Scientific Inquiry in Students: A Systematic Review

Indagación científica en estudiantes: una revisión sistemática

Doris Elizabeth Galecio Mora
https://orcid.org/0000-0001-7416-0611
dgalecio@ucvvirtual.edu.pe
Lima-Peru.

REVISTA INVECOM ISSN: 2739-0063
Received: 05/02/2025 Accepted: 06/05/2025
2026. V6. N1.

Abstract

Scientific inquiry is a fundamental competence that must be developed from the earliest educational levels. The objective of this study was to analyze the implications of scientific inquiry in students. To this end, a systematic review methodology was used with compilation and analysis of scientific articles. The PRISMA method was used, considering keywords in English and Spanish such as: "scientific inquiry" AND "students" and " indagación científica" AND "estudiantes". The inclusion criteria included open access articles published between 2020 and 2025 in databases such as Scopus and Scielo, using search engines with Boolean operators AND and OR. As for the exclusion criteria, articles prior to 2020, restricted or paid articles, or theses or books were not considered. In total, 39 articles were identified in the Scopus and Scielo databases. After applying the selection criteria, 21 articles were analyzed: 11 from Scopus and 10 from Scielo. The results of the review allow us to conclude that prior training in scientific inquiry is required to achieve a better development of this competence in students. Therefore, it is essential to take into account the student's experience as part of the curriculum design. In this sense, the theory of distributed scaffolding offers an innovative alternative by connecting the student's mind with his or her social environment, integrating elements of psychology to strengthen critical and inclusive thinking. Scientific inquiry can be developed more effectively when contextualized, close, and meaningful experiences are promoted. For

example, direct observation of the Moon, accompanied by drawing and dialogue, favors the construction of scientific concepts from a Vigotskian perspective. Likewise, strategies focused on the clarity of objectives, constant feedback and the appropriate selection of research tasks are highlighted. It is also key to consider the emotional and social dimensions of learning, the STEAM approach from primary education, and collaborative validation by consensus as mechanisms to design training strategies based on principles such as teamwork and common welfare.

Keywords: scientific inquiry, inquiry strategies, scientific training.

Resumen

La indagación científica es una competencia fundamental que debe ser desarrollada desde los primeros niveles educativos. El objetivo del presente estudio fue analizar las implicancias de la indagación científica en los estudiantes. Para ello, se empleó una metodología de revisión sistemática con recopilación y análisis de artículos científicos. Se utilizó el método PRISMA, considerando palabras clave en inglés y español como: “scientific inquiry” AND “students” e “indagación científica” AND “estudiantes”. Los criterios de inclusión contemplaron artículos de acceso abierto publicados entre los años 2020 y 2025 en bases de datos como Scopus y Scielo, utilizando motores de búsqueda con operadores booleanos AND y OR. En cuanto a los criterios de exclusión, no se consideraron artículos anteriores al 2020, artículos restringidos o de pago, ni tampoco tesis o libros. En total, se identificaron 39 artículos en las bases Scopus y Scielo. Tras aplicar los criterios de selección, se analizaron 21 artículos: 11 provenientes de Scopus y 10 de Scielo. Los resultados de la revisión permiten concluir que se requiere una formación previa en indagación científica para lograr un mejor desarrollo de esta competencia en los estudiantes. Por ello, es fundamental tener en cuenta la vivencia del alumno como parte del diseño curricular. En ese sentido, la teoría del andamiaje distribuido ofrece una alternativa innovadora al conectar la mente del estudiante con su entorno social, integrando elementos de la psicología para fortalecer el pensamiento crítico e inclusivo. La indagación científica puede desarrollarse de manera más efectiva cuando se promueven experiencias contextualizadas, cercanas y significativas. Por ejemplo, la observación directa de la Luna, acompañada de dibujo y diálogo, favorece la construcción de conceptos científicos desde una perspectiva vigotskiana. Asimismo, se destacan estrategias centradas en la claridad de los objetivos, el feedback constante y la selección adecuada de tareas investigativas. También es clave considerar las dimensiones emocionales y sociales del aprendizaje, el enfoque STEAM desde la educación primaria, y la validación colaborativa por consenso como mecanismos para diseñar estrategias formativas basadas en principios como el trabajo en equipo y el bienestar común.

