Problem-based learning as a strategy to promote environmental culture: A systematic review study

Aprendizaje basado en problemas como estrategia para fomentar la cultura ambiental: un estudio de revisión sistemática

Alicia Esther Navarro Mochcco
https://orcid.org/0009-0000-9855-6127
ANAVARRO@ucvvirtual.edu.pe
Universidad César Vallejo
Lima-Peru

Quiterio Trujillo Reyna
https://orcid.org/0000-0001-5706-1005
quiterio.trujillo@unmsm.edu.pe
Universidad Nacional Mayor de San Marcos
Lima-Peru

REVISTA INVECOM ISSN: 2739-0063

Received: 17-02-2025 Accepted: 8-05-2025

2026. V6. N1.

Abstract

This systematic review study explored the key factors that influence the successful implementation of Problem-Based Learning (PBL) as a strategy to promote environmental culture in school contexts. The methodology was based on an exhaustive review of nine relevant studies, through the PRISMA protocol, with rigorous inclusion criteria and detailed analysis, considering SciELO, Scopus and WoS databases for the search. The results revealed that PBL significantly improves students' environmental awareness, promoting skills such as problem solving, critical thinking and teamwork. Consistency in the effectiveness of PBL was obtained at different educational levels and geographical contexts, demonstrating its validity and transferability. The conclusions highlight that PBL is a valuable pedagogical strategy to form responsible citizens committed to environmental sustainability, emphasizing the importance of teacher training, long-term impact evaluation and the effective integration of this methodology into the curriculum to strengthen environmental awareness and promote proactive action towards environmental protection.

Keywords: problem-based learning, environmental culture, high school student.

Resumen

En este estudio de revisión sistemática, se exploraron los factores clave que influyen en la implementación exitosa del Aprendizaje Basado en Problemas (ABP) como estrategia para fomentar la cultura ambiental en contextos escolares. La metodología se basó en una revisión exhaustiva de nueve estudios relevantes, a través del protocolo PRISMA, con criterios de inclusión rigurosos y análisis detallados, considerando para la búsqueda las bases de datos SciELO, Scopus y WoS. Los resultados revelaron que el ABP mejora significativamente la conciencia ambiental de los estudiantes, promoviendo habilidades como la resolución de problemas, el pensamiento crítico y el trabajo en equipo. Se obtuvo una consistencia en la eficacia del ABP en distintos niveles educativos y contextos geográficos, demostrando su validez y transferibilidad. Las conclusiones destacan que el ABP es una estrategia pedagógica valiosa para formar ciudadanos responsables y comprometidos con la sostenibilidad ambiental, subrayando la importancia de la formación docente, la evaluación a largo plazo del impacto y la integración efectiva de esta metodología en el currículum para fortalecer la conciencia ambiental y promover la acción proactiva hacia la protección del entorno.

Palabras clave: aprendizaje basado en problemas, cultura ambiental, estudiante de secundaria.

Introduction

Educational action as a strategy to foster environmental awareness requires profound discussion and analysis, particularly regarding its relevance in university curricula within the context of Latin America and at a time when pedagogical practices propose experiences focused on seeking solutions to specific problems. In this regard, education based on environmental culture is considered a means to guide educational institutions and their students toward the intentionality aimed at promoting comprehensive development, compelling enough to lead them to genuinely seek artistic, technical, and innovative solutions to sustainable development and environmental quality issues.

Regarding educational action centered on environmental culture, Veracierto Delgado et al. (2021) note that in the 1990s, higher education experienced initiatives linked to discussions on “environmental education,” a formative area particularly aimed at strengthening and raising awareness among various sectors about the need to conserve and properly utilize environmental resources.

Following the declaration of the International Year of Environmental Education, a series of arguments highlighted the drawbacks of developing educational initiatives based on environmental issues, particularly in countries whose economic development largely relied on the utilization and exportation of natural resources, contradicting educational discourse. This led to the marginalization of the aforementioned topic in the curriculum. However, this phenomenon resulted in a partial and sectorized approach that displaced the development of life-centered education (Llanos, 2023).

