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Research skills training implementation and challenges in undergraduate students

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ABSTRACT

Research skills are skills that accommodate technological developments in the 21st century and the competencies that students need to be successful in academic and future careers. The main aim of this review is to explore the implementation and challenges in research skills training for undergraduate students. A systematic literature review (adopted the preferred reporting items for systematic review and meta-analysis (PRISMA) method to synthesize 12 selected articles published within 2019-2023 at the ERIC and Google Scholar databases. The finding shows several methods and approaches in training research skills, including practical systematization models, the 4C-ID model, research-based learning, constant supervisor assistance, working on projects independently, training in accessing and utilizing literature, and applying active learning theory. Limited resources, curriculum integration, and pedagogical effectiveness were common challenges in university students' research skills training. Therefore, students' assignments must introduce active learning and research practices. It is also necessary to integrate research practices into the undergraduate curriculum so that research skills training is more structured and optimum.

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1. INTRODUCTION

Along with the rapid development of technology, all scientific disciplines require an education system to equip the younger generation with new skills and competencies following global demands and 21st-century skills [1]–[3]. Therefore, universities should advance, create, and disseminate knowledge through research and science to prepare competent field experts following current developments. One of the efforts made by the government is to direct universities to implement an independent curriculum to focus on skills development, one of which is research skills and practices [4], [5]. Research skills are a person's ability to create and understand new concepts through data collection. These skills also involve finding answers to questions or solutions to a problem by gathering relevant information [6]. In line with this, Wray and Montgomery [7] stated that research skills involve searching for and analyzing relevant information, critically evaluating information sources, designing and carrying out research studies, collecting and analyzing data, and drawing valid conclusions based on research findings. Research competency is considered one of the critical competencies of the 21st century,

and its development is essential for students to be successful in their future careers, especially at higher education institutions [8].

Research skills are one of the competencies and abilities students must develop to conduct quality research in academic activities [9]. Students are required to understand and apply quantitative and qualitative research methods, including designing experiments, choosing sampling techniques, collecting data, and analyzing it using statistical software or other methods [10]. Developing research skills is very important for students to produce quality research and contribute to advancing knowledge in their respective fields [11]. Known as one of the 21st-century competencies, research skills can help students navigate the complexities of an ever-changing world. The ability to conduct research, especially critical thinking, problem solving, and communication is one of the top six competencies most sought after by employers when recruiting new employees [12], [13]. A survey conducted by the pew research center shows that 87% of workers in the United States say that research skills are necessary for their jobs [14]. However, learning in lectures often does not teach research skills to students. Torres [15] explained that many students still need the research skills needed to be successful in their education. Furthermore, Stewart-Mailhiot [16] explains that many students feel anxious about the research process, indicating a need for more confidence in their research abilities.

Research by Ramli and Muchsini [17] this shows that students' average research skills are only 12 out of 30, which shows that students' research skills could be higher. Additionally, a study by the pew research center found that only 29% of Americans believe that college graduates have excellent research abilities [14]. Salmento *et al.* [18] it was also stated that only half of 179 students could describe theoretical concepts scientifically, while the other half had unscientific theoretical conceptions. Furthermore, the research results of Algahmdi and Dereney [19] show that students' writing and research skills have an average value of 77.04 which is included in the medium category. However, research skills did not differ significantly between men and women on each indicator [20]. This shows that students need to be more trained in conducting scientific research, so efforts are needed to integrate research practices into the undergraduate curriculum. Apart from that, several factors influence students' mastery of research skills.

Research by Samarasinghe and Sellahewa [21] University of Sri Jayewardenepura Sri Lanka revealed that students' research skills are influenced by self-confidence, data access, English proficiency, time management, and resource availability. Apart from that, it can be noted that some of the problems scholars face when conducting research are proper knowledge to analyze data, poor supervisory guidance, and problems related to time, money, and access to accurate data. Other factors that influence research skills are critical thinking and communication skills and mentoring or training activities that students participate in [22]. Research skills are one of the competencies or skills that can be trained by applying learning theories, namely experiential learning, constructivist alignment, and self-efficacy [23]. Universities can improve students' research skills by providing practical research assignments, introducing them to the latest sources of information, and helping develop and hone research strategies [24]. Apart from that, RS can be trained by applying active learning methods. Research by Alghamdi and Derenay [19] shows that students taught using active learning methods can work independently to produce scientific writing and have more advanced research skills than traditional students.