Palabras clave: indagación científica, estrategias de indagación, formación científica.

Introduction

Scientific inquiry has proven to be an effective strategy for enhancing learning outcomes. However, negative attitudes and low willingness toward science education persist in various educational settings, largely attributable to the didactic limitations of teachers and the lack of adequate pedagogical resources (Romero-Ariza et al., 2020).

While the importance of teaching practice as a key factor in educational quality is recognized, challenges remain in implementing methodologies that effectively integrate planning, the use of relevant resources, formative assessment, and adaptation to the sociocultural context of the classroom. These limitations hinder the development of competencies for problem-solving in collaborative learning environments (Ganajová et al., 2022).

Problem-Based Learning (PBL), combined with the use of Information and Communication Technologies (ICT), has been highlighted as an effective pedagogical strategy to foster scientific competencies in various educational contexts. In an experience conducted in Uruguay, both students and teachers positively evaluated this methodology, emphasizing that the integration of ICT into PBL promotes meaningful learning and improves the educational environment, demonstrating its effectiveness in teaching science (Zambrano et al., 2022).

In the educational domain, it is posited that students should acquire knowledge autonomously, which entails the ability to generate new ideas by contrasting them with prior concepts, shifting from a passive to an active role in their learning process (Ruiz, 2021).

In the case of Peru, the limited availability of resources and the scarce time allocated for investigative activities within the school curriculum represent a significant barrier to promoting scientific inquiry in the classroom.

This situation is exacerbated when teachers lack adequate training in student-centered methodologies, further complicating the incorporation of this strategy into their daily pedagogical practice (Vega-Lezama et al., 2025).

The development of inquiry competence in the Peruvian context involves integrating skills such as problem formulation, strategy design, information recording and analysis, results evaluation, and conclusion communication. During this process, students formulate testable questions and hypotheses, which are validated through observation or experimentation based on scientific principles. This approach allows for the explanation of observed phenomena and leads to well-founded conclusions that respond to initial inquiries (Peralta-Roncal, 2022).

In this framework, the objective of the present study was to analyze the implications of scientific inquiry for students.

Methodology

This study was conducted under a systematic literature review approach, focusing on the analysis of research related to scientific inquiry in students. To ensure methodological rigor, the PRISMA protocol guidelines were followed, allowing for the structured identification, evaluation, and synthesis of the most relevant studies available on a given topic.

The information search was conducted using keywords in both English and Spanish: “scientific inquiry” AND “students” and “indagación científica” AND “estudiantes.” Boolean operators AND and OR were employed to broaden and refine the results.

Inclusion criteria were as follows: articles published between 2020 and 2025, from recognized academic databases such as Scopus and Scielo; open-access articles written in English or Spanish. Conversely, articles published before 2020, closed or restricted access research, as well as theses, books, or book chapters not meeting the required rigor for a systematic review were excluded.

As a result of the search, filtering, and evaluation process, 39 articles were initially identified from the Scopus and Scielo databases. From these, 21 articles that met all established criteria were selected: 11 articles from Scopus and 10 from Scielo, which underwent qualitative and comparative analysis (see Table 1).

