RESEARCH SKILLS IN HIGH SCHOOL STUDENTS: A SYSTEMATIC REVIEW

Rogelio Angel Varías-Palacios[1]*, Enrique Guillermo Llontop-Ynga[2], Jackeline Patricia Murillo-Tapia[3], Carmen Tenorio-Vilchez[4]

[1]Educational Psychology, Universidad César Vallejo, Peru; [2]Health Services Management Department, César Vallejo University, Peru; [3]Department of Science and Technology, Universidad César Vallejo, Peru; [4]Department of Strategic Educational Management, Pedro Ruiz Gallo National University of Lambayeque, Pontifical Catholic University, Peru

Abstract

The objective was to conduct a systematic review of the strategies applied for developing investigative competencies in secondary education. The information management was expanded without the segment of years of publication of different scientific articles. For the diagnosis of the information, databases such as Scielo, DOAJ, Scopus, Dialnet, and the Scholar Google metasearch engine were used. As inclusion criteria, only documents related to the development of competencies investigated in secondary school were accepted. As a result, it is evident that the most used strategies for development were Project-Based Learning, Problem-Based Learning, the use of web technologies oriented to education, and incorporation into curricular plans.

Keywords: Research skills. Secondary education. Research strategies. Primary education

Manuscrito recibido: 05/01/2023
Manuscrito aceptado: 06/02/2023

*Corresponding Author: Rogelio Angel Varías-Palacios, Educational Psychology, Universidad César Vallejo, Peru

Correo-e: rvarias@ucvvirtual.edu.pe

Introduction

Curricular interest in the importance of investigative competence in secondary education, especially in Latin America, is very recent (Falavigna et al., 2015; Hernández-Carranza et al., 2015). For example, in Peru, the development of this competence was only promoted in 2016 through the National Education Curriculum.

To understand investigative competencies, it is necessary to explain them as what, why and why to investigate (Wood & Smith, 2018), understood as the set of skills to carry out an investigative process addressing a certain topic, contrasting it, through the reflection, and critical thinking, managing to propose solutions in contexts of daily life (Cañon & Barón, 2015).

In most pedagogical practices, these skills are sought to be developed at the higher educational level, facing the student to solve problems in their field of action, as mentioned by Calderón et al. (2020):

It is essential to develop skills that allow the student to function to solve various situations in the contexts where they develop their pedagogical practice using knowledge, skills, and attitudes. Undergraduate students must develop this type of skills because, with a professionally active life based on research, they can consolidate scientific, cultural, ethical, more productive, professional, and personal preparation (p. 3).

Thus, little has been deepened on investigative competencies in primary education, lacking adaptable models and strategies conducive to our educational context. Therefore, it is essential to establish evaluable levels, achievements, and learning goals in investigative competencies for a diagnosis, monitoring, and implementation of improvement strategies, since it is unknown at what level those students belonging to primary education are (Moreno-Guerrero et al., 2021; van Leeuwen & Janssen, 2019; Zapata et al., 2021).

Training in these skills promotes not only the academic training of the student but also provides them with tools to solve real problems in different contexts, adaptability, critical thinking, decision making, motivation, and technical application of theoretical knowledge. In addition to a better self-learning ability at later educational levels (Fernández, 2006).

According to the Peruvian National Curriculum of Regular Basic Education of the Ministry of Education (2016), it is expected that the student will be able to use the scientific method to inquire about a specific topic, building their knowledge. This achievement requires that the student is motivated to investigate, learn to seek knowledge, evaluate it and acquire it as his own, thus preparing his cognitive capacity for higher education. However, although this expected achievement has been established, how to get there is unknown. Imitating the adaptation of the investigative process in university education in primary education is not the best solution (Zapata et al., 2021).

Research such as that of Murillo & Martínez-Garrido (2019) indicates that the educational system in Latin America does not encourage motivation as the axis of investigative competence in primary, secondary, and regular education since orders are given, and it is sought to strictly comply with the objectives rather than the development of the competence as such, the result is then, students with a forced, monotonous and mechanical research experience, without addressing topics of their own interest.