A systematic review of undergraduate students' research skills has not been exposed recently. However, it is essential to know its current trends and the importance of improving the pedagogical approaches relevant to it. Varías-Palacios *et al.* [25] conducted a systematic review on learning strategies to enhance research skills in high school students. However, the study needs more detailed explanations on inclusion criteria, publication years, and the selection process of papers for analysis. Lee *et al.* [26] conducted a systematic review of various pedagogies to train medical students in research skills, including research, from inception until January 2020. The difference between current research and existing research is the need for previous research that conducts systematic reviews related to research skills training in undergraduate students. In line with the emphasis on developing research skills for students, this research aims to explore the implementation of research skills training in the tertiary environment and identify the challenges. In the context of global development and 21st-century skill demands, it is crucial to understand effective training approaches to prepare students for future careers. This study will contribute to academic literature by providing insights into best practices and highlighting ongoing challenges. Ultimately, it will help universities improve their research skills training programs, better preparing students for an increasingly complex world.

2. METHOD

The systematic literature review (SLR) using the preferred reporting items for systematic review and meta-analysis (PRISMA) was the primary method to screen the articles. In this research, a systematic review was chosen to sort out previous research related to research skills training for students in tertiary institutions. The relevant studies were identified using the Google Scholar and ERIC databases. This study adapted the systematic review guide proposed by Khan *et al.* [27], which can help researchers critically analyze, evaluate, and synthesize complex ideas. The systematic literature review phase in this research is presented in Figure 1.

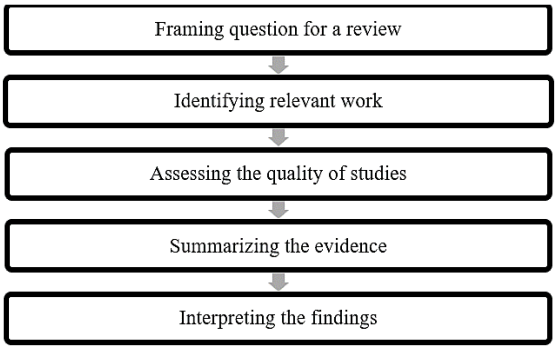

Figure 1. Systematic literature review phase [27]

2.1. Framing question for a review

The questions asked in the review process are prepared based on topics raised in previous research. Researchers have conducted an initial search to identify previous research on systematic reviews related to the implementation and challenges of research skills training for students, especially scientific disciplines that involve research skills in higher education. Researchers found that there was no research related to this, so this research needed to be carried out to answer the following research questions: i) How is the distribution of research that trains research skills among undergraduate students? And ii) What are the implementation and challenges of research skills training for students in higher education?

2.2. Identifying relevant work

In this phase, studies that are relatively suitable in the initial search are collected, and the suitability of these studies is calculated through inclusion and exclusion criteria. This research does not include theses, dissertations, seminar proceedings, and chapter books. In addition, the search in this study was directed at full-text and peer-reviewed articles. Researchers conducted an initial search using Google Scholar and ERIC within one month using various keywords: "implementation of research skills training," OR "challenges in research skills training," OR "research skills in students," OR "research skills in multiple disciplines." After a keyword search, relevant studies will be ranked based on several factors. Including and removing these parameters is a crucial component of the SLR method [28]. During the initial search process, researchers focus on two main aspects: the title and abstract.

2.3. Assessing the quality of studies

In ensuring the quality of the review results, relevant studies are selected using inclusion and exclusion criteria to screen whether the studies are suitable or not to be included in the systematic review. These criteria can invalidate journals that have been obtained for further analysis. This study's inclusion and exclusion criteria differ from existing research, especially regarding topics in the articles reviewed. Selected studies had to meet the following inclusion criteria: i) studies are articles published between 2019–2023, ii) the study focuses on research skills training for students, iii) the study is empirical research, iv) the study evaluates research skills in various fields in higher education, v) the study was published in a peer-reviewed journal publication, and vi) full-text access is available.