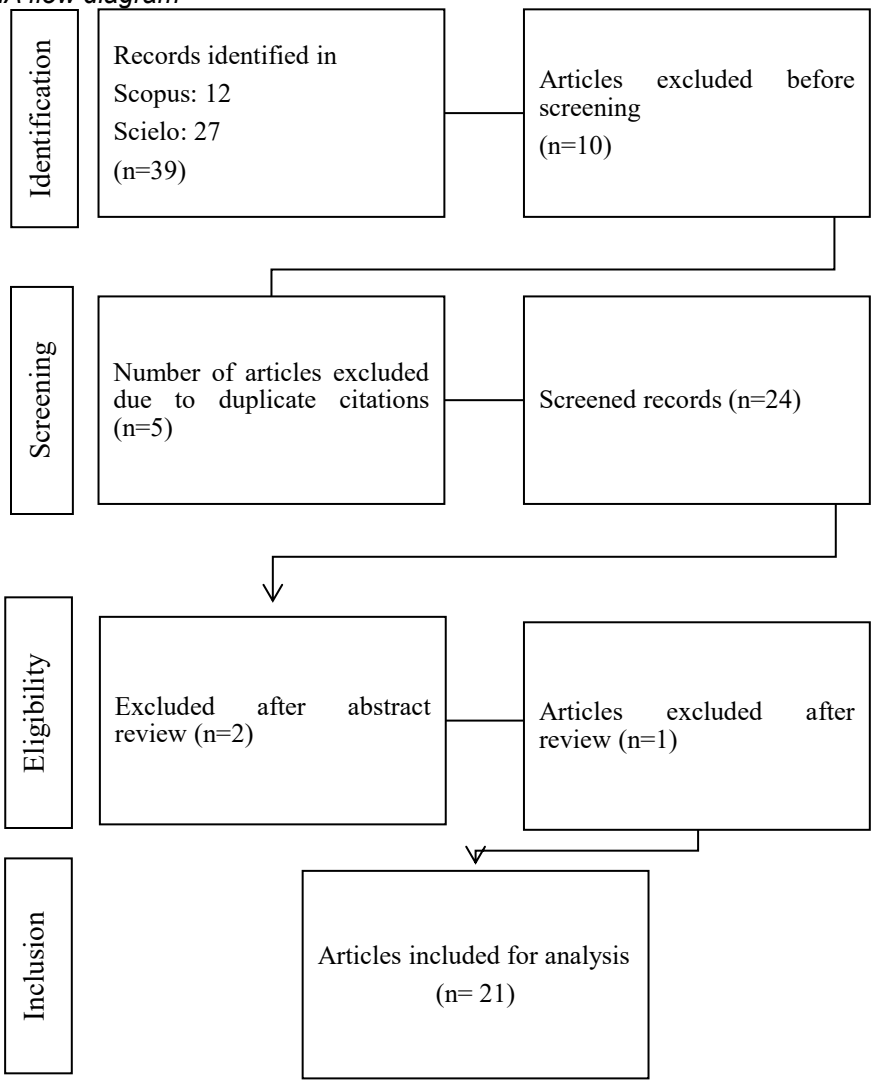
Table 1

Search keywords in articles from Scopus and Scielo databases

Database	Search term	Results	Selected
Scopus	“scientific inquiry” AND “students”	12	11
	“indagación científica” AND “estudiantes”		
Scielo	“scientific inquiry” AND “students”	27	10
	“indagación científica” AND “estudiantes”		
	Total	39	21

Figure 1

PRISMA flow diagram



* Table formatted according to PRISMA with original data.

Results

Table 2

Implications of scientific inquiry

N	Author	Implications of scientific inquiry
1	Rabgay & Kidman (2023).	The implementation of action research as a strategy to improve science teaching is influenced by cultural factors such as educational hierarchy and Buddhist values. While some norms hinder the search for institutional support, principles like collaborative work and common well-being strengthen teacher motivation, highlighting the need to consider cultural context when designing scientific inquiry strategies.