In this sense, the objective of this research was to carry out a systematic review of the strategies that are applied for the development of investigative competencies in secondary education.

Method

A systematic review was carried out on the strategies for the development of research skills in secondary education. The theme of the study is still relatively recent, for which the collection of information was done in an expanded manner. That is, the parameters of the year for the search for information were not segmented (Table 1).

Development

Strategies That Promote Research Skills in Secondary Education

Strategy 1

Project Based Learning (PBL): It implies that the student must be an active protagonist (Packer & Goicoechea, 2000); the teacher as a guiding presence (File, 1993); inquiry as a central path of learning; the integration of the contents, the constant formative evaluation and the use of time and space in a flexible way. According to Corica (2020), the Project-Based Learning strategy leads to training that cannot be based on the reproduction or storage of information but instead seeks its functionality and reconstruction in various situations (Geng et al., 2022). Basically, the essential keys for Project-Based Learning strategies are: starting from a real challenge, assuming the teaching role of guide and support, favoring collaborative work, encouraging inquiry and autonomy, banishing the fear of error, evaluating continuously, allows the project to be seen as an assembly (Dobson & Dobson, 2021; Geng et al., 2022).

Rivera (2019), in a quasi-experimental and longitudinal design study, aimed to determine the influence of Project-Based Learning in the production of

Table 1: Units and axes of study.

Study Units	Study Axes
Strategies that promote research skills in secondary education	• Project-Based Learning (PBL).
	• ENARI Program (Argumentative Essay for Research).
	• Application of web 3.0 tools
	• Digital Educational Materials (DEM).
	• Curricular and didactic planning.
	• Problem-based learning.
Note: The study axes were subtracted from the systematization of strategies that promote research skills in secondary education.	

expository texts in first-year high school students of a Private Educational Institution. The study concludes that there is evidence to affirm that project-based learning influences the production of expository texts.

Cornejo & Guadalupe (2016) set out to establish how project-based learning influences the development of competencies in the area of science, technology, and the environment of students in the fifth grade of secondary school. For data collection, a project-based learning questionnaire and a written test on skills in the area of science, technology and environment were developed. It shows as a result that the PBL significantly influences 33.99% in the development of competencies in the area of science, technology and environment.

Larmer & Mergendoller (2010) suggest that there is a certain association between talent and the student's own cognitive capacity in their performance in research, so methods such as PBL are not applicable to any group and must have previous diagnoses that measure capacities before applying them. educational intervention, while traditional methods tend to be more effective with standard students, PBL presents better results with capable and talented students. The execution of projects has shown good results in collaborative activities. However, their individual effectiveness has not been fully demonstrated, there are cases that in individual projects only stressful and difficult experiences have been achieved.

The orientation, based on an explanatory work, teaches searches, based on the principles of research, motivating the student to create a research plan, searching and selecting sources, how to find them, their synthesis, their schedules, predicting results and testing hypotheses. By following the new paradigms of modern education, the PBL is oriented to "learn by executing the activity". In this sense, to develop the investigative capacities of future specialists, various simplified topics will be delved into, the fact of delving into asking and consulting various sources (not strictly scientific and academic) an effective method is promoted to be used in the lessons, discussions between groups can help prove their own conclusions and acquire knowledge from this activity, in the case of basic primary education, children they will be able to formulate simple conclusions on everyday topics, supported and delimited in their cognitive framework (Salybekova et al., 2021).

At the time of the execution of the projects, the student will have to define: names, objectives, hypotheses, results, difficulties encountered, sense of satisfaction, sources, future interests, capacity and feedback, and a reassessment of the project.

Strategy 2

ENARI Program (Argumentative Essay for Research): It is a planning instrument based on creating argumentative texts (essays) by primary education students, verifying and tracing objectives, using resources, and determining work periods with a result of the text in its final version. In this case, argumentative texts are used due to their easy adaptability to different curricular areas, such as natural sciences, mathematics, language, literature, etc. In the process of writing an essay, reflective, critical, argumentative, and writing skills are involved. This process involves the systematization of data, search for bibliographical sources, citation, formulation of objectives, testing of hypotheses, and formal presentation of the subject under investigation, including the critical analysis and argument of the student himself.

