

Women in Engineering: Academic Challenges and Opportunities in the Current University Setting

Las mujeres en la ingeniería: los desafíos académicos y oportunidades en el ámbito universitario actual

David Salomon Quispe Choque

Facultad de Ciencias y Humanidades, Universidad Andina del Cusco, Perú

<https://orcid.org/0009-0003-6600-4530>

quispec@uandina.edu.pe

Juan Paulo Catunta Huamane

Escuela Profesional de Contabilidad, Universidad Andina del Cusco, Perú

<https://orcid.org/0009-0001-5167-3657>

010220013c@uandina.edu.pe

Ruth Thalia Quispe Mamani

Escuela Profesional de Contabilidad, Universidad Andina del Cusco, Perú

<https://orcid.org/0009-0009-3587-2646>

025120142j@uandina.edu.pe

Sergio Achahui Llusca

Escuela Profesional de Contabilidad, Universidad Andina del Cusco, Perú

<https://orcid.org/0009-0004-6871-5480>

025120001g@uandina.edu.pe

Noemí Tupa Quispe

Escuela Profesional de Contabilidad, Universidad Andina del Cusco, Perú

<https://orcid.org/0009-0007-8520-1483>

025120193c@uandina.edu.pe

Sonia Mejía Ayala

Escuela ESPP Gregoria Santos, Cusco, Perú

<https://orcid.org/0009-0005-3376-7333>

soniamejia@colegiojapan.edu.pe

Cite: Quispe, D., Catunta, J., Quispe, R., Achahui, S., Tupa, N., Mejía, S. (2026). Las mujeres en la ingeniería: los desafíos académicos y oportunidades en el ámbito universitario actual. *Mujer Andina*, 5(1), e050103. <https://doi.org/10.36881/ma.v5i1.1389>

Mujer Andina, July - December 2026, Vol. 5(1)



Corresponding author

David Salomon Quispe
quispec@uandina.edu.pe

No conflict of interest declared

Received: 01/07/2026

Reviewed: 05/08/2026

Accepted: 10/08/2026

Published: 30/08/2026

Abstract

Despite institutional advances aimed at promoting gender equality, careers related to science, technology, engineering, and mathematics (STEM) continue to exhibit a significant underrepresentation of women worldwide. This study aimed to determine the relationship between the academic challenges and opportunities faced by women in the university engineering environment. Methodologically, the research adopted a quantitative approach, basic research type, non-experimental design, and descriptive-correlational level. The sample consisted of 15 students from the Faculty of Engineering and Architecture at the Andean University of Cusco, Sicuani Campus, selected through non-probability convenience sampling. A structured questionnaire comprising 20 items distributed across six critical dimensions was administered. The results revealed the existence of "passive formal inclusion." On the one hand, equal opportunities emerged as the strongest dimension, with 66.7% of participants reaching the optimal level and 0.0% at the critical

level. However, areas of vulnerability persisted in University Participation (26.7% at the critical level) and Institutional Support (26.7% at the critical level). Furthermore, an exact symmetrical pattern was identified between Academic Performance and Personal Growth, with both dimensions recording 40.0% at the optimal level and 40.0% at the moderate level. It is concluded that the faculty has effectively eliminated explicit forms of vertical gender discrimination; however, it needs to strengthen student welfare services, academic tutoring, and institutional mentoring programs to facilitate the transition of female students from purely operational roles to positions of genuine leadership.

Keywords: women in engineering, academic challenges, university opportunities, gender gap, higher education.

