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Development of research skills in distance higher education: analysis of teaching strategies in Engineering careers

Desarrollo de habilidades investigativas en educación superior a distancia: análisis de estrategias docentes en carreras de Ingeniería

Desenvolvimento de competências de pesquisa no ensino superior a distância: análise de estratégias de ensino nas carreiras de Engenharia

Abstract

Introduction: addressing the significance of teaching strategies to develop research skills in autonomous environments within an open and distance university with an asynchronous and self-managed model in Engineering programs. **Objective:** to analyze these strategies in subjects related to research. **Method:** semi-structured interviews were conducted with 13 professors teaching these subjects. **Results:** they reveal that the strategies focus on raising students' awareness about research and gradually presenting the content. Additionally, a lack of clarity in the evaluation of research skills was observed. As a skill, professors understand the learning objectives, though the need to improve planning and design more intentional strategies was identified. **Conclusion:** the importance of structuring and prioritizing teaching strategies aimed at the development of research skills is highlighted, going beyond the actions dictated by the curricular content. Thus, this study underlines the role of planned teaching in strengthening research training in higher distance education.

Keywords: research skills, industrial engineering, distance education, teaching strategies

Resumen

Introducción: abordar la importancia de las estrategias docentes para desarrollar habilidades investigativas en entornos autónomos en una universidad abierta y a distancia con un modelo asíncrono y autogestivo en carreras de Ingeniería. **Objetivo:** analizar dichas estrategias en asignaturas vinculadas a la investigación. Método: consistió en entrevistas semiestructuradas a 13 docentes que imparten estas asignaturas.

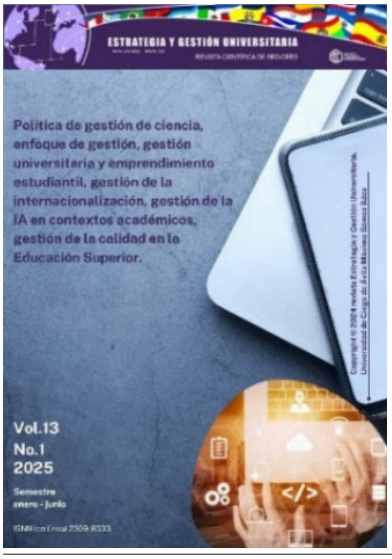
Método: consistió en entrevistas semiestructuradas a 13 docentes que imparten estas asignaturas. **Resultados:** revelan que las estrategias se centran en sensibilizar a los estudiantes sobre la investigación y presentar gradualmente los contenidos. A su vez, se observó poca claridad en la evaluación de las habilidades investigativas. Como habilidad, los docentes comprenden los objetivos de aprendizaje, aunque se identificó la necesidad de mejorar la planificación y diseñar estrategias más intencionadas. **Conclusión:** se destaca la importancia de estructurar y priorizar estrategias didácticas orientadas al desarrollo de habilidades investigativas, más allá de las acciones dictadas por el contenido curricular. De esta manera, este estudio subraya el papel de una enseñanza planificada para fortalecer la formación en investigación en educación superior a distancia.

Palabras clave: habilidades investigativas, ingeniería industrial, educación a distancia, estrategias de enseñanza

Resumo

Introdução: abordar a importância das estratégias de ensino para o desenvolvimento de habilidades de pesquisa em ambientes autônomos em uma universidade aberta e a distância com um modelo assíncrono e autogerenciado em cursos de Engenharia. **Objetivo:** analisar essas estratégias em disciplinas vinculadas à pesquisa. **Método:** foram realizadas entrevistas semiestruturadas com 13 professores que ministram essas disciplinas. **Resultados:** revelam que as estratégias se concentram em conscientizar os alunos sobre a pesquisa e apresentar gradualmente os conteúdos. Além disso, observou-se falta de clareza na avaliação das habilidades de pesquisa. Como habilidade, os professores compreendem os objetivos de aprendizagem, embora tenha sido identificada a necessidade de melhorar o planejamento e projetar estratégias mais intencionais. **Conclusão:** Destaca-se a importância de estruturar e priorizar estratégias didáticas voltadas para o desenvolvimento de habilidades de pesquisa, indo além das ações ditadas pelo conteúdo curricular. Assim, este estudo enfatiza o papel de um ensino planejado para fortalecer a formação em pesquisa no ensino superior a distância.