2	López-Banet et al. (2021)	The STEAM approach based on contextualized problem-solving promotes scientific inquiry by integrating contributions from various disciplines in a cohesive manner. This strategy overcomes isolated multidisciplinary approaches, fostering a deeper and more meaningful understanding of the investigated phenomenon.
3	Villapudua et al. (2021).	Scientific inquiry, through qualitative methodologies, makes visible the impact of critical situations like the pandemic on students, evidencing the necessity for strategies that respond to their academic, emotional, and social challenges.
4	Ortiz-Revilla et al. (2021).	Integrated STEAM education is an effective strategy for strengthening scientific competencies from primary education, addressing the demands of the contemporary world.
5	De la Parra et al. (2022).	The use of collaborative research and consensus validation is key to designing effective formative strategies, with direct application in complex professional contexts.
6	Pericacho-Gómez (2023).	To achieve sustainable educational improvements, leadership, collective engagement of the school community, and a transformation of the cultural mindset towards a participatory and innovative culture are crucial.
7	Monereo & Hermans (2023)	The distributed scaffolding theory offers an innovative approach to understanding educational processes by connecting the mind with the social environment and reclaiming the value of psychology in developing critical and inclusive thinking.
8	Bautista (2021).	The consolidation of STEAM education requires strengthening its theoretical and empirical foundation to overcome barriers to its application and construct effective didactic strategies.
9	Rodríguez-Muñiz et al. (2022).	Integrating context into statistical teaching improves data interpretation and promotes informed decision-making, thereby strengthening scientific inquiry in the classroom.
10	Freidenberg (2022).	Fostering dialogue between anthropological perspectives from the North and South contributes to a more critical, contextualized, and equitable scientific inquiry.
11	Del Río & Álvarez (2023).	Critical reflection on current technological and scientific paradigms is essential for understanding the future of humanity, which should be part of students' training as researchers.
12	Alvarado et al. (2025).	Incorporating scientific inquiry and emotional education strategies in teacher training enhances future teachers' emotions and attitudes towards scientific content, favoring their learning.
13	Parra et al. (2024)	Strengthening social skills through scientific inquiry is crucial for improving health management among teachers and promoting more effective comprehensive training.
14	Retana-Alvarado et al. (2023).	Emotional intervention through scientific inquiry in teacher training improves students' emotional and scientific competencies,

		promoting an increase in positive emotions and a decrease in negative ones.
15	Olórtegui-Alcalde et al. (2023)	Student satisfaction directly influences academic performance, and educational institutions must better understand the student experience to improve educational quality.
16	Teixeira de Sousa et al. (2022).	The evaluative practices of teacher Eva, centered on scientific inquiry, enhance the development of scientific competencies through feedback, clarity in learning objectives, and the selection of appropriate investigative tasks.
17	Izquierdo & Solaz-Portolés (2022)	The inquiry competence of pre-service teachers is low, highlighting difficulties in identifying variables, formulating hypotheses, and designing experiments. Female students and those with prior training in Science or Technology show better results.
18	Rodríguez et al. (2022).	Scientific literacy among third-grade students is limited to theory and neglects understanding the nature of science, presenting a traditionalist view. Significant efforts are required to improve teaching and achieve comprehensive scientific literacy that includes both theoretical knowledge and an understanding of the social impact of science.
19	Pereira & Silva (2021).	Research shows that direct observation of the Moon, combined with drawing and discussions, facilitates meaningful learning for students about the movements and characteristics of the celestial body, promoting the formation of scientific concepts from a Vygotskian perspective.
20	Rodríguez. (2020).	Students showed a disconnect between the information provided by problems and the solutions they proposed. However, authentic procedures were evident when the statement did not guide them towards a specific method, highlighting the importance of contextualizing problems to enhance scientific inquiry.
21	Stott & Hattingh (2020).	The study shows that future teachers in South Africa have a less sophisticated understanding of the nature of science compared to their peers in China, but similar to those in Turkey and the U.S. Age and prior educational experience in science and mathematics were key factors positively influencing their understanding.

Importance of scientific inquiry

Scientific inquiry is a fundamental competency that should be developed from the earliest educational levels. However, various studies indicate that significant limitations still persist. In primary students, scientific literacy remains largely theoretical, neglecting the understanding of the nature of science. This traditional view hinders the development of deep critical thinking, making it essential to transform teaching practices toward a scientific literacy that integrates both conceptual knowledge and its social dimension (Rodríguez Ruiz et al., 2022).

In this regard, comparative research reveals that future teachers in South Africa possess less sophisticated knowledge about the nature of science compared to their peers in China, although their understanding is similar to that of Turkey and the United States. Additionally, variables such as age and prior educational experience in science or mathematics positively influence their comprehension level (Stott et al., 2020).