Resumen

A pesar de los avances institucionales orientados a promover la igualdad de género, las carreras vinculadas a las ciencias, la tecnología, la ingeniería y las matemáticas (STEM) continúan registrando una marcada subrepresentación de mujeres a nivel global. Tuvo como objetivo determinar la relación entre los desafíos académicos y las oportunidades que enfrentan las mujeres en el entorno universitario de la ingeniería. Metodológicamente, se adscribe a un enfoque cuantitativo, tipo básico, diseño no experimental, nivel descriptivo-correlacional. La muestra estuvo conformada por 15 estudiantes de la Facultad de Ingeniería y Arquitectura de la Universidad Andina del Cusco, sede Sicuani, seleccionadas mediante un muestreo no probabilístico por conveniencia, a quienes se les aplicó un cuestionario estructurado de 20 ítems distribuido en seis dimensiones críticas. Los resultados revelan la existencia de una “inclusión formal pasiva”: por un lado, la igualdad de oportunidades se consolida como la dimensión más fortalecida con un contundente 66.7% en nivel óptimo y 0.0% en nivel crítico; sin embargo, persisten focos de vulnerabilidad en la participación universitaria (26.7%) nivel crítico y en el apoyo institucional (26.7%) nivel crítico. Asimismo, se identificó una réplica simétrica exacta entre el rendimiento académico y el crecimiento personal, donde ambos registraron un 40.0% en rango óptimo y un 40.0% regular. Se concluye que la facultad ha erradicado eficazmente las barreras de discriminación vertical explícita, pero requiere dinamizar sus servicios de bienestar, tutorías y mentorías institucionales para potenciar el tránsito de las alumnas desde roles puramente operativos hacia posiciones de liderazgo real.

Palabras clave: mujeres en ingeniería, desafíos académicos, oportunidades universitarias, brecha de género, educación superior.

Introduction

Despite substantial progress in female inclusion within higher education over recent decades, a marked underrepresentation of women persists in science, technology, engineering, and mathematics (STEM) disciplines, particularly within engineering programs—a phenomenon consistently observed across Ibero-America and globally. This

disparity represents not only a matter of equity and social justice but also constitutes a strategic challenge for technological development, innovation, and national competitiveness, especially within a global context that increasingly demands qualified professionals in scientific and technological fields (Ortiz-Martínez et al., 2023).

Gender gaps are closely intertwined with region-specific sociocultural, economic, and institutional factors. Although women's access to higher education has increased, this has not translated into proportional representation within engineering degree programs. Female underrepresentation in STEM fields remains a persistent issue that compromises both the entry and retention of women in these disciplines. Gender stereotypes exert a crucial influence on engagement in these areas. From an early age, society establishes gendered roles that significantly shape identity formation (Garvizu & Vargas, 2025). Coupled with these are institutional barriers, including the scarcity of female role models in academic leadership positions, the absence of work-life balance policies, and the persistence of androcentric organizational cultures that naturalize the masculinization of knowledge spaces within engineering (Radovic et al., 2021).

Women who choose to pursue this path confront multifaceted obstacles that hinder their admission and persistence in the field, such as a lack of familial, social, and institutional support, a dearth of visible role models, and societal pressure to balance work and family responsibilities—particularly motherhood. These prevailing norms reinforce the perception that engineering and technology are inherently male-dominated fields, thereby discouraging many women from entering and, even more so, from remaining in these disciplines (Garvizu & Vargas, 2025). The lack of role models reported by participants in this study underscores the critical importance of mentors and visible figures in guiding STEM career choices (Trejo et al., 2024).

The growing recognition of gender diversity's role in driving innovation and scientific excellence has catalyzed institutional policies and targeted programs aimed at promoting the inclusion and retention of women in engineering (Loría & Villagómez, 2023). Women who successfully persist in these programs develop strategies of resistance and agency that enable them to navigate structural barriers, highlighting the critical role of peer support networks, mentorship, and the construction of alternative professional identities that challenge dominant stereotypes (Martínez-Galaz et al., 2022).

The increasing institutionalization of the gender perspective and the implementation of equity policies offer a conducive framework for transforming academic cultures within engineering (Zepeda & Villagómez, 2021); hence, promoting a culture of gender equity across university environments is essential. This entails training faculty and administrative staff, alongside implementing comprehensive measures to prevent and eradicate gender-based harassment and discrimination on university campuses (Garvizu & Vargas, 2025). The implementation of mentorship programs, the increased visibility of female role models, gender-informed curriculum reviews, and the establishment of robust anti-discrimination and anti-harassment protocols constitute fundamental actions toward achieving greater equity in engineering (Carrasco & Valenzuela, 2021).