Palavras-chave: habilidades de pesquisa, engenharia industrial, educação a distância, estratégias de ensino



Introduction

Research has recently been conceived as a vital resource for enhancing the quality of education, prompting higher education institutions to consolidate programs and strategies aimed at developing research competencies, as noted by Ripoll-Rivaldo (2021). In this context, engineering programs offered through distance learning have represented a particular area of interest, as they require students to manage their learning process autonomously and asynchronously.

Moreover, there is a recognized need to stimulate skills such as critical thinking, creativity, and problem-solving, which are considered fundamental for knowledge generation and for addressing the challenges of a constantly transforming society (De la Cuesta, 2024).

However, significant obstacles have been identified that restrict research teaching, such as the decontextualization of content, the reduction of research to the study of methodology, and the limited connection between research groups and teaching activities (Rojas & Ducoing, 2021). These limitations have significantly impacted the training of new professionals and highlighted the urgency of designing pedagogical approaches that integrate research as a transversal and continuous practice.

Despite efforts over the past decade to reform curricula and introduce curricular innovations, the literature has shown that much of the research teaching has been concentrated in isolated courses or projects (Marañón Cardonne et al., 2020; Quispe-Mamani et al., 2024).

Furthermore, in Mexico, there has been an excessive emphasis on the preparation of graduation projects, which, while relevant, did not guarantee the progressive acquisition of research competencies throughout the entire program (Tinoco-Cuenca et al., 2020). This approach may lead to a fragmented view of research, failing to achieve full integration with other subjects or the real needs of the productive sector and the scientific community.

It is worth noting that distance higher education poses an additional challenge, as it requires specific pedagogical strategies to maintain motivation, participation, and constant interaction between teachers and students in virtual spaces.

In addressing these issues, this article aims to analyze teaching strategies that promote the development of research skills in engineering programs within the context of distance higher education. It intends to provide a comprehensive approach that allows for the recognition of the concrete implementation of these strategies throughout the academic program, as well as to identify strengths and areas for continuous improvement.

This analysis seeks to contribute to the debate on research training in virtual environments by proposing lines of action that strengthen the role of teachers as facilitators of inquiry and critical reflection processes. Ultimately, it is expected to positively influence the establishment of a research culture that supports future engineering professionals throughout their educational journey and enhances the overall quality of higher education.

Teaching as an activity of teachers in distance higher education

Teaching, conceived as a professional and intentional activity, demands mastery of knowledge, skills, and ethical principles from teachers (Acuña-Gamboa, 2022). In the context of distance higher education, this body of knowledge becomes particularly relevant, as teachers must design effective learning experiences in virtual and asynchronous environments, catering to the diverse rhythms and styles characteristic of engineering students.

To achieve this, it is essential for teachers to have a clear understanding of what students need to learn, as well as the most appropriate pedagogical strategies to guide that learning process in an online environment. Based on this understanding, the teacher selects and adapts activities that provide learning opportunities, facilitating access to scientific knowledge and promoting the development of research skills.

This process involves various types of knowledge, classified by Acuña-Gamboa (2022) into categories such as content knowledge (disciplinary content of engineering), general pedagogical knowledge (principles of organizing classes on virtual platforms), curriculum knowledge (mastery of engineering study programs), pedagogical content knowledge (the fusion of discipline with specific teaching strategies), knowledge of students and their characteristics (particularly important in distance environments), and knowledge of educational contexts (the functioning of the virtual classroom, the institution, and the academic community). Additionally, this includes knowledge of the educational objectives and values that guide engineering education, emphasizing the need to foster research competencies for solving technological and social problems.