Pacherres et al. (2021) proposed to implement the Argumentative Essay Program (ENARI) to strengthen investigative skills in fifth-grade high school students from an educational institution in Catacaos, in Piura (Peru). It was developed from the quantitative approach, propositional descriptive modality, and simple descriptive cross-sectional design. It was concluded that the ENARI Program constitutes a didactic strategy that helps to constructively strengthen investigative skills in secondary school students.

Strategy 3

Application of web 3.0 tools: Unlike web 2.0, web 3.0 is a web-semantic tool with the use of executable information engines and processors on any device (Corino-López, 2017). Because in the teaching-learning process, the organization and personalization of information are essential, web 3.0 is presented as a dynamic tool in the teaching-learning process. By facilitating the organization of information (main capacity in research), the student can develop their digital and investigative skills with great dynamism; this tool encourages the creation of conceptual and mental maps, digital content in online or offline multimedia, presentations, podcasts, blogs, wikis, among others (Sandoval, 2016).

Suárez-Triana et al. (2020) proposed the pedagogical strategy based on web 3.0 tools to develop the competence of interpretation and problem solving of research projects in high school students. The work had a qualitative approach with an exploratory scope. The study population corresponded to 32 students from the tenth and eleventh grades of a Colombian educational institution. Two questionnaires were used to carry out the diagnosis and the advancement of competencies, applied one before and the other after the pedagogical strategy, respectively. Initially, 16 students formulated the research problem correctly, while after applying the pedagogical strategy, only one student failed to formulate it. It is concluded that the implementation of web 3.0 tools allows students to achieve the necessary skills to develop transversal research projects, leading the educational process both inside and outside the classroom.

Digital Educational Materials (DEM)

The use of educational materials is effective when strengthening capacities or facilitating student learning regarding certain subjects. It is so for (Navia, 2016).

Interpretive, argumentative, and propositional skills (axes of the individual's cognitive potential to participate in a research process) can be highly developed if they are correctly structured in digital educational materials. The author explains that multimedia materials strengthen prior knowledge and encourage the acquisition of new ones. It also highlights the importance of material design in terms of aesthetics and functionality since the attractiveness of the material will be one of the motivations for the student body, so a correct application and condensation of content allows the student to identify and propose solutions to the problems presented dynamically with critical thinking, these skills are closely linked to research (interpretative, argumentative and propositional) (ICFES, 2013).

Strategy 4

Curricular and didactic planning: Calderón et al. (2020) mention that the acquisition of these skills is part of an integrating process, with the teacher as the protagonist, who must be interdisciplinary and transversal to the curriculum that he/she develops. In other words, the teacher can be the axis of change in their own class, but an improvement of the collective curriculum (generally national) will notably improve the collective training of the student body. Rojas (2013) explains that curricular improvement triggers a series of benefits in a specific educational group. At the basic education level, the student will improve their personal learning processes, leading to better opportunities for their academic performance and even the integration of research into their professional performance. Calderon et al. (2020) finally suggest that regular education curricula adapt to an investigative approach of the teacher, the questioning of the knowledge imparted, and promote an exchange of knowledge with synergies with other strategies such as collaborative learning.

According to Alamettälä and Sormunen (2021), teaching research skills (especially in digital media) is a challenge for teachers more than in other subjects since it includes an entire process of digital literacy in research. Didactic methods and the pedagogical management of teachers are often not effective, not because they are poor methods but because they are poorly oriented (Limberg et al., 2008). Literacy includes a process in which the student can learn to solve their problems through research assignments guided by a teacher in the process. In this participatory methodology, the student takes an active role in applying theories to the confirmation of their own answers. However, unlike the other strategies, the role of the teacher is also active since if he does not identify the crucial points in which students need support, he will only end up building a meaningless web of knowledge for the student (Kuhlthau et al., 2015).

It is even highlighted that participatory teaching in research must be individualized and personalized since each student will have different rhythms, approaches, and forms of criticism that cannot be fully developed in a group standard. The design of a model of guided inquiry is effective in terms of self-efficacy and the attitude of students regarding research as long as the teacher in his pedagogical capacity knows how to carry out each situation differs from one to the other. It is based on the position that the same problem will not always be approached in the same way, and each student can have a position regarding it (the objective is to develop critical thinking, not standardize it) (Alamettälä & Sormunen, 2021).

