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Development of research competences in undergraduate students

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ABSTRACT

This study addresses the limited involvement of university students in research activities, which reflects a significant gap in the development of key research competencies for their academic and professional advancement. Lack of involvement restricts essential skills such as problem formulation, rigorous data analysis and communication of findings, preventing students from generating relevant knowledge and meeting the challenges of their future careers. Through a systematic review of the literature on the development of research competencies in undergraduate students, using reliable sources such as Scielo, Dialnet and other academic journals, this study identified effective methodologies to foster such competencies. Rigorous exclusion criteria were applied to ensure the relevance and timeliness of the selected studies. In conclusion, educational strategies such as flipped learning and research workshops were found to have a positive impact on the development of research competences, enhancing both technical and transversal skills, such as innovation and critical thinking. These methodologies prepare students for academic and professional challenges and foster a research culture in educational institutions. This article explicitly identifies and synthesizes innovative educational strategies (flipped learning, Lean startup, and research workshops) that have a proven impact on strengthening both technical and transversal research competences in undergraduates in Latin America. This systematic approach and regional focus are not found in prior reviews.

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1. INTRODUCTION

The novelty of this article lies in its systematic synthesis and comparative analysis of innovative strategies such as flipped learning, Lean startup, collaborative work, and research workshops applied in Latin American universities over the last 5 years, something not addressed in previous literature reviews in the region. According to University Law No. 30220, universities must adopt a more rigorous approach, considering research as an essential function to train students with a solid foundation in research concepts, capable of contributing to financial and community growth and the implementation of public policies in Peru [1]. Despite this, only 12% of university students actively participate in research throughout their academic training, showing a significant gap in the encouragement of research activities that are crucial for national development and global competitiveness [2]. This limitation in student participation restricts the ability to develop research skills that involve the student to be critical in the planning and elaboration of research [3]. Therefore, there is a need to promote and develop these research competences within university education,

which aims to improve critical knowledge, the ability to solve difficulties and the ability to generate new knowledge [4]. Thus, research competencies are fundamental to the effective conduct of research, ranging from the accurate formulation of problems to the rigorous analysis of data and the ethical communication of findings [5]. The development of these competencies promotes essential skills such as the appropriate selection of methodologies and the critical analysis of results [6]. This approach not only strengthens the capacity to generate relevant knowledge, but also fosters a deep understanding of the ethical principles inherent in scientific research [7]. The effective integration of these competencies empowers students to tackle difficult problems in their careers, contributing greatly to the continuous advancement of understanding in various areas and consolidating their role as future researchers and leaders in their respective fields [8].

This study will focus on conducting a systematic literature review on the development of research competencies in undergraduate students, with the aim of discovering the best methodologies and strategies that promote effective learning in this area. Fundamental aspects such as problem formulation, methodological design, collection, analysis, critical understanding of findings and effective communication of scientific discoveries will be addressed. This review seeks to contribute to the strengthening of educational programs aimed at cultivating strong research competencies among future researchers and practitioners in various academic disciplines. This systematic review will begin with an analysis of the last 5 years of experimental and descriptive research, providing an overview of how research strategy development is approached in Peru.

Castro-Rodríguez [9] conducted a study with health students at the Pontifical Catholic University of Peru, various effective strategies for developing research competencies were identified. These strategies included research groups, collaborative work, problem-based learning, the use of conceptual diagrams, practical case studies, essay writing, project methods, seminars, and workshops. The study highlighted that, for undergraduate students, summer programs, the promotion of scientific evidence, internship workshops, and team activities accompanied by advisors were particularly useful. These approaches significantly contributed to fostering communication and advancing research competencies among university students.

Similarly, study by Morales-Cerna *et al.* [10] investigated the influence of cooperative learning on the research competencies of students at the National University of Santiago Antúnez de Mayolo in Peru. They selected two groups of 30 students each, one as a control group and the other as an intervention group. After developing learning sessions, the results showed that in the control group, 16.7% of students were at the starting scale, 25% were in progress, and 8.3% achieved expected outcomes. In contrast, in the intervention group, 3.3% of students were at the starting scale, 8.3% were in progress, 31.7% achieved expected outcomes, and 6.7% demonstrated outstanding achievement, demonstrating that cooperative knowledge acquisition significantly influences the development of research competencies.