According to the Programa Estado de la Nación (2023), targeted university policies aimed at closing gender gaps can directly yield positive impacts on academic performance and graduation indicators, thereby optimizing the overall cost-efficiency of the learning process. Progress in the labor market remains tightly linked to work-life balance. To mitigate the structural interdependencies that continue to constrain opportunities for women, establishing diverse support systems is critical (Galhardi de Pujalt, 2007).

Furthermore, STEM education—particularly in engineering and technology—serves as a vital catalyst for achieving the Sustainable Development Goals (SDGs), notably SDG 5 on gender equality (Garvizu & Vargas, 2025).

Accordingly, this study aims to examine the academic challenges and opportunities faced by women within university engineering programs, considering the intersection of structural, institutional, and personal factors that shape their educational trajectories (Loría & Villagómez, 2023). Female underrepresentation in engineering represents a multidimensional problem requiring diverse theoretical and methodological approaches (Zepeda & Villagómez, 2021) to dismantle the mechanisms that perpetuate gender inequality, as well as to

identify policies and strategies proven effective in promoting female inclusion and persistence (Radovic et al., 2021). Continuous monitoring and rigorous evaluation of progress remain crucial for refining these strategies to secure meaningful medium- and long-term outcomes (Garvizu & Vargas, 2025).

Although the path ahead remains arduous and the obstacles manifold, immense opportunities exist to strengthen the effective protection of women’s rights and, consequently, drive gains in national economic productivity (Román Forastelli, 2023). Ultimately, a multisectoral approach centered on educational institutions is imperative to foster an organizational culture genuinely open to equitable and fair female participation in STEM disciplines (Garvizu & Vargas, 2025).

Methodology

This study is situated within a positivist paradigm and adopts a basic quantitative approach, utilizing a non-experimental, descriptive-correlational design aimed at understanding and measuring the experiences of women in engineering (Hernández-Sampieri & Mendoza, 2018). The sample comprised 15 female students enrolled in the 1st through 6th semesters at the Faculty of Engineering and Architecture, Universidad Andina del Cusco (Sicuani campus), selected via non-probability convenience sampling. The inclusion criteria were: (a) identifying as female, (b) being officially enrolled in the Faculty of Engineering during the active academic term, (c) being currently enrolled in any semester from the 1st to the 6th academic term, and (d) providing informed consent to voluntarily participate in the study. Conversely, the exclusion criteria encompassed students not currently enrolled in the present academic semester, those belonging to other academic departments or faculties, and individuals who chose not to participate.

Inclusion criteria were verified through the official enrollment records provided by the Coordination of the Professional School of Engineering at the Universidad Andina del Cusco, Sicuani campus.

Data collection took place during the 2026-I academic semester, specifically between May 26 and May 28, 2026, on the premises of the Universidad Andina del Cusco, Sicuani campus, following institutional authorization from academic authorities and upon obtaining informed consent from participants.

The survey technique was employed using a structured 20-item questionnaire organized across six dimensions (academic performance, university participation, institutional support, professional development, equality of opportunity, and personal growth), measured on a Likert scale (never, sometimes, and always). Statistical analysis was performed using Microsoft Excel and IBM SPSS Statistics (v. 26) to compute item-level and dimension-level means. Finally, regarding research ethics, response anonymity and confidentiality were strictly maintained, informed consent was secured, and standard research ethics principles were observed (Resnik & Shamoo, 2011).

Results

The following section presents the findings derived from the survey administered to 15 female engineering students at the Universidad Andina del Cusco (Sicuani campus). Descriptive data analyses were conducted to evaluate six dimensions.

Table 1. Academic Performance

	Levels	Frequency	Percentage	Valid Percentage
Valid	Never	3	20,0	20,0
	Sometimes	6	40,0	60,0
	Always	6	40,0	100,0
	Total	15	100,0	

Table 1 indicates that 40.0% of the students reported always demonstrating adequate academic performance, while another 40.0% indicated doing so only sometimes. Conversely, 20.0% stated that they never achieve this level of performance. These findings demonstrate that the majority of students exhibit moderate to favorable academic achievement; nevertheless, the presence of

a subgroup in the “Never” category highlights the need to reinforce academic support and tutoring strategies to enhance performance.