Additionally, exclusion criteria were used to identify irrelevant articles that should not have been included in the study. Thus, the exclusion criteria are as follows: i) studies are applied outside the higher education (university) level, ii) studies not published within 2019–2023, iii) the study does not review research skills in students, iv) studies other than journal articles and conference proceedings (theses, dissertations, and book chapters are not included), v) the study was not published in a peer-reviewed journal publication, and vi) paper may have to be accessed through payment by the reader.

Six inclusion and exclusion criteria are used in this study based on the research questions. These criteria are critical because they will determine the scope and validity of the systematic review results. The selection process must follow these criteria from the initial evaluation to the final stage of study classification.

2.4. Summarizing the evidence

The literature databases used to identify relevant studies in this research were Google Scholar and ERIC. Some key terms used by researchers during the search include implementation of research skills training, challenges in research skills training, research skills in students, and research skills in various scientific disciplines. A total of 364 studies (Google Scholar=361; ERIC=2) published within 2019-2023 were identified through the two databases. Then, the results were filtered into non-English texts and non-journal sources (101 results remaining),

texts not completely accessible (76 results remaining), not meeting the inclusion criteria (14 results remaining), and two duplicates that were removed. Finally, the researchers identified 12 articles, which would be analyzed further. The PRISMA flow diagram, which represents a summary of the search process, can be seen in Figure 2.

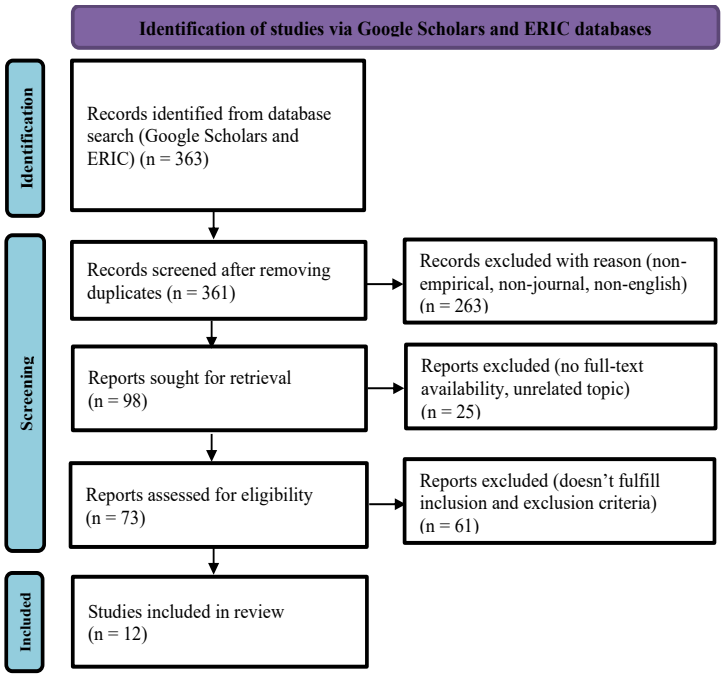

Figure 2. PRISMA flow diagram

2.5. Interpreting the findings

Data analysis in this research uses content analysis to interpret the findings. The results of previous studies were grouped based on the methodology used, using quantitative, qualitative, and mixed-method categories. From a systematic review of research published between 2019-2023 on general disciplines involving research skills training at the higher education level, only 12 empirical studies were found that would be the basis for answering research questions. Next, an in-depth, full-text review is conducted on selected articles to answer the research questions.

3. RESULTS AND DISCUSSION

3.1. Distribution of research that trains students' research skills

Analysis of the methodology used in previous studies from 2019 to 2023 shows that the quantitative approach is the most widely used method compared to other methods (Table 1). Overall, research skills training still needs to be applied to learning in higher education. However, there are several implementations of research skills training in various general disciplines, such as preschool education, primary education, law, pedagogy, language, social education and pedagogy, and postgraduate learning. The distribution of general disciplines that train research skills in learning can be seen in Table 2.