In this regard, teaching is configured as a process that begins with clarity about the content to be transmitted, continues with the selection of appropriate means for teaching, and culminates in the implementation of these actions in the virtual classroom. Acuña-Gamboa (2022) referred to this cycle as the Model of Pedagogical Reasoning and Action, whose stages of understanding, transformation, teaching, assessment, reflection, and new understanding are constantly interrelated. In the context of distance higher education, this cycle takes on special importance, as the teacher must make intentional decisions grounded in the virtual nature of interaction.

Among these decisions is the design of teaching strategies, which, according to Vicarioli & Solano (2020), are procedures developed to contribute to effective student learning, and which, according to Shadiev et al. (2020), aim to promote comprehension and cognitive performance. These strategies are conceived during the transformation stage, at which point the teacher transforms specific engineering content into activities designed for a virtual environment, providing students with opportunities to investigate, experiment, and reflect—essential elements for developing research competencies in engineering programs.

Didactics of research in distance higher education for engineering programs

The didactics of research, understood as the analysis of operations related

to teaching what and how research is taught, is particularly relevant in distance higher education, especially in engineering programs. Rojas Arenas et al. (2020) proposed four propositions that could serve as a foundation for a "new didactics of research": a) teaching research yields better results when it emphasizes the practices, processes, and mechanisms inherent to scientific activity; b) the focus of research teaching should be less on abstract theory and more on the practical operations that occur in knowledge production; c) teaching research is a prolonged process, necessitating continuous and strategic approaches throughout training, from secondary education to postgraduate studies; d) research training is facilitated by working with active research teams, where students have the opportunity to engage directly in scientific practice.

For teachers in distance engineering programs, Parra Castrillón (2023) highlights the importance of possessing competencies to understand the relevance of research in educational practice. This entails the ability to observe, identify, question, interpret, and analyze the challenges that arise in virtual learning environments. Additionally, the need to design solutions based on research methods and to promote scientific writing practices for recording progress and drafting research reports was emphasized. This approach fosters a research-oriented environment in virtual courses, recognizing the potential to generate new knowledge linked to the challenges of engineering in a distance education context.

Rojas Arenas et al. (2020) assert that the work of researchers is conveyed through the knowledge of the teacher, which requires not only research competencies but also a deep understanding of scientific endeavors in the field of engineering. This involves skills to problematize, formulate observables, theoretically ground, describe, discover, explain, and develop scientific writing strategies—essential aspects for guiding students toward producing new knowledge in virtual environments. Silva et al. (2021) identified a set of cognitive and discursive skills necessary for understanding and executing the research process: strategic thinking, reasoning, argumentation, problem-solving, and project development.

In line with this perspective, various models have emphasized the importance of research practice as a fundamental strategy, based on the premise that one learns to conduct research through actual research activities (Valenciano-Canet, 2019).

In engineering programs offered through distance learning, curricula often incorporate subjects and transversal objectives aimed at fostering research training. However, it is essential to analyze the focus and type of research that is prioritized, as different modalities can be distinguished: formative research (as a teaching tool), action research (for reflection on practice and continuous improvement), and strict research (aimed at generating disciplinary scientific knowledge) (Hernández & Moreno, 2021).

These perspectives contribute to a broader debate about the possibility of integrating teaching and research (Cebrián, 2020), discussing the feasibility of engaging in both activities full-time, the rigor required for research, and the potential for teachers to make significant contributions to the scientific field while teaching at a distance.

In most engineering curricula in virtual environments, there is an emphasis on applied research aimed at solving practical problems related to the discipline. While the production of scientific knowledge is also promoted, it has been observed that the level of rigor may be relatively limited, as students wishing to pursue research more deeply tend to continue their education in postgraduate programs. With this frame of reference, a study was conducted focusing on understanding the teaching process of research in engineering programs offered through distance learning.