In a similar context, Ventura *et al.* [11] investigated the educational strategies with quantitative and conceptual-epistemological approaches used by educators in teaching the scientific method. A random sample of 215 students out of a total of 570, all in their final cycle at the University of Huánuco, Peru, was selected. The research results confirmed that the pedagogical approach of educators regarding the scientific method has a significant effect on the development of research competencies in students, with a margin of error of only 3.2%. To measure this influence, they used an assessment of research competencies where students had to demonstrate their mastery of the scientific method by solving research problems and generating prospects to develop theories that lead to innovative initiatives.

On the other hand, Chancahuana *et al.* [12] investigated the impact on the development of research competencies through a study that included initial and final assessments. The research was conducted with a sample of 178 students from the Nursing Department of the University of Amazonas, Peru, specifically selecting 30 students from the sixth and seventh cycles. Using the observation technique with a structured form, data were collected to analyze the impact of inquiry. The results of the final assessment revealed that 46.7% of students were able to develop research competencies, while 3.3% showed moderate development in these competencies. These findings underscore the importance of inquiry as an effective strategy for strengthening research skills among nursing students.

In another study, the authors [13], [14] analyzed the influence of research competencies in university students from southern Peru. The study included 302 students, for whom data were collected using the research competency questionnaire. The results indicated that 72.8% of respondents exhibited moderately developed research competencies, 17.5% had undeveloped competencies, and 9.6% had fully developed competencies. Additionally, organizational, communicative, and collaborative skills were identified, showing medium development. Furthermore, many students reported associating with research groups and dedicating a significant number of hours to research activities. These findings highlight the importance of involving students in practical and collaborative tasks for the development of research competencies. Similarly, this systematic review encompasses studies conducted in various Latin American countries over the past 5 years, including both experimental and descriptive research. Effective strategies for the development of research

competencies in undergraduate students will be identified, offering a comparative view of pedagogical practices in the region.

Various studies have addressed the development of research competencies in different contexts. For example, in a study conducted in the field of dentistry [15], activities such as digital newsletters and training workshops were carried out. These initiatives aimed to reinforce existing knowledge in scientific research, thereby facilitating the development of research skills and competencies among undergraduate students. This approach was designed to ensure relevant academic production aligned with the required professional profile.

In study by Suárez-Triana *et al.* [16], a Web 3.0 tool was implemented to strengthen problem interpretation and resolution competencies in research projects among 32 students. Through training sessions on the use of this technology as a methodological strategy, it was observed that initially only 16 students were able to adequately articulate the research problem. However, after the implementation of the Web 3.0 tool, all participants, except for one, were able to achieve this objective, thus demonstrating the effectiveness of this tool in enhancing research competencies among the involved students.

Chávez *et al*. [17] found a lack of integration among the student community in research development. To address this issue, they implemented award-based competitions as a strategy. Various methods, including analysis and synthesis, inductive-deductive reasoning, and a systematic approach, along with interviews, surveys, and participant observation, were used to plan, execute, and evaluate this strategy. This initiative involved 419 students under the supervision of teachers, who collaborated in creating presentations, posters, and talks. These activities not only fostered the development of research skills among participants but also strengthened the overall student community.

According to previous studies [18], [19], the lack of research practice at the National Corporation of Higher Education in Sucre has highlighted the strategy of strengthening formative research in the university context. This practice is crucial because it facilitates inquiry, knowledge elaboration, and utilization. Through this strategy, significant progress has been observed in the preparation of graduation projects, the formation of groups, and participation in research activities. Furthermore, the importance of designing enriched curricula with teaching strategies that promote participation, reflection, and faculty contribution is emphasized, aiming to enhance the holistic progress of research competencies among students. Similarly, another studies [20], [21] confirmed a change in the university curriculum, as surveys conducted among seventh-semester university students indicated numerous deficiencies in research skills. This change should focus on fostering a research culture that involves greater participation from both educators and students.