Table 1. Demography of research method

Method	Google scholar	ERIC
Quantitative	9	1
Qualitative	1	
Mixed-method	1	

Table 2. Distribution of general disciplines that train research skills

Discipline	Total research
Social education and pedagogy	1
Language	1
Pedagogy	5
Pre-school education	1
Elementary education	1
Law	1
General (not stated)	2

Table 3 provides a comprehensive summary of studies investigating diverse research skills training strategies for students in higher education. The research by López-Novoa *et al.* [29] underscores the lack of

instructor emphasis on research skill development, contrasting with Ayala *et al.* [30] findings that implementing the practice systematization model effectively enhances research skills. Additionally, Bartosh *et al.* [31] advocate for research-based learning, while Volynets *et al.* [32] emphasize the importance of research-centric educational process design. These studies collectively offer insights into varied approaches that educational institutions can adopt to enhance student research skills, encompassing structured learning models and integrating research methods across all educational stages. Furthermore, the impact of these strategies on student development is evident, as demonstrated by Aranda *et al.* [33] study showcasing significant improvements in research skills through mentoring and digital resource access, and Prosekov *et al.* [34] findings indicating enhancements in motivation, epistemological understanding, operational abilities, and personal aspects among students engaged in research activities. These outcomes underscore the substantial benefits of a research-focused approach in fostering students' academic and professional growth.

Table 3. Research skills training for students

No.	Author	Research skills training
1.	López-Novoa *et al.* [29]	The way instructors plan their teaching has a limited relationship to students' research abilities. Teachers tend to focus less on developing research skills, which can be seen in the need for more alignment and coherence in their teaching approaches. The relationship between university didactics and teachers must be more complete concerning students' research skills.
2.	Ayala *et al.* [30]	Models of systematization of practice involving monitoring, reconstruction of experience, feedback, and theorizing have proven effective in developing research skills during university and higher-level pedagogical education.
3.	Bartosh *et al.* [31]	Research-based learning involves introducing scientific research methods into the process of educational cognition at all stages (from perception to application in practice) and determining how to organize students' educational and extracurricular research activities, which is considered adequate for training research skills in students.
4.	Volynets *et al.* [32]	The formation of practical research skills in future preschool educators significantly depends on the research-oriented design of the educational process, considering the basic patterns and stages of the educational process.
5.	Aranda *et al.* [33]	Students with constant assistance from supervisors and technological support who have digital libraries with access to databases such as Scopus, WOS, Ebesco, and other databases have grown by 80.94%. Research skills are carried out with the ERLA test, so it is proven that the pedagogical model contributes to developing and strengthening research skills in students.
6.	Prosekov *et al.* [34]	This research explores the theoretical foundations of research work planning in higher education, encompassing motivation, epistemological understanding, operational abilities, and personal aspects. The development of research competence lies in the successful application of research knowledge and skills in practical tasks. Notably, increased student motivation reflects a greater appreciation for the value of science and research. Additionally, the growth of the epistemological component can be attributed to cognitive processes stimulated by research activities, fostering systematization, planning, comparison, and generalization. Improvement in operational capabilities and personal aspects is evident through the enhanced quality of research reports and scientific publications.
7.	Purizaga-Sorroza *et al.* [35]	Using a methodological model design based on Tobón's competency-based approach and the Tunning Project, critical-humanistic teaching theory, and Jorge Witker's active education theory can effectively train research skills in students. In this model, the instructor becomes a guide for student learning so that the student's role is much more active. Therefore, the instructor needs to conduct activities to develop research skills in teaching and learning. This will help students to relate directly to reality and find answers according to the context of the problem.
8.	Gyurova [36]	Practical training in research skills can be achieved through an integrated approach in 21st-century education. The focus is on developing students' abilities to access and evaluate diverse information sources and mastering efficient information searching. Sofia University's Faculty of Pedagogy has successfully implemented independent assignments to foster creativity and innovative thinking, allowing students to develop research skills and collaboration abilities within a dynamic environment. To support students' self-development and improvement, universities should offer specialized courses on research skills and creativity.
9.	Ipanaqué-Zapata *et al.* [37]	The training program emphasizes the development of student competencies in accessing and utilizing information from databases and reference managers for effective literature searching and management. It includes introducing students to global databases like Scopus and Web of Science, as well as bibliographic reference managers like Mendeley. The curriculum also focuses on enhancing skills in formulating research problems, objectives, and hypotheses, and applying statistical techniques for data analysis. The training can be integrated into an online learning environment to suit the student's specific contexts.
10.	Ciraso-Calí *et al.* [38]	Among the 154 students assessed, there was room for improvement in their ability to communicate and conduct in-depth reviews effectively. Students acknowledged the need to enhance their skills in staying up-to-date, acquiring subject matter knowledge, and improving communication abilities. While research efforts have primarily emphasized reflective thinking and communication skills, improving a solid understanding of scientific concepts and acquiring reliable information searching skills is still needed.
11.	Vieno *et al.* [39]	Students will have a deeper understanding of the value and significance of developing these skills by identifying seven core research skills such as critical judgment, information synthesis, decision-making, problem-solving, data collection and analysis, and communication, where training needs to be carried out in the application of the seven core skills so that they can provide benefits in the form of deeper understanding, the ability to articulate skills, increased performance, and research interest for students.
12.	Maddens *et al.* [40]	Using the 4C/ID model as a framework, this research investigates the impact of autonomy, competency, and relationship support in online learning environments on students' cognitive and motivational outcomes in research skill development. The findings underscore the significance of incorporating needs support to enhance students' research skills and inform the design of more efficient learning programs, ensuring students are well-prepared for their future careers and educational pursuits.