In the realm of initial teacher training, significant deficiencies in the competence of scientific inquiry are also identified, particularly in hypothesis formulation, experimental design, and variable identification. Nevertheless, it is observed that women and students with prior training in science or technology achieve better results, highlighting the need to reinforce pedagogical strategies in universities to adequately prepare future teachers for meaningful scientific inquiry processes (Izquierdo Sanchis et al., 2022).

Moreover, understanding the student's educational experience is key to strengthening their learning process. Student satisfaction directly influences academic performance, so institutions must consider the student experience as part of curricular design and educational quality improvement (Olórtegui-Alcalde et al., 2023). From a qualitative perspective, scientific inquiry allows for the identification of how critical situations—such as the pandemic—affect students' academic, emotional, and social development, underscoring the urgency of implementing contextualized educational strategies (Villapudua et al., 2021).

In this sense, adopting broader and more inclusive educational approaches is proposed. The theory of distributed scaffolding offers an innovative alternative by connecting the student's mind with their social environment, integrating psychology to strengthen critical and inclusive thinking (Monereo et al., 2023). Furthermore, fostering dialogue between anthropological perspectives from the global North and South enriches the practice of scientific inquiry, making it more critical, contextualized, and equitable (Freidenberg et al., 2022). Finally, the scientific training of students should include critical reflection on contemporary scientific and technological paradigms, as understanding the evolution of humanity through science is essential in preparing them as future researchers (Del Río et al., 2023).

Strategies for developing scientific inquiry

Scientific inquiry can be developed more effectively when contextualized, relatable, and meaningful experiences are promoted for students. This is evidenced by Rodríguez et al. (2020), who demonstrated how students engage in authentic procedures when problems do not direct them toward a specific method, emphasizing the importance of contextualizing tasks to enhance understanding. Similarly, Pereira et al. (2021) highlight that direct observation of the Moon, accompanied by drawing and dialogue, fosters the formation of scientific concepts from a Vygotskian perspective, enhancing meaningful learning. Teixeira de Sousa et al. (2022) also note that implementing strategies focused on clarity of objectives, continuous feedback, and appropriate task selection improves the development of scientific competencies in the classroom.

Additionally, scientific inquiry should not be limited to content; it must also address the emotional and social dimensions of learning. In this regard, incorporating emotional education strategies into teacher training has shown positive effects on attitudes toward scientific content, enhancing both learning and the emotional disposition of future teachers (Alvarado et al., 2025). This idea is reinforced by findings from Retana-Alvarado et al. (2023), who found that emotional interventions based on scientific inquiry increase positive emotions and decrease negative ones while strengthening scientific competencies. Furthermore, Parra-Gálvez et al. (2024) emphasize that fostering inquiry in educational environments promotes the development of social skills and improves health management among teachers, thereby contributing to more effective comprehensive training.

The STEAM approach emerges as a robust strategy to enhance scientific inquiry by integrating various disciplines around contextualized problems. López-Banet et al. (2021) argue that this approach surpasses mere juxtaposition of multidisciplinary content, promoting a deeper understanding of the phenomena being investigated. Similarly, Ortiz-Revilla et al. (2021) indicate that a well-structured STEAM education strengthens scientific competencies from primary education, addressing the challenges of an increasingly complex world. However, Bautista (2021) warns that to consolidate its impact, it is essential to strengthen its theoretical and empirical foundations, overcome implementation barriers, and design effective didactic strategies.

Beyond the Classroom, the effectiveness of these strategies also depends on a conducive institutional and cultural framework. Leadership, collective involvement of the educational community, and the transformation of cultural imaginaries are key elements for achieving sustainable improvements (Pericacho-Gómez, 2023). In this context, collaborative research and consensus validation allow for the design of formative strategies that have a real impact in complex professional settings (De la Parra et al., 2022). Additionally, Rodríguez-Muñiz et al. (2022) propose incorporating context into the teaching of statistics as a means to improve data interpretation and promote informed decision-making, thereby reinforcing students' investigative competencies.