In Mexico, a virtual environment known as “Drive” was implemented in three different universities to facilitate the creation of research projects and course content aimed at developing research competencies [22]. This space was used by 100 students, distributed across specific activities: 32 dedicated to creating new research, 43 working on thesis development, and 32 on preparing academic content. Most of the students were in their ninth semester of studies. This research concluded that “Drive” served as an interactive space where teachers and students collaborated empathetically, receiving continuous feedback. Additionally, it facilitated access to links between repositories, information management, and promoted the use of American Psychological Association (APA) formatting to support students’ research. In research by Vicente *et al*. [23], the “Mirror Class” was examined as a strategy to improve research competencies in universities across Latin America. Various methodological techniques, such as observing phenomena, collecting information, using rubrics for final presentations, and video recordings, were applied. These tools allowed educators to reflect on their teaching practices, identify shortcomings, and promote improvements, thus overcoming traditional approaches. The results demonstrated that the “Mirror Class” is an effective communication strategy capable of breaking down common barriers and fostering relationships between students and educators.

The level of competencies and research disposition among business administration students was investigated [24]. The study was conducted using surveys applied to 49 students in their eighth semester of the thesis project. The results revealed significant deficiencies in technical-instrumental competencies, research competencies, and attitudes towards research, which were considered of considerable severity. These deficiencies could negatively impact students’ success upon graduation and in their professional careers.

A significant problem was identified at Central University of Ecuador related to a predominantly teacher-centered approach that emphasized passive knowledge transmission through traditional methods such as listening, note-taking, and memorization for exams [25]. To address this issue, the strategies of the knowledge project (PIS) and collaborative learning were investigated. After the implementation of these innovative strategies, substantial improvements were observed in the dynamic interaction between teachers and students, which not only promoted a more participatory learning environment but also led to a reevaluation and adaptation of the educational methodologies employed, aimed at fostering the comprehensive development of competencies among students.

According to Melo-López *et al*. [26], information and communication technology (ICT) is fundamental in the research process within the education, science, and technology area. Teachers of the ICT

subject emphasized the progress of specific competencies in their students, including the appropriate use of digital resources and advanced skills such as the ability to critically evaluate and analyze. ICT is viewed as an essential tool for accessing rigorous scientific information in various formats, highlighting the importance of incorporating them into the educational process to enhance students' research skills.

In summary, these studies highlighted the diversity of approaches and strategies implemented to develop research competencies in various educational contexts. The effectiveness of these interventions underscored the importance of having robust methodologies and appropriate resources. In this regard, it is essential to detail the materials and methods used in the reviewed studies to provide a precise understanding of the procedures followed and the resources employed.

2. METHOD

This study used a systematic literature review as a research method, developed through a rigorous and structured process involving several key phases, as explained in Figure 1. In the first identification phase, specific search objectives were defined and the area of interest was established using key terms such as 'research competences', 'undergraduate students', and 'university teaching'. Search engines recognized for their coverage of relevant academic literature were selected, including Scielo and Dialnet. Boolean operators (AND and OR) were used to broaden and refine the search for related topics, and advanced filters were applied to limit the search to peer-reviewed articles, published in the last 5 years, available in full text and in Spanish, and review articles, excluding original articles, books, theses and those in Portuguese.

In the second duplication phase, duplicate articles were identified and eliminated. In the third eligibility phase, additional filters were applied to exclude articles that did not contain keywords in the title or abstract. In the fourth screening phase, a more thorough review was carried out, excluding articles older than 5 years, those dealing with students in secondary or postgraduate education, as well as articles related to teachers, masters and doctoral students, articles in English and those unrelated to the research topic.

Finally, in the critical appraisal phase, a thorough evaluation of each paper was carried out, prioritizing those that offered empirical evidence, effective methodologies and key findings. This rigorous selection process identified a total of 50 articles that met the established criteria and were relevant to the study. This ensures a comprehensive and reliable literature review that establishes a robust foundation for the analysis and synthesis of information on the development of research competences in undergraduate students.