3.2. Implementation and challenges of research skills training for students

Research skills training is an essential component of learning in higher education because it prepares students for future careers and helps develop the competencies necessary for personal, academic, and professional achievement [41], [42]. A systematic review regarding the implementation and challenges of research skills training in students is an important topic that requires further investigation. The results of the literature review that has been carried out provide valuable insight into training in developing students' research skills, which includes using various pedagogical approaches, developing soft skills, mastering teamwork skills, as well as challenges in the context of developing life skills, all of which are crucial points of attention in the domain of this research.

The challenges of teaching technically advanced research skills to students are widely discussed in various research articles. One is research by Ahmad and Al-Thani [43], which revealed that these challenges include the need for scaffolding research skills, the transition to independent research, and integrating research into the undergraduate curriculum. To overcome these challenges, research by Finn and Crook [44] created a project that aims to train students to be competent in conducting research called scientific training by assignment for research students (STARS). This project focuses on identifying problems that arise in student research projects and equipping students with the skills necessary to overcome these challenges. STARS consists of internet-based learning resources designed to help students develop several basic skills related to scientific research, which aims to improve students' ability to plan, design, manage, and carry out scientific research.

Willison [45] explains that there are six indicators of research skills according to the research skills development framework (RSDF), namely: i) embark and clarify (starting research and clarifying research problems); ii) find and generate (find and produce data/information); iii) evaluate and reflect (evaluate and reflect on the research process); iv) organize and manage (organizing data/information and managing the research process); v) analyze and synthesis (analyze and synthesize data/information); and vi) communicate and apply (communicate and apply research results). These six indicators are interrelated and support training, especially for students who face academic challenges and the demands of the world of work. In addition, research skills can be measured to determine the extent to which students possess these skills. In this case, Maddens *et al.* [46] developed a ts to measure research skills called the Leuven research skills test (LRST), which can be used to assess (individual differences in) overall research skills and the effect of specific interventions to promote research skills in future studies.

Research by Maddens *et al.* [9] expressed the importance of curricular characteristics and instructional design principles to promote students' research skills proficiency as a primary goal rather than focusing on learner characteristics such as gender differences. In this context, the learning model is essential to help students develop their research skills. Therefore, Bartosh's *et al.* [31] study highlights the effectiveness of research-based learning models in training research skills in students. Integrating scientific research methods into the entire educational process, from understanding to practical application, has successfully formed strong research skills in students. Additionally, Hoffman *et al.* [47] explained that the flipped classroom learning model allows for adapting instruction to student needs but requires more time to prepare materials and evaluation assessments. However, the advantage is that students can grow their confidence to use the research skills taught.

Vieno *et al.* [39] identified seven core research skills also provides a strong foundation for understanding the value and significance of developing research skills. In this context, research skills training provides benefits beyond technical aspects, such as critical assessment, information synthesis, decision-making, problem-solving, data collection and analysis, and communication skills. Research by Tahsildar and Hasani [48] regarding lecturers' perceptions of research skills and productivity shows that identifying research skills has important implications. The lecturers have a medium level of research skills with low research productivity, which aligns with the findings in identifying core research skills expressed by Vieno *et al.* [39]. This research also provides higher education policy recommendations to improve research policy and planning, including reducing teaching loads, providing research facilities, and encouraging research training.

