations. Given these limitations, we interpret our results with caution, emphasizing general patterns.

4.2 Alignment of academic training with practical needs

Notably, an adequate environment is the first step for internships to reach their formative potential. However, the acquisition of professional experience through effective integration of theoretical and practical knowledge was also an indicator of internship program effectiveness. A significant proportion of students indicated that their academic training prepared them for their internships and allowed them to apply theoretical knowledge effectively. This highlights the role of situated learning in fostering knowledge mobilization, as described by Ponce-Ceballos et al. (2024). The students also mentioned that the activities they performed were really related to their career. According to Chávez-Loor et al. (2019), they need to participate in activities that aim to develop specific skills related to their specialty, as this contributes to their training as future professionals in a specific context. Internships allow for the integration of the knowledge and skills that are necessary for the problems solution (Carrera-Erazo et al., 2018). However, it is necessary to train highly competent professionals (Rodríguez-Díaz et al., 2022), responses to open-ended questions revealed a gap between specific academic courses and industry demands, suggesting the need for curriculum updates to stay relevant.

The internships not only allowed students to apply theoretical knowledge in real-world settings, but were also fundamental to the development of new skills and knowledge in their fields of study. The internships fostered the development of both technical and soft skills, providing students with hands-on experience in using applied technology, employing career-specific techniques, methods, and standards, as well as designing experiments and projects to address problems in specialized areas. Similar Wan et al. (2024) and Zakaria et al. (2024), the formative impact of internships on students was observed, with multifaceted learning experiences that enhanced knowledge, technical and soft skills, as well as the ability to solve problems, effective communication, teamwork, and critical thinking, among others. Zakaria et al. (2024) highlight the important role of internships in equipping students with essential skills and practical experience, thereby enhancing their future employability. Simultaneously, internships benefit companies by reducing costs and streamlining the recruitment process through the targeted training of professionals in areas aligned with their specific needs.

An important tool for developing technical skills was the continuous training during the internship. Although some students stated that they did not feel fully prepared at the beginning of the program, they mentioned that they had access to technical training. Haddouchane et al. (2017) mention that this strategy is essential in order to align the academic training with the labor market demands. This approach enables students to acquire specific competencies that enhance their employability and facilitate a successful transition into the professional field.

4.3 Opportunities for improvement

The data also reveal that while technical skills were developed to some extent (with 66 to 79% of students reporting positive outcomes), there is still room to enhance soft skills training. Responses regarding soft skills were generally favorable, particularly in teamwork, adaptability, and feedback reception, with the highest-rated items exceeding 85%. However, a notable gap remains in the development of communication-related competencies. Specifically, only 27% of students reported practicing a second language during their internship, highlighting a critical area for improvement. This finding aligns with Byrne et al. (2020), who argued that language proficiency is an often overlooked yet essential skill for employability in global industries.

It is important to note that the data analyzed primarily reflect the experiences of students from a limited number of academic programs —specifically Industrial Engineering, Pharmaceutical Chemistry, Chemical Engineering, and Civil Engineering— which may introduce a disciplinary bias in the findings. Future studies should aim to include a more balanced representation across all academic programs or consider conducting program-specific analyses to better capture the diversity of internship experiences.

Future research could explore longitudinal data to assess the long-term impact of internships on employment outcomes and professional growth. Additionally, comparative studies across different academic disciplines and institutions could provide a broader understanding of best practices in professional internship programs. Other perspective would be recovery information from the employers which receive these students.

4.4 Conclusion

This study supports the role of professional internships as a relevant component of science and engineering education. The internship experiences analyzed were generally effective in supporting students' satisfaction, technical and soft skill development, and the practical application of academic knowledge. However, the findings also reveal variability in learning opportunities and underscore the need to strengthen curriculum-industry alignment.

Internships show potential not only as formative experiences but also as a pathway to professional integration, offering students opportunities to extend their training, receive compensation, and transition into long-term employment.

A key aspect of this study is the thorough development and validation of the questionnaire used for data collection. The study highlights areas for improvement, such as incorporating more training in specific tools and integrating language-focused activities to enhance global employability. Student feedback also suggests increasing hands-on learning opportunities and fostering stronger collaborations with industry partners, aligning with research advocating for adaptive learning strategies.

Data availability statement

The datasets underlying this study are not publicly available. However, qualified researchers may request access by contacting humberto.gpulido@academicos.udg.mx.

Ethics statement

The studies involving humans were approved by Colegio Departamental del Departamento de Matemáticas del CUCEI. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

HG-P: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Validation, Writing – review & editing. CO-R: Conceptualization, Funding acquisition, Investigation, Methodology, Writing – review & editing.