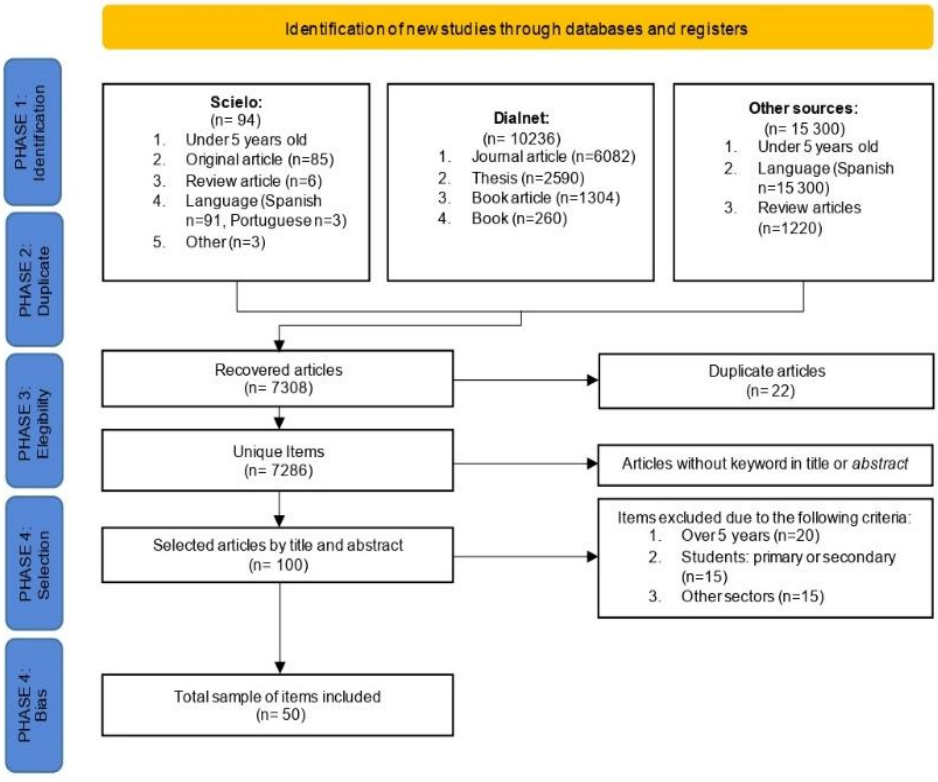

Figure 1. Flowchart of the systematic review process

3. RESULTS

In the study on the flipped learning strategy in the development of research skills in higher education, the implementation of the flipped classroom model had a significant impact on undergraduate students [27]. This approach enabled the students to make considerable progress in identifying the research problem, developing the theoretical framework, literature review, analysis of previous studies, methodology and procedures, as well as in presenting results and discussion, comprehensively addressing the essential elements that make up a research paper. The researcher was able to comprehensively justify the relevance and scope of the research conducted, highlighting how the flipped learning strategy facilitated the comprehensive development of these crucial competences in scientific research among the students. Furthermore, the use of the flipped classroom stands out as an effective strategy because it facilitates the acquisition of deep learning strategies and promotes high levels of cognitive and emotional engagement among students [28]. This methodology allows students to review pre-recorded lectures prior to face-to-face sessions, which fosters greater preparation and deepening of the topics covered in class, thus leading students to develop their research and application skills. Besides, this strategy facilitates a more rigorous and efficient literature review, as well as the precise formulation of research problems, contributing significantly to the development of research competences among university students [29].

In previous studies [30], [31], they used the Lean startup methodology for the development of research competences among undergraduate students, where they observed that, by implementing this strategy, students acquired dynamic attitudes based on the create-measure-learn cycle, thus facilitating the development of research competences and providing them with comprehensive professional training. Furthermore, other studies [32], [33] suggest that the inclusion of Lean startup in the university curriculum promotes innovation, contextualization and the viability of knowledge, stimulating the generation of ideas, learning from mistakes and continuous improvement in learning. This methodology not only develops research competences, but also forms adaptive and well-rounded professionals.