It is crucial to consider the sociocultural context when implementing scientific inquiry strategies. Rabgay et al. (2023) emphasize that factors such as educational hierarchy or religious values, like those of Buddhism, can influence the adoption or resistance to methodologies such as action research. Nevertheless, principles like

collaborative work and common well-being have proven to be significant drivers of teacher motivation, reminding us that every strategy must adapt to the cultural environment in which it is implemented.

Conclusions

The study concluded that prior training in scientific inquiry is necessary for more effective development and implementation. In this regard, it is fundamental to consider the student's experience as part of curricular design and strategies to improve educational quality. The theory of distributed scaffolding offers an innovative alternative by connecting the student's mind with their social environment and integrating psychological principles to strengthen critical and inclusive thinking.

Scientific inquiry is developed more effectively when contextualized, relatable, and meaningful experiences are promoted for students. For instance, direct observation of the Moon, accompanied by drawing and dialogue, fosters the formation of scientific concepts from a Vygotskian perspective. Furthermore, strategies focused on clarity of objectives, continuous feedback, and appropriate task selection enhance scientific competencies.

Moreover, scientific inquiry should not focus solely on content but also on the emotional and social dimensions of learning. A well-articulated STEAM approach strengthens scientific competencies from primary education, responding to the demands of a complex and ever-changing world. Finally, collaborative research and consensus validation enable the design of formative strategies based on principles such as teamwork and common well-being, enhancing a more integral and inclusive scientific education.

References

Alvarado, Diego Armando Retana, Pérez, María Ángeles De las Heras, Vázquez-Bernal, Bartolomé, & Pérez, Roque Jiménez. (2025). Emociones de Estudiantes Universitarios durante una Enseñanza Indagatoria de las Ciencias: ¿Construir Hoteles en un Parque Natural? *Sisyphus - Journal of Education*, *12*(3), 98-125. Epub 10 de dezembro de 2024.https://doi.org/10.25749/sis.36560

Bautista, A. (2021). STEAM education: contributing evidence of validity and effectiveness (*Educación STEAM: aportando pruebas de validez y efectividad*). *Journal for the Study of Education and Development*, *44*(4), 755–768. https://doi.org/10.1080/02103702.2021.1926678

De la Parra, G., Zuñiga, A. K., Crempien, C., Morales, S., Errázuriz, A., Martínez, P., … Ferrari, T. (2022). Delphi-validation of a Psychotherapeutic Competencies Training Protocol (PCTP) for the treatment of depression in primary care: evidence-based practice and practice-based evidence (*Validación Delphi de un Protocolo de Entrenamiento en Competencias Psicoterapéuticas (PECP) para el tratamiento de la depresión en atención primaria: práctica basada en la evidencia y evidencia basada en la práctica*). *Studies in Psychology*, *43*(3), 546–582. https://doi.org/10.1080/02109395.2022.2127239

Del Río, P., & Álvarez, A. (2023). Humanism or transhumanism? Scissions of thought and the technological drift of science, a crisis for psychology (*¿Humanismo o transhumanismo? Las escisiones del pensamiento y la deriva tecnológica de la ciencia, una crisis para la psicología*). *Studies in Psychology*, *44*(2–3), 157–251. https://doi.org/10.1080/02109395.2023.2253111

Freidenberg, J. N. (2022). Antropología Aplicada en América Latina: Hacia un Diálogo Hemisférico. *Human Organization*, *81*(2), 111–121. https://doi.org/10.17730/1938-3525-81.2.111

Ganajová, M., Sotáková, I., Lukáč, S., Ješková, Z., Jurková, V., & Orosová, R. (2021). Formative assessment as a tool to enhance the development of inquiry skills in science education. *Journal of Baltic Science Education, 20*(2), 204-222. https://doi.org/10.33225/jbse/21.20.204

Izquierdo Sanchis, Eva, & Solaz-Portolés, Joan J. (2022). Capacidad de indagación científica del profesorado de primaria en formación: efectos del género y de la formación previa. *Revista Universidad y Sociedad*, *14*(5), 109-120. Epub 30 de octubre de 2022. Recuperado en 06 de abril de 2025, de http://scielo.sld.cu/scielo.php?script=sci_arttext&pid=S2218-36202022000500109&lng=es&tlng=es.