Methods and materials

This study was conducted within the constructivist paradigm (Bustos-Viviescas et al., 2023) and adopted a qualitative approach (Forni & Grande, 2020). To gain an in-depth understanding of the teaching strategies that promote the development of research skills in engineering students in the context of distance higher education, a case study (Cohen et al., 2018) was carried out at an open and distance university based in Mexico City.

The program selected was the Engineering program with the highest number of subjects aimed at promoting research competencies, making it an ideal environment to examine the research question posed. The choice of this university was due to its history of implementing research projects and the active participation of teachers in research training activities, both in conferences and academic networks. Additionally, the institution offers a set of elective subjects focused on research applied to engineering, a feature not found in other programs of the same modality.

To delve into teaching practices, a purposive sampling method was employed (Abad & Arango, 2024), with the primary criterion being that participants taught courses from the most recent curriculum, specifically referencing the teaching of research. This included teachers from various semesters of the program, as well as project or thesis advisors.

Non-participation and exclusion criteria

Exclusion criteria were established to ensure the relevance of the sample: (a) not teaching courses with a research focus; (b) having less than one year of teaching experience at the institution, which would hinder the evaluation of consolidated strategies; and (c) not being available to participate in the interviews. Additionally, those teachers who were not part of the most recent curriculum or who did not meet the profile required to promote research were excluded. Some potential participants also opted out due to scheduling conflicts or lack of interest in the project, which reduced the final sample size.

A total of 13 teachers, both men and women, were interviewed, with an average age of 38 and approximately 8 years of experience at the institution. A semi-structured interview was conducted, lasting between 20 to 55 minutes, which was recorded for later transcription. The collected information underwent an open coding process (Calle-Arango & Avila-Reyes, 2020), initially generating Emic

categories derived from the data, followed by Etic categories linked to theoretical references (Abad & Arango, 2024).

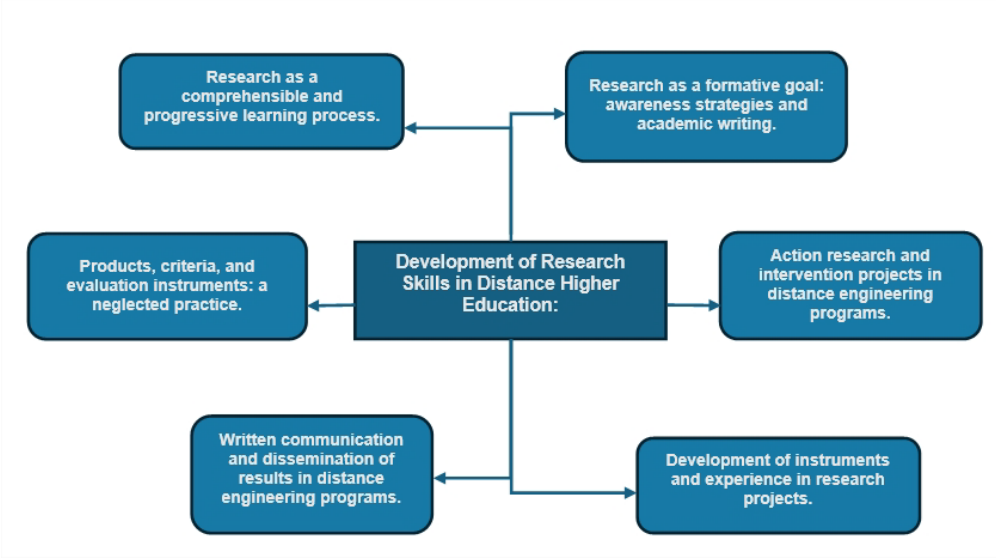
For this article, findings related to the teaching strategies employed by teachers to develop research skills in virtual learning environments were selected, thus addressing one of the central questions of the research.