Another case of the application of teaching didactics in the learning of research competencies occurs in two cases. According to Limberg et al. (2008), they distinguish between two types of investigative learning designs. The first is an atomistic learning design, where complex skills are broken down into a series of simple skills and trim pieces, and these fragmented skills are accumulated into the design. The reduction used in the atomistic design is efficient when there are few interconnections between the different elements of matter.

The second is integrated learning design, the design that pays attention to the interconnectedness between different skills and tasks. In a holistic design, different skills and tasks are framed into the big picture, making students more aware of how to accomplish them independently. A holistic design is supposed to be more beneficial for learning complex skills because an atomistic design loses sight of the complexity of the entire task and does not show the interconnections between the skills being taught.

Janssen et al. (2019) explain that the pedagogical strategy must be aimed at making the student aware of the different skills that they have to use simultaneously. That is those innate abilities of the individual and how to use them to solve difficulties presented. Later, the student must learn where is the knowledge that is required to complement those abilities.

The importance of this fragmentation of the entire research process is also highlighted so that it is assimilated in parts by the student. It is vital to approach cases that show the importance and application of their knowledge outside the classroom. Although it is true that the Units of knowledge are easier to learn divided and organized, the skills that students are acquiring should not be fragmented. That is, the teacher must be able to link them in stages, showing the usefulness of the previous competence to acquire the next one. This provides them with essential tools that the student uses in real-life situations (Janssen et al., 2019).

Strategy 5

Problem-based Learning: Problem-Based Learning aims to promote cognitive ability, is oriented to the process rather than the result, and is part of a solid base of student knowledge and personal experiences (Fidan & Tuncel, 2019; Kanyesigye et al., 2022). The principle of this Learning is "The student knows at the moment that influences his learning as the most important factor" (Ausubel, 1978).

On the other hand, for Noriega (2022), Problem-Based Learning is "learning to learn" using cooperative work on many occasions in small groups seeking the solution to the problem through inquiry. The strategy is based on three components: 1) Representation Learning, which is characterized by the use of symbols and associates concepts with particular objects. 2) Learning of Concepts, which is characterized by the representation of the concept to an object, the formation of concepts falls on its attributes, formulating and contrasting hypotheses. This generates a solid cognitive structure, not mechanical but acquired with contrast. 3) Learning of propositions, from the foundation of the cognitive structure, new meanings are generated, that is, the ability to search for or refute concepts already acquired. The student is shown that no conception is rigid but changing.

Problem-Based Learning often focuses on learning to formulate hypotheses (the solution or the reason for the research problem). By acquiring this ability, the student is able to develop an involvement by contrasting and reinforcing their skills through their own self-learning. In this methodology, the results are not relevant since it is the student's cognitive construction process, their analysis, and defense posture that is relevant for the construction of their knowledge, even if their hypothesis is rejected, the student will have acquired the experience for new approaches (Zapata et al., 2021).

Conclusion

The evidence on the strategies that promote the development of research skills in secondary education starts from applying the Project-Based Learning program (which also includes the ENARI Program) and Problem-Based Learning, which influence the area of letters and sciences.

Another critical aspect for developing these skills is the application of web 3.0 tools and the use of digital educational materials, which allow the collaborative organization and systematization of diverse knowledge found in the era of connectivity and information.

Finally, we find that it is necessary to incorporate the development of investigative skills in the curricular plans and the application in the educational didactics of the teacher. In Latin America, it has been seen that the promotion of educational competence in curricular plans is very recent.

References

Alamettälä, T., & Sormunen, E. (2021). Learning online research skills in lower secondary school : long-term intervention effects, skill profiles and background factor. *TUNICRIS-julkaisut*.

Ausubel, D. (1978). *Psicología Educativa. Un punto de vista cognoscitivo* (Trillas (ed.)).