López-Banet, L., Perales, F. J., & Jimenez-Liso, M. R. (2021). STEAM views from a need: the case of the chewing gum and pH sensopill (*Miradas STEAM desde la necesidad: el caso de la sensopíldora chicles y pH*). *Journal for the Study of Education and Development*, *44*(4), 909–941. https://doi.org/10.1080/02103702.2021.1927505

Monereo, C., & Hermans, H. (2023). Education and dialogical self: state of art (*Educación y yo dialógico: estado de la cuestión*). *Journal for the Study of Education and Development*, *46*(3), 445–491. https://doi.org/10.1080/02103702.2023.2201562

Olórtegui-Alcalde, Luis Miguel, Deroncele-Acosta, Angel, Romero-Salas, Mónica, Aguilar-Morante, Willy Frans, &

Olórtegui-Alcalde, Oscar Wilfredo. (2023). El estudiante universitario como cliente: relación con la satisfacción estudiantil y el rendimiento académico. *Revista Universidad y Sociedad*, *15*(3), 535-544. Epub 30 de junio de 2023. Recuperado en 06 de abril de 2025, de http://scielo.sld.cu/scielo.php?script=sci_arttext&pid=S2218-36202023000300535&lng=es&tlng=es.

Ortiz-Revilla, J., Greca, I. M., & Meneses-Villagrá, J. Á. (2021). Effects of an integrated STEAM approach on the development of competence in primary education students (*Efectos de una propuesta STEAM integrada en el desarrollo competencial del alumnado de Educación Primaria*). *Journal for the Study of Education and Development*, *44*(4), 838–870. https://doi.org/10.1080/02103702.2021.1925473

Parra Gálvez, Nathalie, De la Cruz Rojas, Milagros Mirella, Culqui Rojas, Víctor Mario, Copa Pérez, July Canela, Barreto Espinoza, Luz Antonia, & Flores Pérez, Luz Karen. (2024). Habilidades sociales en estudiantes, adquiridas mediante indagación científica y gestión por procesos para la salud, con evaluación en línea. *Revista Finlay*, *14*(2), 121-127. Epub 01 de junio de 2024. Recuperado en 06 de abril de 2025, de http://scielo.sld.cu/scielo.php?script=sci_arttext&pid=S2221-24342024000200121&lng=es&tlng=es.

Peralta Roncal, L. E., Gaona Portal, M. del P., Luna Acuña, M. L., & Dávila Rojas, O. M. (2022). Herramientas digitales e indagación científica en estudiantes de educación secundaria: una revisión de la literatura. *Ciencia Latina Revista Científica Multidisciplinar*, 6(2), 989. https://doi.org/10.37811/cl_rcm.v6i2.1933

Pereira, M. G., & Silva, E. M. (2021). O ensino sobre a Lua e suas fases: uma proposta observacional para os Anos Iniciais do Ensino Fundamental. *Ensino & Pesquisa em Educação Científica*, 23, 1-15. https://doi.org/10.1590/1983-21172021230118

Pericacho-Gómez, F. J. (2023). School improvement and school efficiency: reflections and evidences in the liquid society (*Mejora de la escuela y eficacia escolar: reflexiones y evidencias en la sociedad líquida*). *Culture and Education*, *35*(4), 976–1000. https://doi.org/10.1080/11356405.2022.2154737

Rabgay, T., & Kidman, G. (2023). Cultural factors influencing Bhutanese secondary science teachers' implementation of action research (*Factores culturales que influyen en la práctica de la investigación acción del profesorado de ciencias de un centro de secundaria de Bután*). *Culture and Education*, *35*(4), 905–937. https://doi.org/10.1080/11356405.2023.2255798