In another research [34], [35], authors used the collaborative work strategy in higher education students from the School of Initial Education to develop cognitive competences. The results showed that students improved significantly in the cognitive dimension, understanding and analyzing scientific methodology and knowledge better, thus achieving a remarkable development in research strategies and skills. This improvement led to increased motivation and a superior ability to appreciate and handle research challenges. Similarly, Silva *et al*. [36] highlighted that the strategy of collaborative work in students to develop research competences significantly strengthened their research skills. Furthermore, this approach was reinforced with the Vygotskyan model, which emphasizes social interaction and scaffolding within the zone of proximal development, proving to be an innovation that provided substantial support for the strengthening of their research competences.

Morales-Rocha *et al.* [37] highlighted that the implementation of the 'research seedbed' constituted an effective pedagogical strategy and an evaluative method that allowed students to apply theoretical concepts in research courses. This approach facilitated the gathering of evidence on various topics, promoted group discussion and refutation, and fostered critical reflection, generating deep questions between teachers and students and enriching the educational process. In addition, the workshop encouraged orderly and disciplined work among the participants. Eraso [38] emphasized that research workshops are fundamental for the development of research competences in higher education students. This approach facilitated the understanding of the complexity of social reality, the identification of problems, their causes and relationships, and the comprehensiveness of the phenomena studied. By encouraging the formation of groups with common interests, where each member actively collaborated and committed to teamwork, research capacity was strengthened and leadership within the group was promoted. In addition, research by Rodríguez-Vargas *et al.* [39] emphasized that research seed groups in universities developed cognitive and procedural competences, strengthening formative research in university students. This strategy will help professionals to have scientific culture and hunger, contributing significantly to society.

According to Vera *et al.* [40], the participatory action strategy was implemented to enhance students' research competences, demonstrating that participation in research projects promotes skills such as critical analysis, methodological innovation, deep reflection and the ability to propose effective solutions to problems posed. This approach not only strengthened students' technical skills, but also provided them with practical and applied research experience, preparing them to face challenges in their future professional careers. Furthermore, Chávez *et al*. [41] supported this strategy by emphasizing that students not only contributed to the generation of relevant knowledge, but also acquired skills to address and overcome challenges in the field of research competencies, integrating theory and practice effectively and fostering the development of collaborative skills essential for success in academic and professional research.

According to previous research [42], [43], authors implemented the strategy of faculty mentoring for the development of research competencies in undergraduate students, providing continuous guidance from

inception to completion of their research, including the process of submission and acceptance by any journal. Each project was spread over 5 months, during which time the importance of student-tutor trust, continuous feedback, and a technical approach to solving real problems was emphasized. This methodology facilitated an environment conducive to effective hands-on learning, ensuring that students developed critical research skills and acquired the ability to apply theoretical knowledge to concrete situations, thus preparing them for future academic and professional challenges.

Several researches [44], [45] implemented the project-based strategy to strengthen the development of research competencies in health sciences students. This approach allowed students to select topics according to their prior knowledge, motivating them significantly. The direct supervision of the teacher from the beginning to the completion of the research was fundamental, highlighting the crucial role of the teacher in the process. Students were able to highlight their strengths in the search for reliable information and at each stage of the research development, which facilitated deeper learning and greater integration of research skills in their academic and professional training.

Prosekov *et al*. [46] implemented the didactic strategy of research competences in university students. This methodology included group and individual tutorials facilitated by the teacher, which promoted a collaborative work environment. During the process, students not only acquired advanced planning and organizational skills, but also significantly improved their competence in the effective use of technology and the application of precise scientific language. Special emphasis was placed on the development of methodological competences, thus preparing students to rigorously address research challenges in their academic and professional environment. On the other hand, Ramírez *et al.* [47] emphasize that the implementation of didactic strategies in the development of research competences enables students to address issues ranging from the conceptual to the attitudinal. This approach facilitates the investigation of complex problems, encourages critical reflection and promotes integrity in academic production.