Results and discussion

The development of teaching skills is closely linked to the decisions that teachers make to guide learning processes and foster the acquisition of research competencies in engineering programs within the context of distance higher education. Analyzing teaching practices in this context revealed strategies aimed at strengthening students' ability to conduct research autonomously and gradually. These strategies were included in the category "Teaching strategies for the development of research skills," which encompasses various subcategories discussed below.

Figure 1

Development of research teaching skills and subcategories



Source: Authors' own elaboration.

Research as a comprehensible and progressive learning process

In the case of the engineering program studied, the curriculum is designed to take a progressive approach to research, starting with conceptual content and advancing to the practical implementation of projects in later stages of the degree. Some teachers exemplify this by noting that in the early semesters, general knowledge about research and its phases is introduced, while in subsequent semesters, the execution of projects and the application of specific methodologies

are promoted. This sequence is considered essential for reducing the resistance that students often exhibit when faced with research activities.

> *"We start with the basics from the first semesters regarding research, so that later on they can begin to conduct projects on their own" [participant 14].*

The review of teachers' testimonies shows a particular focus on the dosage of content, recognizing the inherent complexity of research activities. Given that many students perceive research as a complex and distant process, efforts are made to present it in an accessible manner, emphasizing that the necessary skills can be developed gradually. These perceptions align with the reflections of Rojas Arenas et al. (2020), who suggested the appropriateness of adopting a practical rather than merely theoretical approach to foster a real research experience.

> *"There is a significant taboo among them; they believe it is something very complex and unattainable... it is important for them to see that it is within reach, that they can do it, that they can generate small research projects initially..." [participant 1].*

The statements from teachers highlight the importance of counteracting preconceived notions and the fear that students experience regarding research, a phenomenon described by Silva et al. (2021) as a significant cognitive and attitudinal barrier. Similarly, Turpo-Gebera et al. (2020) referred to this phenomenon as "anything but a thesis," referencing the reluctance of undergraduate students to develop research projects for their degrees. In the context of distance education, particularly in engineering programs, this challenge is exacerbated by the autonomous and asynchronous nature of the model, reinforcing the need to design teaching strategies that make research more approachable and gradual, promoting the confidence and competencies necessary for scientific inquiry.

Research as a formative goal: awareness strategies and academic writing

In contrast, the engineering program analyzed in distance higher education differs from the trend observed in other institutions of the same modality, as it has a considerably high rate of graduation based on project work or research theses. As a result, teachers aim to prepare students from the early semesters so that they acquire the confidence and competencies necessary to develop their own research projects. While this emphasis contributes to raising students' awareness of the research process, much of the effort is focused on alleviating their fears and motivating them emotionally to face the challenges of their theses.

Among the most common strategies to demonstrate the accessibility of research is the search for information on specific topics, which involves consulting background literature or the state of the art regarding the phenomenon under study (Alba & Buenaventura, 2020). This approach introduces students to specialized literature review, emphasizing criteria for determining the relevance and reliability of sources. Teachers reinforce the importance of this exercise as a foundation for research advancements, promoting its gradual construction over several semesters.

> *"We have an approach because we need to support the projects they*

> *are working on, so we address issues related to the state of the art, having them investigate methodologies, what has been done, and what the results have been" [participant 2].*

Additionally, the use of relatable examples is encouraged to illustrate the feasibility of conducting research in real contexts, such as when a teacher shares their own projects or disseminates the work of other students who have presented results at specialized conferences. This aims to demonstrate the feasibility and utility of the research process from a practical perspective, consistent with the idea of "learning to research by researching" (Rojas Arenas et al., 2020). Although these strategies focus on motivating students and fostering their interest in engaging in research, they serve to evidence that the process is attainable and contributes to solving concrete problems in the field of engineering.