Table 2.
University participation

	Levels	Frequency	Percentage	Valid Percentage
Valid	Never	4	26,7	26,7
	Sometimes	8	53,3	80,0
	Always	3	20,0	100,0
	Total	15	100,0	

Table 2 illustrates that 53.3% of the students reported participating in university activities only sometimes, whereas 26.7% stated that they never do so, and merely 20.0% indicated that they always participate. These results demonstrate that student participation is predominantly occasional, with a significant proportion of female students exhibiting low levels of involvement in academic, extracurricular, or student representation activities. Consequently, these findings highlight the need to strengthen institutional strategies that foster greater participation and engagement among female students in university life.

Table 3.
Institutional Support

	Levels	Frequency	Percentage	Valid Percentage
Valid	Never	4	26,7	26,7
	Sometimes	8	53,3	80,0
	Always	3	20,0	100,0
	Total	15	100,0	

Table 3 indicates that 53.3% of the students reported perceiving institutional support from the university only sometimes, whereas 26.7% stated that they never receive such support, and merely 20.0% indicated that they always perceive it. These findings demonstrate that institutional support is perceived at a moderate level by the majority of students, although a significant subgroup considers the support provided by the institution to be insufficient. Within this context, the results highlight the necessity of strengthening academic

support services, psychological counseling, tutoring, and orientation programs to promote the well-being and retention of women in engineering degree programs.

Table 4.
Professional Development

	Levels	Frequency	Percentage	Valid Percentage
Valid	Never	2	13,3	13,3
	Sometimes	10	66,7	80,0
	Always	3	20,0	100,0
	Total	15	100,0	

Table 4 shows that 66.7% of the students reported perceiving opportunities for their professional development only sometimes, whereas 20.0% stated that they always have access to them, and 13.3% noted that they never perceive such opportunities. These results demonstrate that professional development exists at a predominantly moderate level, suggesting that while training and professional advancement opportunities do exist, they are not yet sufficiently available or accessible to all female students. Consequently, it is necessary to strengthen institutional strategies aimed at expanding internship programs, specialized training, mentorships, and linkages with the industrial sector to promote the comprehensive development and workforce integration of future female engineers.

Table 5.
Equality of Opportunity

	Levels	Frequency	Percentage	Valid Percentage
Valid	Never	0	0	0
	Sometimes	5	33,3	33,3
	Always	10	66,7	100,0
	Total	15	100,0	

Table 5 indicates that 66.7% of the students reported always perceiving equality of opportunity throughout their university education, while 33.3% indicated that this occurs only sometimes. Notably, no responses were recorded in the “Never” category (0.0%). These findings demonstrate a favorable perception regarding equitable

conditions within the Faculty of Engineering and Architecture, suggesting that the majority of female students consider themselves to have access to opportunities comparable to those of their peers in terms of utilizing resources, participating in academic activities, and advancing within the university environment. Nevertheless, the proportion of responses in the “Sometimes” category indicates that room for improvement remains to consolidate fully inclusive and complete equality of opportunity.

Table 6. Professional Growth

	Levels	Frequency	Percentage	Valid Percentage
Valid	Never	3	20,0	20,0
	Sometimes	6	40,0	60,0
	Always	6	40,0	100,0
	Total	15	100,0	

Table 6 illustrates that 40.0% of the students reported always experiencing professional growth throughout their university education, while another 40.0% indicated doing so only sometimes. Conversely, 20.0% stated that they never perceive professional growth. These findings demonstrate a generally favorable perception regarding students’ professional development, suggesting that the majority view their personal growth as comparable to that of their peers. Nonetheless, these results highlight the need to reinforce institutional strategies focused on competency development, continuous training, and professional updating opportunities to foster meaningful professional growth within university classrooms, while identifying critical areas for improvement to achieve successful growth on a broader scale.