Funding

The author(s) declare that financial support was received for the research and/or publication of this article. This research was partially funded by the Centro Universitario de Ciencias Exactas e Ingenierías (CUCEI) of the University of Guadalajara, under project number P3E 280441.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The authors declare that Gen AI was used in the creation of this manuscript. ChatGPT was used to analyze responses and calculate the average word count. It also synthesized key terms and insights from the data and generated a table categorizing tools commonly reported by students during their internships. DeepL Write was used to refine the writing in English.

Publisher's note

Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/feduc.2025.1563361/full#supplementary-material

References

Agresti, A., and Kateri, M. (2011). "Categorical data analysis" in International encyclopedia of statistical science. ed. M. Lovric (Berlin, Heidelberg: Springer), 206–208. doi: 10.1007/978-3-642-04898-2_161

Arias-Marín, L., García-Restrepo, G., and Cardona-Arias, J. A. (2020). Evaluación psicométrica de una rúbrica para evaluación de prácticas profesionales desde la perspectiva de los estudiantes: un estudio de caso (Psychometric Evaluation of a Rubric for the Evaluation of Professional Practices from the Students' Perspective: A Case Study). *Trilogía Ciencia Tecnología Sociedad* 12, 61–84. doi: 10.22430/21457778.1713

Arias-Marín, L. A., García-Restrepo, G., and Cardona-Arias, J. A. (2021). Evaluación del proceso de prácticas profesionales en Microbiología Industrial y Ambiental desde la perspectiva de instituciones externas, Medellín-Colombia, 2009-2017. *Hechos Microbiológicos* 12, 13–23. doi: 10.17533/udea.hm.v12n2a02

Bolarinwa, O. A. (2015). Principles and methods of validity and reliability testing of questionnaires used in social and health science researches. *Niger. Postgrad. Med. J.* 22, 195–201. doi: 10.4103/1117-1936.173959

Bórquez-Tamayo, G. B., Rossetti-López, S. R. R., and Ozuna-Beltrán, A. G. O. (2024). Valoración de estudiantes sobre la gestión, desarrollo, satisfacción y utilidad de Prácticas Profesionales en instituciones de Educación Superior. *RIDE Revista Iberoam. Investig. Desarrollo Educativo* 15. doi: 10.23913/ride.v15i29.2125

Broder, H.L., McGrath, C., and Cisneros, G.J. (2007). Questionnaire development: face validity and item impact testing of the child Oral health impact profile – Broder – 2007 – community dentistry and Oral epidemiology – Wiley online library

Byrne, Z. S., Weston, J. W., and Cave, K. (2020). Development of a scale for measuring students' attitudes towards learning professional (i.e., soft) skills. *Res. Sci. Educ.* 50, 1417–1433. doi: 10.1007/s11165-018-9738-3

Calonge, D. S., and Shah, M. A. (2016). MOOCs, graduate skills gaps, and employability: a qualitative systematic review of the literature. *Int. Rev. Res. Open Distributed Learn.* 17, 68–90. doi: 10.19173/irrodl.v17i5.2675

Carrera-Erazo, S. C., Perreño-Sánchez, J. C., and Ayala-Esparza, V. A. (2018). El desempeño profesional de los Estudiantes universitarios Un las Prácticas Pre-profesionales. *Opuntia Brava* 9, 89–96. doi: 10.35195/ob.v9i1.120

Chan-Pavon, M. V., Mena-Romero, D. A., Escalante-Euán, J. F., and Rodríguez-Martín, M. D. (2018). Contribución de las Prácticas Profesionales en la formación de los Estudiantes de la Facultad de Ingeniería Química de la Universidad Autónoma de Yucatán (México). *Formación Universitaria* 11, 53–62. doi: 10.4067/S0718-50062018000100053

Chávez-Loor, M. D., Chancay-Cedeño, C. H., Chávez-Loor, Y. P., and Mendoza-Bravo, K. L. (2019). Las prácticas pre profesionales y su impacto social. *ReHuSo* 4, 129–136. doi: 10.33936/rehuso.v4i2.1764

Chyung, S. Y., Hutchinson, D., and Shamsy, J. A. (2020). Evidence-based survey design: ceiling effects associated with response scales. *Perform. Improv.* 59, 6–13. doi: 10.1002/pfi.21920

Corbella, V., and Giuliania, M. C. (2024). Competencias transversales: Percepción del alumnado de la Universidad Católica Argentina. *Revista Andina Educ.* 7:22. doi: 10.32719/26312816.2024.7.2.3

González-Riaño, X. A., and Hevia-Artime, I. (2011). El Practicum de la Licenciatura de Pedagogía: estudio empírico desde la perspectiva del alumnado. *Revist. Educ.* 354, 209–236.