Quezada-Castro *et al*. [48] implemented the design of a rubric for the development of research competences in university students. This tool made it possible to evaluate skills such as analyzing reality, searching for relevant information, identifying research objectives, describing the problem studied, and writing solid background information. It also focused on the effective management of time dedicated to research. As a result of this strategy, the students demonstrated a significant improvement in critical thinking, fostered a research culture, strengthened the academic seedbeds, and contributed to the process of training new researchers at the university level [49].

4. DISCUSSION

In the study of Mahasneh [27], it is argued that the flipped learning strategy is highly effective for the comprehensive development of research skills, as it allows students to significantly advance through all phases of the research process, strengthening both theoretical understanding and practical application of knowledge. However, Hava [28] stated that the effectiveness of this methodology depends critically on the accessibility and quality of the previous educational resources provided; to maximize its impact, these resources must be clear and relevant, ensuring active and meaningful participation during the face-to-face sessions. In turn, research by Hernández-Silva and Flores [29] emphasized that flipped learning facilitates more rigorous and efficient literature review, as well as contributing to the accurate formulation of research problems. These observations are in line with this review, which highlights that flipped learning fosters a more holistic and autonomous approach to research training.

In another study, Rodríguez *et al*. [34] demonstrated that collaborative work among students significantly improves cognitive competences and research skills, highlighting how interactive learning and peer cooperation enrich methodological understanding and analysis, promoting a greater ability to address research challenges. On the other hand, Silva *et al*. [36] argued that collaborative work, based on the Vygotskian model, reinforces research competencies by fostering social interactions and scaffolding within the zone of proximal development. These contributions are consistent with the findings of this review, which highlights that collaborative work enhances the collective construction of knowledge, strengthening the research process from a social and contextual perspective.

Finally, Morales-Rocha *et al.* [37] emphasized that research workshops are effective tools for developing research competences, promoting critical debate and reflection among students. This study highlights how these spaces facilitate the practical application of theories and concepts learned in the courses, encouraging intellectual curiosity and methodological rigor. In contrast, Eraso [38] points out that research workshops not only foster understanding of the complexity of social phenomena, but also strengthen teamwork and leadership skills. These contributions are in line with what is reported in this review, which shows that research workshops are key spaces for meaningful learning, the development of interpersonal skills and the formation of academic leaders committed to research.

5. CONCLUSION

Various innovative educational strategies (including flipped learning, Lean startup, collaborative projects, research workshops, mentoring, project based approaches, and other didactic techniques) have had a highly positive impact on the development of research competences among undergraduate students. These approaches effectively train students in key research tasks such as formulating research problems, conducting rigorous literature reviews, applying appropriate methodologies, and presenting results while simultaneously fostering technical skills and transversal competences like innovation, collaboration, and critical thinking. The integration of educational technology and modern pedagogical models through these methods facilitates deep, meaningful learning and better prepares students to meet evolving academic and professional challenges. Furthermore, by promoting active participation and autonomous learning beyond the mere acquisition of information, these strategies help students transform information into applicable knowledge, thereby cultivating a research culture in higher education and ensuring that future professionals are well-equipped to contribute significantly to knowledge advancement in their fields.

Future studies should explore adapting these strategies to diverse disciplines, socio-cultural contexts, and educational levels, and examine the influence of emerging technologies (e.g., artificial intelligence and virtual reality) on developing research competences. Longitudinal research would be valuable to assess the long-term effects of these educational interventions on students' academic and professional trajectories. It is also important to investigate combined approaches (such as blending flipped classroom models with research workshops), consider the psychosocial impacts of these methods on student motivation, self-esteem, and leadership, and design inclusive strategies to benefit students in disadvantaged contexts. Additionally, developing more robust assessment tools (e.g., standardized rubrics) is essential for objectively measuring progress in students' research competences.

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C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

DATA AVAILABILITY

No new data were created or analyzed in this study. Data sharing is not applicable.

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