Discussion

The findings demonstrate that female students enrolled in engineering programs experience a reality characterized by significant progress regarding equality of opportunity, even as persistent limitations remain concerning academic performance, university participation, institutional support, and professional growth. This coexistence of achievements and challenges reflects a dy-

namic widely documented in international literature on women in STEM, where institutional policies have progressively reduced formal barriers to access but have yet to fully eliminate the disparities that emerge throughout university trajectories (OECD, 2023; UNESCO, 2021).

Regarding academic performance, 40.0% of the students achieved an optimal level, another 40.0% exhibited a moderate level, and 20.0% remained at a critical level. These results suggest that female enrollment in engineering programs does not in itself guarantee equivalent conditions for academic success. Recent research indicates that female performance in engineering relies not solely on cognitive capabilities, but also on the institutional climate, sense of belonging, and the availability of academic support networks (Radovic et al., 2021; Rodríguez-Garcés et al., 2024). Furthermore, Martínez-Galaz et al. (2022) contend that female students continue to face gender-differentiated expectations—a phenomenon explained by Role Congruity Theory, which posits that social stereotypes yield more stringent evaluations when women participate in traditionally male-dominated professions. Consequently, the proportion of students positioned at the critical level may reflect structural conditions within the university environment rather than individual factors alone.

With respect to university participation, the finding that 26.7% of students are at a critical level demonstrates that women continue to engage to a limited extent in extracurricular activities, student representation spaces, and leadership roles. This result aligns with Loria-Lizama and Villagómez (2023), who report that female representation decreases as leadership responsibilities increase within engineering faculties. International studies reach similar conclusions, pointing out that the so-called “leaky pipeline” continues to manifest during undergraduate education, where many female students progressively reduce their participation due to cultural factors, the absence of female role models, and perceived scarcity of professional development opportunities (Cheryan et al., 2017; OECD, 2023; UNESCO, 2021).

In terms of institutional support, more than half of the participants (53.3%) perceived a moderate level, while 26.7% reported a critical level. This result reveals a gap between formally established institutional policies and students' actual perceptions of their effectiveness. Araneda-Guirriman and Sepúlveda-Páez (2021) contend that while many Latin American universities have incorporated equity policies, such actions tend to focus on access rather than permanent mechanisms for academic support, tutoring, mentorship, and student well-being. Similar findings were reported by UNESCO (2021), which identifies academic mentorship and support networks as key factors with the highest impact on female retention in STEM fields.

In the dimension of professional growth, a moderate level predominated (66.7%), followed by optimal (20.0%) and critical (13.3%) levels. These results indicate that female students recognize progress in acquiring technical competencies, yet perceive limited opportunities to strengthen professional skills through internships, research, or industry linkages. Vega Cano et al. (2023) found comparable results, demonstrating that female students value their disciplinary training positively but demand greater opportunities for specialization and early work experience. Numerous international studies indicate that participation in research projects, mentorship programs, and professional internships significantly increases female persistence and career aspirations in engineering (OECD, 2023; UN Women & UN DESA, 2024).

One of the most favorable results corresponds to equality of opportunity, where 66.7% of participants achieved an optimal level and no participant reported a critical level. This finding suggests that the faculty has successfully established institutional conditions perceived as equitable regarding academic access and treatment received during their education. However, this positive perception does not necessarily imply the elimination of structural inequalities. Recent research warns that formal equality constitutes only a first stage toward effective inclusion, as implicit mechanisms related to gender stereotypes, unconscious bias, and low female representation in academic leadership po-

sitions continue to persist (European Commission, 2024; UNESCO, 2021). In this regard, the results of the present study demonstrate a situation that could be characterized as "passive formal inclusion," wherein explicit barriers of discrimination appear to have diminished, yet limitations to achieving fully equitable participation remain.