Problem-Based Learning (PBL) originated in Canada in the late 1960s with the aim of training medical professionals at a university's Faculty of Medicine. Since then, it has been incorporated at various levels and modalities within the education system. Its growth is reflected in a substantial body of literature, with over 10,000 documents published. Jiménez Espinosa et al. (2025) suggest that PBL can be utilized to promote education for sustainable development, constituting an active approach to learning where knowledge is acquired through the interest in solving problems. Typically, students work in small groups on topics of interest derived from everyday problems, and the research they conduct makes them active participants in the processes of analysis, synthesis, and categorization of knowledge based on concrete facts.

Thus, Gayá Reig & Martínez Agut (2025) conclude that the knowledge created individually by each student and shared within the group is interconnected, categorized, filtered, and organized through a cognitive process in which new knowledge connects and relates to what each student already possesses. By choosing how to resolve these issues, they continuously enhance their cognitive processes, geared toward meaningful learning that involves the progressive construction of synaptic connections. PBL facilitates teamwork, allowing students to develop skills such as problem-solving and decision-making, among others.

In this context, Guamán Gómez & Espinoza Freire (2022) indicate that properly implemented PBL demonstrates its capacity to develop or reinforce certain competencies among students, including collective responsibility among team members when addressing the research case both in and out of the classroom. An environmental culture is characterized by awareness, respect, and training fostered for the proper use of resources, as well as for taking necessary actions to reduce negative impacts on the environment. It is understood that the entire educational community—including both faculty and students—must have a firm commitment to improvement and promote actions that favor sustainable management.

Therefore, PBL is a student-centered teaching methodology that has consolidated over the years as an effective strategy for teaching specific competencies across various fields of knowledge. Although it was originally conceived in the context of medical education, its effectiveness has been validated in other academic contexts. Espinoza Freire (2021) defines PBL as an investigative and collaborative process in which students confront problematic situations they must resolve to acquire, deepen, or modify the necessary knowledge.

In this way, the structure of the PBL model is based on the goal of finding the best solution to a specific conflict of interests in a given place and time. According to Román (2021), all processes following this methodology share three essential components: the existence of a problem with conflicting interests, an autonomous working group primarily guided by a tutor, and a process for evaluating the competencies being developed.

Regarding the concept of environmental culture, it can be defined as the set of values, traditions, and behaviors adopted by a community concerning the use, conservation, and utilization of natural resources in their environment. This culture is formed through formal, informal, and non-formal education, becoming a significant component of the identity of any human group. As Tarapues-Quiroz et al. (2023) note, environmental culture is a profound reflection of collective idiosyncrasy and the manner in which we interact with our environment.

Therefore, environmental education is, in itself, the response to a different way of seeing and living in the world in which we operate. It seeks possible solutions to environmental problems by raising awareness of the importance of the natural and social environment in which we develop, which constitutes us as individuals. Even when these solutions are partial and insufficient, if we continue to develop a different option from now until the next generation, we will be able to improve outcomes in this area of human life development (Borja-Sánchez et al., 2024).

Consequently, environmental education has gained relevance within educational systems worldwide, driven by the need to prepare new generations to face growing environmental challenges and to develop a solid ecological awareness (Pérez et al., 2021). However, the integration of environmental education still faces various limitations, from a lack of resources and teacher training to the absence of connection between teaching and students' daily lives, which reduces its impact and hinders awareness (Saldaña-Almazán et al., 2020). In this context, active methodologies, such as Problem-Based Learning (PBL), have emerged as innovative pedagogical tools that facilitate active, meaningful learning connected to the social and cultural environment of students.

Active methodologies, understood as approaches that promote student participation and agency in the learning process, have proven effective in fostering critical competencies for solving environmental problems (Chassot, 1995; Camargo & Daros, 2021). In particular, PBL encourages students to take ownership of their learning, fostering skills such as critical thinking and independent research (Albarrán Torres & Díaz Larenas, 2021). This constructivist approach allows students to develop transversal competencies when addressing issues such as environmental pollution, facilitating not only the acquisition of knowledge but also the internalization of environmental values.