Calderón, E., Rubio, L., & Naranjo, B. (2020). El desarrollo de competencias investigativas en la formación de estudiantes normalistas a través de pasantías internacionales desde la conformación de redes entre Cuerpos Académicos. *Debates en Evaluación y Currículum/Congreso Internacional de Educación*.

Cañon, L., & Barón, M. (2015). Colegio Pablo Neruda ied: A 15 años de la implementación de las competencias investigativas. De la resistencia a la complacencia. *Nodos y Nudos*, *4*(38), 45-52. https://doi.org/doi:10.17227/01224328.4326

Corica, A. R. (2020). Aprendizaje Basado en Proyectos en la escuela secundaria argentina: un estudio exploratorio sobre la experiencia de profesoras y profesores en servicio. *Revista Educación*, 382-397. https://doi.org/10.15517/revedu.v45i1.43084

Corino-López, C. (2017). *Evolución de la web 2.0 a la 3.0, y su impacto en la empresa*. Universidad de Cantabria.

Cornejo, A., & Guadalupe, Y. (2016). Influencia del aprendizaje basado en proyectos en las competencias del área de ciencia, tecnología y ambiente de estudiantes del quinto grado de una Institución Educativa secundaria de Ica - 2016. *Universidad César Vallejo*. https://repositorio.ucv.edu.pe/handle/20.500.12692/19756

Dobson, J., & Dobson, T. (2021). Empowering student voice in a secondary school: Character Education through project-based learning with students as teachers. *Teacher Development*, *25*(2), 103-119. https://doi.org/10.1080/13664530.2020.1865442

Falavigna, A., Filho, D. E. M., Avila, J. M. J., Guyot, J. P., Gonzáles, A. S., & Riew, D. K. (2015). Strategy to increase research in Latin America: project on education in research by AOSpine Latin America. *European Journal of Orthopaedic Surgery & Traumatology*, *25*(S1), 13-20. https://doi.org/10.1007/s00590-015-1648-8

Fernández, A. (2006). Metodologías activas para la formación de competencias. *Educatio siglo XXi*, *24*, 35-56.

Fidan, M., & Tuncel, M. (2019). Integrating augmented reality into problem based learning: The effects on learning achievement and attitude in physics education. *Computers & Education*, *142*, 103635. https://doi.org/10.1016/j.compedu.2019.103635

File, N. (1993). The teacher as a guide of children's competence with peers. *Child and Youth Care Forum*, *22*(5), 351-360. https://doi.org/10.1007/BF00760944

Geng, F., Srinivasan, S., Gao, Z., Bogoslowski, S., & Rajabzadeh, A. R. (2022). An Online Approach to Project-Based Learning in Engineering and Technology for Post-secondary Students. En *Lecture Notes in Networks and Systems* (pp. 627-635). Springer. https://doi.org/10.1007/978-3-030-96296-8_56

Hernández-Carranza, E. E., Romero-Corella, S. I., & Ramírez-Montoya, M. S. (2015). Evaluation of Digital Didactic Skills in Massive Open Online Courses: a Contribution to the Latin American Movement. *Comunicar*, *22*(44), 81-90. https://doi.org/10.3916/C44-2015-09

ICFES. (2013). *Módulo de Pensamiento científico Ciencias biológicas SABER PRO 2013 –2*.

Janssen, E., Depaepe, F., Claes, E., & Elen, J. (2019). Fostering students' scientific reasoning skills in secondary education: An intervention study. *International Journal of Science, Mathematics and Technology Learning*, *26*(19). https://doi.org/10.18848/2327-7971/CGP/v26i01/1-19

Kanyesigye, S. T., Uwamahoro, J., & Kemeza, I. (2022). The Effect of Professional Training on In-service Secondary School Physics «Teachers» Motivation to Use Problem-Based Learning. *International Journal of Learning, Teaching and Educational Research*, *21*(8), 271-287. https://doi.org/10.26803/ijlter.21.8.16

Kuhlthau, C., Maniotes, L., & Caspari, A. (2015). *Guided Inquiry. Learning in the 21st Century* (Libraries Unlimited (ed.)).

Larmer, J., & Mergendoller, J. (2010). Essentials for Project-Based Learning. *Educational Leadership*, *68*(1), 52-55.