Finally, personal growth exhibited a balanced distribution between optimal (40.0%) and moderate (40.0%) levels, while 20.0% remained at a critical level. This trend confirms that engineering education strengthens self-confidence and perceived self-efficacy among a substantial proportion of female students; nevertheless, another group continues to face difficulties related to professional identity construction. Martínez-Galaz et al. (2022) contend that gender stereotypes continue to affect women's sense of belonging within traditionally male-dominated fields, thereby lowering their future career expectations. Complementarily, Nava Preciado (2018) asserts that female engineering students develop processes of resilience that enable them to overcome these barriers and serve as role models for upcoming generations. This finding also aligns with recent research by Master et al. (2021), who demonstrated that strengthening STEM identity constitutes one of the primary predictors of female retention, psychological well-being, and leadership within university engineering programs.

Taken together, these findings support the conclusion that the Faculty of Engineering and Architecture has succeeded in significantly reducing explicit barriers related to equality of opportunity; however, persistent challenges remain regarding institutional support, student participation, and professional development (Nava, 2020). From a university policy perspective, these results substantiate the need to reinforce permanent programs for mentorship, academic tutoring, female leadership, formative research, and industry linkages. Such measures are vital to fostering substantive inclusion that transcends normative equality and effectively contributes to the retention and professional advancement of women in engineering.

Conclusions

This research reveals a complex landscape in which significant progress toward equal opportunity coexists with persistent challenges regarding academic performance, university participation, institutional support, professional development, and personal growth among women in engineering.

Female engineering students at the Universidad Andina del Cusco exhibit an academic profile predominantly categorized at the “always” level (80.0%) for academic performance, demonstrating high capability and commitment when facing the demands of STEM programs; nevertheless, 20.0% of students remain at the “never” level, underscoring the need for targeted intervention. The dimensions of university participation and institutional support represent the weakest areas within the academic challenge matrix, with over a quarter of students falling into the “never” category for both. Low assessments of psychological counseling and extracurricular involvement highlight concrete gaps in student welfare services and platforms for academic visibility.

Equality of opportunity stands out as the most reinforced dimension in this study, recording zero cases in the “never” category and the highest mean scores across the entire instrument. Students perceive an environment of relative formal equity, representing a significant institutional step forward. Conversely, professional development emerges as the dimension with the greatest potential for improvement—particularly regarding pre-professional internships and specialized training programs—indicating an urgent need to expand university-industry partnerships. Finally, personal growth demonstrates meaningful internal heterogeneity, suggesting that female empowerment trajectories in engineering are diverse and mediated by individual and contextual

factors that future research should examine using mixed-methods designs and larger sample sizes.

Regarding the limitations of this study, the primary constraint lies in the small sample size—which reflects the entire population of female students enrolled in the Faculty of Engineering and Architecture at the Sicuani campus—thereby limiting the generalizability of the findings. Future research should expand the sample size and broaden the scope to include other academic faculties in order to provide deeper insights into the academic, institutional, and personal factors that shape the opportunities and challenges faced by women in STEAM fields.

Acknowledgments

The authors express their gratitude to the 15 female engineering students who voluntarily participated in this study, as well as to the administrative authorities at the Universidad Andina del Cusco for granting the necessary permissions and facilities for data collection.

Conflict of Interest

The authors declare that they have no conflicts of interest.

AI Declaration

The authors declare the use of Gemini (Version 1.5) solely to assist in style editing and enhancing the clarity of selected paragraphs. The authors comprehensively reviewed and edited the manuscript content and take full responsibility for its originality, scientific integrity, data interpretation, results, and conclusions.

Author Contributions

David Salomon Quispe Choque: Conceptualization, methodology, investigation, formal analysis, supervision, writing – original draft, writing – review and editing, project administration.

Juan Paulo Catunta Huamane: Conceptualization, methodology, investigation, data curation, formal analysis, writing – original draft.

Ruth Thalia Quispe Mamani: Investigation, data collection, data curation, formal analysis, writing – original draft.

Sergio Achahui Llusca: Methodology, investigation, formal analysis, validation, data preparation and presentation.

Noemí Tupa Quispe: Investigation, data collection, data curation, writing – original draft, writing – review and editing.

Sonia Mejía Ayala: Investigation, validation, formal analysis, writing, writing – review and final editing.

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