In this context, information seeking has been valued as a crucial activity for research training, as it allows for an understanding of existing knowledge production and the development of new proposals (Zeballos & Pumacahua, 2023). For teachers, this skill constitutes the starting point of the research process; thus, there is an emphasis on searching for specialized literature and exploring reliable sources as one of the first phases for developing projects or theses.

> *"I always encourage students to look for specialized search engines in their research. That is the first requirement... We have pointed out places where they can research and the elements to focus on" [participant 7].*

Furthermore, it is emphasized that students must learn to be "consumers of knowledge" with critical and reflective capabilities (participant 12). From this perspective, training in distance engineering includes the practice of academic writing, the integration of various sources, and the rigorous analysis of results. Consequently, future engineers not only develop a deep understanding of the topics they investigate but also acquire the discursive and methodological skills necessary to integrate into the scientific community and competently face the challenges of an increasingly demanding professional environment.

Action research and intervention projects in distance engineering programs

In the analyzed engineering program, courses have been implemented where the final product consists of developing intervention projects focused on identifying and solving real problems related to the workplace or social context. Throughout the semester, students identify challenges in contexts related to their training, such as companies, communities, or productive environments, and design improvement proposals based on research methods. These initiatives culminate in the implementation of actions and the evaluation of results, aligning them with the action research approach, characterized by the pursuit of concrete changes in reality (Chávez Vera et al., 2022).

While there are specific subjects that explicitly promote action research, most teachers agree on using everyday experiences or practices in real environments to motivate students to identify and solve problems through reflection and scientific inquiry. Thus, students are engaged in projects that stem from the observation and

analysis of specific situations, encouraging them to propose and apply evidence-based solutions with teacher support at each stage of the research.

> *"I share projects with several courses. For instance, in one subject, they work with data analysis software, and based on the information they gather, they design strategies to address a real problem. Then they implement these strategies and compare the results with the initial diagnosis. They must also support their projects with a literature review and relevant methodologies" [participant 1].*

The vision of research as a tool for improving practice is shared among the teachers, promoting that students address technological, productive, or social problems and generate proposals that have a direct impact on their environment through reflection. In this way, research training transcends the mere generation of documents and is oriented toward transforming reality, aligning with the aim that knowledge should not remain solely theoretical (Chávez Vera et al., 2022).

Among the phases taught for developing intervention projects is the design and application of data collection instruments (surveys, interviews, or field notes) suitable for the engineering field. Generally, the creation of these instruments occurs during online class activities, while their application takes place during professional practices, field visits, or students' work experiences. This dynamic allows students to develop action research skills, validating their tools with teachers and academic bodies that provide feedback, and reflecting on the results to propose solutions to real problems.

> *"When they go to carry out their project, they design interviews or surveys and validate them with teachers who have research experience. Then, in their practices or work settings, they apply those instruments to gather information and return with data that they can analyze to propose improvements" [participant 6].*

In essence, the implementation of intervention projects in the distance engineering curriculum reinforces the idea that investigative learning becomes more relevant when connected to practical situations. This fosters in students the capacity to observe, diagnose, and act on problems in their environment, consolidating the vision that engineers should be, above all, reflective and innovative professionals.

Development of instruments and experience in research projects

In the analyzed distance engineering courses, students typically design small data collection instruments (surveys, interviews, or questionnaires) as part of curricular activities aimed at identifying and solving real-world problems. For example, when they identify areas of opportunity in industrial environments or community projects, they are guided to formulate questions directed at various stakeholders, such as managers, technical staff, or clients, to obtain reliable data for analysis. This exercise promotes the adoption of an investigative perspective and fosters the awareness that engineers must inquire, contrast, and reflect before proposing solutions (participant 13).

However, when evaluating the preparation of final projects or theses in this educational model, it is noted that students often employ instruments previously designed by advisors or reference researchers. This practice suggests that, while regular courses encourage the creation of instruments tailored to specific problems, the formalization of these works in the thesis phase tends to standardize. Thus, the priority is for students to have an initial research experience, understand the main phases of the research process, and generate an academic product that, while it may contribute to knowledge, does not necessarily seek to differentiate rigorously between the studies of each student.