In research regarding active methodologies, they are considered procedural teaching tools focused on providing diverse learning strategies within the classroom, aimed at granting students greater agency in their learning process (Camargo & Daros, 2021). These methodologies, including PBL and contextualization of content, do not hinder the development of competencies and skills necessary for solving environmental problems, especially when linked to scientific knowledge (Chassot, 1995). The implementation of active methodologies in the classroom seeks to stimulate active student participation and promote a culture of inquiry within the educational setting.

However, in the realm of environmental pollution, some studies show that classes tend to adopt a conservative and expository approach, neglecting students' prior knowledge and everyday experiences, which diminishes their interest and renders the teaching monotonous (Garritz & Raviolo, 2008). The purpose of this educational experience is to introduce PBL, along with content contextualization, as a strategy for developing scientific concepts related to environmental pollution by presenting problems in diverse contexts and times, so that students, by taking an active role in their resolution, experience a more dynamic learning process.

The general objective is to identify and analyze the key factors that influence the successful implementation of PBL as a pedagogical strategy to foster environmental culture, through a systematic review of previous studies. Similarly, the following specific objectives are proposed: to explore the methodological and pedagogical elements that facilitate the effective application of PBL in the field of environmental education; to examine the impact of PBL on the development of an environmental culture among students, as reported in previous studies; to identify the main barriers and limitations faced by teachers and educational institutions in implementing PBL for the formation of environmental attitudes; to evaluate the role of educational resources and institutional support in the effectiveness of PBL to promote environmental awareness and responsibility; and to

propose recommendations, based on the review of studies, that could facilitate the implementation of PBL as an environmental education tool at different educational levels.

Methodology

A systematic narrative literature review was conducted with the aim of identifying, analyzing, and synthesizing relevant studies on PBL and its relationship with environmental culture in the school context, using the PRISMA protocol. This type of review is characterized by following a rigorous process of searching, selecting, and analyzing scientific publications within a specific time frame, with the purpose of answering a clearly defined research question.

To ensure comprehensiveness in recovering relevant literature, various search equations were formulated in the databases Scopus, Web of Science (WOS), and SciELO. The most effective equation was as follows:

- In Spanish:

((("Aprendizaje Basado en Problemas") OR "ABP") AND (aprendizaje) AND ("cultura ambiental") AND (escolares) NOT (universitarios).

- In English:

((("Problem-Based Learning") OR "PBL") AND (learning) AND ("environmental culture") AND ("school students") NOT ("university students").

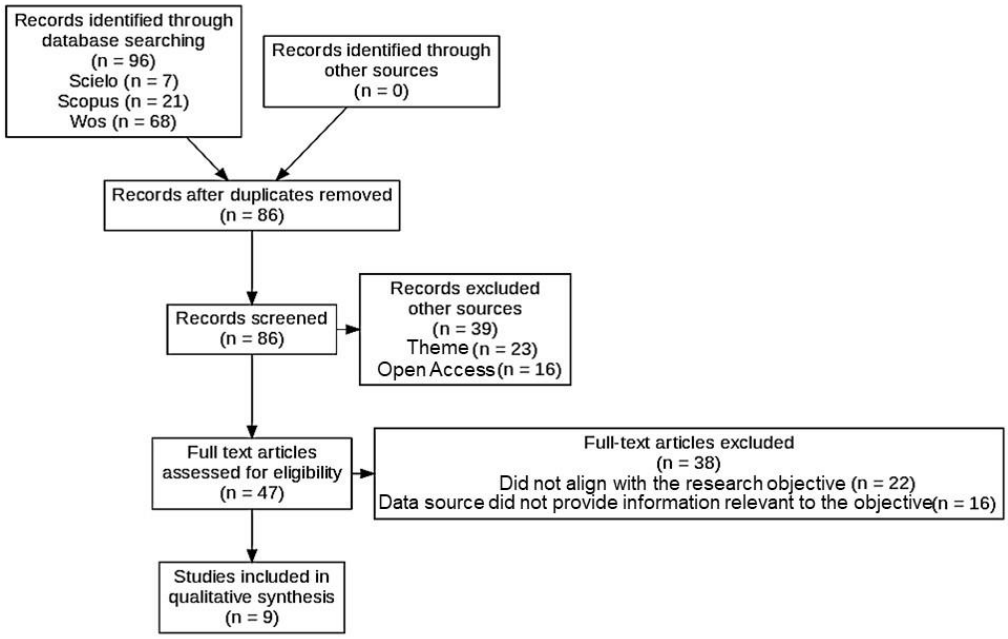
To select the studies included in this systematic review, rigorous inclusion criteria were established to ensure the relevance, quality, and pertinence of the information gathered. First, studies explicitly addressing PBL applied to school contexts with a direct focus on fostering environmental culture were considered. Additionally, research employing qualitative, quantitative, or mixed methodological approaches was included, provided it presented a clear and validated methodological structure. Furthermore, studies published between 2013 and 2024 were required to ensure updated and contextualized evidence. Another fundamental criterion was publication in peer-reviewed scientific journals indexed in recognized databases such as Scopus, Web of Science (WOS), or SciELO. Finally, only those studies with complete texts available for comprehensive reading and evaluation were included.