Retana-Alvarado, Diego Armando, de las Heras-Pérez, María Ángeles, Vázquez-Bernal, Bartolomé, & Jiménez-Pérez, Roque. (2023). El cambio en las emociones de futuros maestros en la interacción con una enseñanza de las ciencias basada en indagación. *Tecné, Episteme y Didaxis: TED*, (53), 139-161. Epub January 01, 2023.https://doi.org/10.17227/ted.num53-13772

Rodríguez Jara, Miguel Alejandro. (2020). Fomentando la indagación en estudiantes de secundaria mediante la resolución de problemas, una estrategia para articular matemática y ciencias: Un estudio de caso. *Revista electrónica de investigación en educación en ciencias*, *15*(1), 60-71. Recuperado en 06 de abril de 2025, de https://www.scielo.org.ar/scielo.php?script=sci_arttext&pid=S1850-66662020000100005&lng=es&tlng=es.

Rodríguez-Muñiz, L. J., Muñiz-Rodríguez, L., García-Alonso, I., López-Serentill, P., Vásquez, C., & Alsina, À. (2022). Navigating between abstraction and context in secondary school statistics education (*Nadando entre dos orillas: abstracción y contexto en educación estadística en Secundaria*). *Culture and Education*, *34*(3), 689–725. https://doi.org/10.1080/11356405.2022.2058794

Rodríguez Ruiz, Ana Elena, Cáceres Mesa, Maritza Librada, & Moreno Tapia, Javier. (2022). Diagnóstico de alfabetización científica promovida en alumnos de secundarias públicas de México. Un estudio de caso. *Revista Universidad y Sociedad*, *14*(1), 212-220. Epub 10 de febrero de 2022. Recuperado en 06 de abril de 2025, de http://scielo.sld.cu/scielo.php?script=sci_arttext&pid=S2218-36202022000100212&lng=es&tlng=es.

Romero-Ariza, M., Quesada, A., Abril, A. M., Sorensen, P., & Oliver, M. C. (2020). Highly recommended and poorly used: English and Spanish science teachers' views of inquiry-based learning (IBL) and its enactment. *EURASIA Journal of Mathematics, Science and Technology Education*, *16*(1), 1793. https://doi.org/10.29333/ejmste/109658

Ruiz, P. A. (2021). Implementación del modelo pedagógico constructivista: Una experiencia en Educación Superior. Armenia, Colombia: Corporación Universitaria Empresarial Alexander Von Humboldt. https://editorial.cue.edu.co/upload/file/202110121015304.pdf

Stott, Angela, & Hattingh, Annemarie. (2020). Pre-service teachers' views about the nature of science and scientific inquiry: The South African case. *South African Journal of Education*, *40*(1), 1-12. https://doi.org/10.15700/saje.v40n1a1573

Teixeira de Sousa, Margarida, & Santos, Leonor. (2022). Avaliar para aprender em ciências experimentais. *Revista Portuguesa de Educação*, *35*(2), 190-210. Epub 08 de outubro de 2021.https://doi.org/10.21814/rpe.21275

Vega Lezama, G., Pérez Azahua, M. Á., Castro Luján, F. N., & Rivera León, L. M. (2025). Aprendizaje basado en proyectos en la indagación científica en estudiantes de secundaria. *Revista Tribunal*, 5(10), 104-119. https://doi.org/10.59659/revistatribunal.v5i10.105

Villapudua, K. C., Ley, D. D. M., & Arteaga, Ma. A. M. (2021). Precariedad digital y el impacto del COVID-19 en la educación superior: un estudio narrativo en la frontera norte de México. *Journal of Iberian and Latin American Research*, *27*(3), 489–505. https://doi.org/10.1080/13260219.2021.2030285

Zambrano, M., Hernández, A., y Mendoza, K. (2022). El aprendizaje basado en proyectos como estrategia didáctica. *Revista Conrado*,18(84), 172-182. http://scielo.sld.cu/pdf/rc/v18n84/1990-8644-rc-18-84-172.pdf