Teachers agreed on the importance of fostering reflection and critical thinking as fundamental skills for research training, in line with the views expressed by Silva et al. (2021). It is considered vital that students question the information they find, generate their own positions, and ultimately assume an active role in seeking solutions to the posed problems.

> *"I aim for them to be critical, to question, to ask any doubts, to reflect, or to try not to accept ideas as they are" [participant 12].*

Nonetheless, despite clarity regarding the desired skills, many teachers expressed difficulties in detailing the strategies they implement to achieve them. Their efforts are primarily based on fulfilling the objectives set out in the curriculum rather than designing a unique teaching methodology. This situation contrasts with the suggestions of Pinchao Benavides (2020), who indicated that teaching strategies should involve intentionality, proactivity, and adaptability. Although there is awareness of the goal to foster critical and reflective thinking, there is a lack of explicitness regarding the concrete actions to achieve it, which may limit the impact of the educational process on the acquisition of research competencies.

Written communication and dissemination of results in distance engineering environments

Written communication is another fundamental competency that teachers strive to develop due to its importance in disseminating findings in the form of reports or scientific articles (Santillán-Iñiguez & Rodas-Pacheco, 2022). From this perspective, teachers seek to create opportunities that stimulate academic writing and provide constructive feedback on the texts produced by students. The aim is for students to express themselves with clarity, rigor, and formality as they progress in their training—skills that are indispensable in any field of engineering.

> *"I try to instill in students the need to learn to communicate not only orally but also appropriately through writing […] as future professionals who learn to communicate efficiently and effectively" [participant 13].*

The preparation of projects or class activities in some subjects can lead to outputs with potential for presentation at scientific dissemination forums or conferences. Although the formality and rigor of these productions are often limited since they stem from tasks designed for educational purposes, their dissemination at academic events serves as an incentive for students to consolidate their interest in research. Similarly, inviting specialists in engineering or distance education to participate in virtual sessions or seminars has been identified as another strategy to

reinforce research motivation and broaden students' perspectives on the possibilities that research offers in the professional realm.

> *"Sometimes you find class activities and read the reflections of students […] You realize that if you provide more formality and bibliographic support, a presentation for a conference could emerge" [participant 5].*

However, the dependency on tasks or curricular activities to generate these outputs reveals that, at times, there is a lack of a formal research process that provides greater depth and differentiation between studies. Nevertheless, these dissemination opportunities allow for an early engagement with the academic community and subject matter experts, enhancing students' interest in participating in research projects.

Additionally, although the importance of written communication and contact with specialists is recognized, it has been observed that most teachers describe their strategies in general terms, primarily guided by the objectives of the curriculum, without detailing their own teaching methods. This aligns with the logic of a student-centered model, where the focus is on student participation and the facilitation of the process by the teacher (Sánchez et al., 2020). However, adopting this approach does not exempt teachers from planning and designing specific strategies, as it is crucial to intentionally guide the acquisition of research and communication competencies in future engineering professionals.

Products, criteria, and evaluation instruments: a neglected practice

Regarding the evaluation of investigative learning in distance engineering programs, several teachers mentioned the use of checklists and rubrics to grade academic outputs and research projects. However, it was unclear how these tools are specifically used to assess the development of investigative skills. This indicates limited tracking of student progress and the assumption that such competencies emerge automatically, without a structured feedback process.

> *"In the courses, we generally also have checklists. It would be the most viable option concerning research" [participant 8].*

The lack of clarity regarding evaluative criteria contrasts with what Cóndor and Remache (2020) deemed necessary for productive evaluation: prior planning that defines methodologies, criteria, and specific indicators. Similarly, although teachers described their assessment as "formative," the absence of prior design and the equating of evaluation to simple checklists highlight a lack of an authentically formative system (Cangalaya Sevillano, 2020). In this sense, not specifying which dimensions of research are assessed and how continuous feedback is provided reduces the potential for the evaluative process to enhance the development of investigative skills—a key objective in engineering training under a distance education model.