The learning methods and techniques instructors apply in lectures are believed to be related to developing students' research competencies. López-Novoa *et al.* [29] research revealed that how teachers plan classroom learning shows a low relationship with how well students research. Teachers often focus less on helping students learn how to research well, in this case, the teacher needs to integrate research skills in lectures or project assignments. Apart from being very important for academic success, research skills are also crucial for supporting a career in the world of work. The study by Gatta *et al.* [49] revealed that conducting research is one of the five skills most sought after by companies when recruiting new employees. In this case, research skills are one of the positive points that increase students' chances of being accepted into the workplace after graduating.

Based on the systematic review that has been carried out, research skills training for university students is still relatively rare. This aligns with research by Ciraso-Cali *et al.* [38], which states that students need to gain more research skills, especially the ability to make up-to-date reviews and communicate research findings. A study in Nigeria that examined the relationship between principals' managerial skills and teacher performance in secondary schools revealed that principals' managerial skills, including communication, interpersonal, and technical skills, were related to teachers' job performance [50]. This shows that research skills are essential in supporting a career in the world of work, considering that communication skills are one of the six indicators of research skills, as stated by Willison [45].

Another research on research skills training and development was conducted by Rodriguez-Vargas *et al.* [51], who explained that implementing research skills through research groups affected cognitive and procedural competence rather than attitudinal competence. In this context, universities must be able to integrate the development of research skills competencies in the curriculum to train a scientific culture and motivate students to develop their research skills. This aligns with research by Willison [52], which shows that research skills are related to attitudes and behavior that support evidence-based practice (EBP) in transferring knowledge and skills through affective interaction when graduating and working. Research skills also positively impact the world of work, as proven by research highlighting the importance of this skill in recruiting employees. This follows the statement of Salybekova *et al.* [53], who explained that research skills are essential to academic success and career success and the improvement of attitudes supporting practice.

Research skills training in higher education prepares students for future careers and self-development [54]. Studies on the implementation and challenges of research skills that have been carried out show that research skills development focuses on technical aspects, pedagogical approaches, soft skills, teamwork, and life skills. Various program initiatives such as STARS, research-based learning, and flipped classrooms can be alternatives to improve students' research skills. Research skills measurement instruments such as LRST were also developed to evaluate students' mastery of research skills. This is useful in adapting appropriate and effective learning strategies to practice research skills. According to Sergeeva *et al.* [55], with developments in technology and communication, skills in managing information and analyzing data are also increasingly important. Hence, the use of information technology and digital literacy needs to be integrated into research skills training. This aligns with research by Yahya *et al.* [56], which explains that collaboration is needed between faculties, libraries, and learning development centers in universities to support comprehensive and sustainable research skills training for students.

Research skills training must be distinct from the role of lecturers, who significantly influence the learning process. This is in line with Agah *et al.* [57], which states that the relationship between lecturers and students significantly contributes to students' attitudes towards research, time spent studying, and students' acquisition of research skills. Shakibi *et al.* [58] conducted research skills training specifically for faculty members to improve research skills, so it is hoped that research assistance and the quality of research carried out by students will be better. In addition, the success of research skills training depends on integrating research practices into the curriculum, which can increase students' motivation to conduct research and foster confidence that the research is relevant to learning [59]. Finally, maintaining a research-oriented environment is critical for successfully integrating research and teaching [60].

4. CONCLUSION

Based on the systematic review conducted, quantitative methods are the most commonly used research methods in studies related to training research skills for undergraduate students, with pedagogy being the most prevalent discipline. Various methods and approaches are used to train research skills, including systematic practice models, the 4C/ID model, research-based learning, ongoing supervision, independent project work, training in accessing and utilizing literature, and applying active learning theory. Resource limitations, curriculum integration, and pedagogical effectiveness are common challenges in training research skills for students. The limitations of this review are that it only considers studies that train research skills in undergraduate students and uses a limited database of studies so that future research can conduct research with a broader scope.

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