Limberg, L., Alexandersson, M., Lantz-Andersson, A., & Folkesson, L. (2008). What Matters? Shaping Meaningful Learning through Teaching Information Literacy. *De Gruyter*. https://doi.org/doi.org/10.1515/libr.2008.010

Ministerio de Educación. (2016). *Currículo Nacional de Educación Básica*.

Moreno-Guerrero, A.-J., Soler-Costa, R., Marín-Marín, J.-A., & López-Belmonte, J. (2021). Flipped learning and good teaching practices in secondary education. *Comunicar*, *29*(68), 107-117. https://doi.org/10.3916/C68-2021-09

Murillo, J., & Martínez-Garrido, C. (2019). Una Mirada a la Investigación Educativa en América Latina a partir de sus Artículos. *REICE. Revista Iberoamericana sobre Calidad, Eficacia y Cambio en Educación*, *17*(2), 5-21. https://doi.org/https://doi.org/10.15366/reice2019.17.2.001

Navia, L. (2016). Los Materiales Educativo Digitales – MED para el desarrollo de competencias investigativas con estudiantes de educación secundaria. En *Utilizando Tecnología en la Educación para Fortalecer la Práctica Docente en América Latina*. Universidad Nacional Abierta y a Distancia.

Noriega, L. (2022). *Las estrategias de aprendizaje basado en problemas*

para desarrollar capacidades investigativas en estudiantes de educación secundaria. Universidad César Vallejo.

Pacherres, M., Zapata, J., Vélez, J., & Tumi, B. (2021). Experiencias de ensayo argumentativo para fortalecer competencias investigativas en estudiantes de secundaria. *Revista Conrado*, *17*(82), 411-417. https://conrado.ucf.edu.cu/index.php/conrado/article/view/1973

Packer, M. J., & Goicoechea, J. (2000). Sociocultural and Constructivist Theories of Learning: Ontology, Not Just Epistemology. *Educational Psychologist*, *35*(4), 227-241. https://doi.org/10.1207/S15326985EP3504_02

Rivera, L. (2019). *Influencia del aprendizaje basado en proyectos en la producción de textos expositivos en los estudiantes de 1ro de secundaria de una institución educativa privada* [Universidad Peruana Cayetano Heredia]. https://repositorio.upch.edu.pe/handle/20.500.12866/7768

Rojas, M. (2013). La formación del profesorado en el contexto de la posmodernidad. Algunas reflexiones sobre los saberes de los docentes de nivel básico. En . *La escuela normal: una mirada desde el otro* (p. 392). MX: IISUE.

Salybekova, N., Issayev, G., Abdrassulova, Z., Bostanova, A., Dairabaev, R., & Erdenov, M. (2021). Pupils' research skills development through project-based learning in biology. *Cypriot Journal of Educational Sciences*, *16*(3), 1106-1121.

Sandoval, C. (2016). *7 tipos de herramientas web2.0 que mejoran la experiencia del aprendizaje virtual*.

Suárez-Triana, Y. M., Rincón-Duran, R., & Niño-Vega, J. A. (2020). Aplicación de herramientas web 3.0 para el desarrollo de competencias investigativas en estudiantes de educación media. *Pensamiento y Acción*, *29*, 3-20. https://doi.org/10.19053/01201190.n29.2020.11069.

van Leeuwen, A., & Janssen, J. (2019). A systematic review of teacher guidance during collaborative learning in primary and secondary education. *Educational Research Review*, *27*, 71-89. https://doi.org/10.1016/j.edurev.2019.02.001

Wood, P., & Smith, J. (2018). Investigar en educación. Conceptos básicos y metodología para desarrollar proyectos de investigación. *Educatio Siglo XXI*, *36*(1), 263-266.

Zapata, Z., Vargas, J., Peña, L., Encinas, J., & Condori, H. (2021). Actitud, responsabilidad o técnica: estudio de caso de competencias investigativas en estudiantes de quinto grado de nivel secundaria. *Educare et Comunicare*, *9*(1), 39-46. https://doi.org/https://doi.org/10.35383/educare.v9i1.559.