González, J., Wagenaar, R., and Beneitone, P. (2004). Tuning-América Latina: un proyecto de las universidades. *Revista Iberoamericana De Educación*, 35, 151–164. doi: 10.35362/rie35088

Green, B. P., Graybeal, P., and Madison, R. L. (2010). An exploratory study of the effect of professional internships on students' perception of the importance of employment traits. *J. Educ. Bus.* 86, 100–110. doi: 10.1080/08832323.2010.480992

Gutiérrez Pulido, H., Gutiérrez González, P., Garibay López, C., and Díaz Caldera, L. (2014). Multivariate analysis and QFD as tools to listen to the voice of the customer and improve service quality. *Ingeniare. Revista Chilena Ingeniería* 22, 62–73. doi: 10.4067/S0718-33052014000100007

Haddouchane, Z. A., Bakkali, S., Ajana, S., and Gassemi, K. (2017). The application of the competency-based approach to assess the training and employment adequacy problem. *IJE* 5, 01–18. doi: 10.5121/ije.2017.5101

Lowe, D., Tilley, E., Willey, K., and Roach, K. (2024). Student reactions to the development of professional engineering competencies. *Eur. J. Eng. Educ.* 50, 281–297. doi: 10.1080/03043797.2024.2354240

Marín-Marín, J. A., Moreno-Guerrero, A. J., Dúo-Terrón, P., and Belmonte, J. L. (2021). STEAM in education: a bibliometric analysis of performance and co-words in Web of Science. *IJ STEM Ed* 8:41. doi: 10.1186/s40594-021-00296-x

Mayorga Fernández, M. J., Sepúlveda Ruiz, M. P., Madrid Vivar, D., Gallardo Gil, M., Mayorga Fernández, M. J., Sepúlveda Ruiz, M. P., et al. (2017). Grado de satisfacción y utilidad profesional de las prácticas externas del alumnado de la Facultad de Ciencias de la Educación de la Universidad de Málaga (España). *Perfiles Educativos* 39, 140–159. doi: 10.22201/iisue.24486167e.2017.157.58446

McHenry, R., and Krishnan, S. (2022). A conceptual professional practice framework for embedding employability skills development in engineering education programmes. *Eur. J. Eng. Educ.* 47, 1296–1314. doi: 10.1080/03043797.2022.2164255

Nogueira, T., Magano, J., Fontão, E., Sousa, M., and Leite, Â. (2021). Engineering students' industrial internship experience perception and satisfaction: work experience scale validation. *Educ. Sci.* 11:671. doi: 10.3390/educsci11110671

Peña, T., Castellano, Y., Díaz, D., and Padrón, W. (2016). Las Prácticas Profesionales como Potenciadoras del Perfil de Egreso: Caso: Escuela de Bibliotecología y Archivología de La Universidad del Zulia. *Paradígma* 37, 211–230.

Ponce-Ceballos, S., Castellanos-Ramírez, J.-C., and Aviña-Camacho, I. (2024). Formación universitaria a través de prácticas situadas en ambientes reales. *Revista Iberoam. Educ. Superior* 15, 56–77. doi: 10.22201/iisue.20072872e.2024.42.1663

Ramírez-Cruz, J. C., Pedraza-Medina, R., and Latorre, M. L. Á. (2018). Validación de una Escala de Satisfacción Académica de Prácticas Profesionales. *Acta Ciencia Salud* 5, 36–44. doi: 10.32870/acs.v0i5.55

Revelle, W. (2025). Psych: Procedures for Psychological, Psychometric, and Personality Research (Version 2.5.3) [Manual]. Northwestern University. Available at: https://personality-project.org/r/psych/HowTo/psych_manual.pdf

Rodríguez-Díaz, J. L., Cabrera-Olvera, J. L., and Muñoz-Guanga, A. P. (2022). El éxito de las Prácticas pre-profesionales: ¿De qué depende? *Revista Habanera Ciencias Médicas* 21, 1–8.

Tuning Academy (2025). "Generic competences." *Universidad de Deusto*. https://www.unideusto.org/tuningeu/competences/generic/ (Accessed April 28, 2025)

Wan, N. Z. N., Razak, S., San, S., Hussin, S. N. A., Aziz, A. A., and Saidi, N. (2024). Exploring the educational impact: a study on accounting students' learning and development during internship. *Int. J. Educ. Psychol. Counsel.* 9, 581–592. doi: 10.35631/IJEPC.954044

Winberg, C., Bramhall, M., Greenfield, D., Johnson, P., Rowlett, P., Lewis, O., et al. (2020). Developing employability in engineering education: a systematic review of the literature. *Eur. J. Eng. Educ.* 45, 165–180. doi: 10.1080/03043797.2018.1534086

Zakaria, Z. N. Z., Awang, Y., Nasir, N. E. M., and Taib, A. (2024). Examining the Nexus between internships and employability: a bibliometric perspective. *Advances Soc. Sci. Res. J.* 11, 120–134. doi: 10.14738/assrj.119.2.17407