The findings of this study indicate that research training in distance engineering programs follows a progressive approach, beginning with familiarization with general concepts and advancing to the execution of projects with real-world

interventions. This result aligns with previous research (Rojas Arenas et al., 2020; Quispe-Mamani et al., 2024), which emphasizes the utility of gradually introducing research to reduce students' initial resistance or fear. Additionally, the implementation of action research-based projects has served as a means to connect theoretical content with real problems, consistent with the observations of Chávez Vera et al. (2022), who highlight the importance of articulating theory with practice through solutions that positively impact professional or social environments.

Regarding the integration of teaching strategies, there is a reaffirmed need to design educational activities that not only motivate participation but also ensure a planned teaching approach centered on specific research objectives (Parra Castrillón, 2023). Although teachers show awareness of the importance of formative evaluation and feedback, as suggested by Cóndor and Remache (2020), there is an emerging development of specific evaluation criteria and instruments to measure the progress of investigative competencies. This limitation coincides with findings by Silva et al. (2021) and reinforces the recommendation to establish clear guidelines for evaluating key phases of the research process (information search, question formulation, instrument design, data analysis, and result communication).

On the other hand, the importance of promoting academic writing and the written communication of findings aligns with what has been proposed in studies that highlight the central role of scientific dissemination in the development of research skills (Zeballos & Pumacahua, 2023). Nevertheless, as Rojas Arenas et al. (2020) point out, the challenge remains to transcend initial academic outputs to foster a broader research culture that encourages student participation in forums, conferences, and collaborative networks. In this sense, current experiences coincide with the reflections of Quispe-Mamani et al. (2024) on the need to promote active and virtual learning that continuously consolidates research skills in future engineering professionals.

Overall, teaching strategies aimed at raising awareness, reinforcing written communication, and implementing action research have contributed to a more dynamic approach to scientific inquiry. However, there is a need to deepen lesson planning and develop more specific evaluation instruments that make the progression of research competencies visible. It is also essential to enhance the integration of collaborative projects and to strengthen academic mentoring and specialized feedback—elements that, according to previous studies (Turpo-Gebera et al., 2020; Valenciano-Canet, 2019), can increase student engagement in research and reinforce their training in engineering within the distance higher education model.

Conclusions

The findings of this research suggest that teachers in distance engineering programs perceive research training as an initial approach that allows students to familiarize themselves with the research process, understanding it more as preliminary preparation than as complete mastery. In this regard, teaching strategies focus on sensitizing students to the feasibility of conducting research, emphasizing its progressive and accessible nature. This gradual approach is evident

in the curricular structure, which establishes a sequence of courses aimed at developing various stages of inquiry.

However, teachers describe their methods in general terms, without delving into the design of specific teaching strategies, which limits the potential of these training efforts. One of the most common resources for practically integrating research is action research, encouraging students to carry out projects with real applications. In contrast, thesis work often centers on other methodologies for knowledge production, implying that students' research experience throughout their studies is primarily concentrated on applied projects, with less practice in other types of approaches. Additionally, there was some imprecision regarding the evaluation criteria for research skills. The absence of a clear assessment model hinders formative tracking and systematic feedback on students' progress, reducing the impact of the evaluative process on their training.

Regarding future lines of inquiry, it is proposed to advance the development and validation of specific evaluation instruments for research competencies, as well as to conduct comparative analyses of different teaching modalities (in-person, distance, and hybrid) to determine their impact on research training. From a practical perspective, it would be highly beneficial to design concrete guides and teaching sequences—based on active and innovative methodologies—that can be implemented in virtual learning environments, providing continuous support and timely feedback.

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Declaration of author responsibility

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