On the other hand, exclusion criteria were applied to eliminate studies that did not meet quality standards or thematic relevance. Investigations that did not focus on PBL or that addressed environmental culture outside the formal school context, particularly at the university level, were excluded. Theoretical articles, essays, opinions, or non-systematic reviews that did not present verifiable empirical data were also discarded.

Moreover, studies with evident methodological deficiencies, such as a lack of theoretical justification or the presence of uncontrolled biases, were excluded. Duplicated or redundant articles across different databases were removed, as well as those that did not provide full text access, hindering in-depth analysis. Finally, all publications written in languages other than Spanish or English were excluded for failing to meet the established linguistic criteria.

In total, nine publications were selected: three from Scopus, three from Web of Science (WOS), and three from SciELO. The selected articles were evaluated based on their methodological quality, internal validity, reliability, and thematic relevance. To ensure transparency and traceability of the process, a bibliographic review matrix was utilized, systematically organizing key information such as authors, year, country, objective, methodology, and main findings.

Figure 1
PRISMA flow diagram



Results

From the articles selected for this review, information was extracted and analyzed according to the study's objectives. The following sections present, first, the results related to the methodological aspects of the chosen studies, and second, the aspects that allow for the evaluation of the effectiveness of PBL strategies in enhancing environmental awareness among regular education students.

Table 1
List of articles included in the systematic review

Author	Results	Strategy
Goes Sampaio & Silva de Araújo (2024)	The PBL strategy is useful for improving environmental awareness, as it allows students to develop responsibility and guides them toward problem-solving.	PBL
Occhipinti (2019)	The PBL strategy enabled students to investigate the problem in depth and seek specific solutions.	PBL
Pérez Báez (2019)	The PBL strategy significantly improved environmental awareness; it increased motivation, but students require guidance and support.	PBL
Ayerbe López & Perales Palacios (2020)	PBL significantly improves environmental awareness; during the process, children develop social skills such as assertiveness, autonomy, leadership, cooperation, conflict resolution, and empathy.	PBL
Ayerbe López & Perales Palacios (2023)	The PBL strategy significantly enhances environmental awareness and promotes environmental care.	PBL
Fuentes & Pérez Villalobos (2013)	The PBL strategy allowed students to investigate the problem in depth and promotes the search for specific solutions.	PBL
Nawi et al. (2019)	The PBL strategy significantly improved environmental awareness among primary school children, who showed better performance in assessments.	PBL
Loera-Balenzuela et al. (2023)	PBL is an active strategy that improves knowledge of natural sciences.	PBL
Paredes-Curin (2016)	The PBL strategy significantly enhanced environmental awareness, increasing student autonomy and motivation in caring for their environment.	PBL

The systematic review included nine relevant studies addressing the application of PBL as a pedagogical strategy to foster environmental culture in the school context. All analyzed studies demonstrated significant improvements in students' environmental awareness, as well as in essential transversal competencies such as problem-solving, critical thinking, teamwork, and autonomy.

The study by Goes Sampaio & Silva de Araújo (2024), conducted in Brazil with secondary school students, showed that PBL facilitates the development of responsibility and a deeper understanding of environmental issues by actively involving students in seeking practical solutions. Similarly, Occhipinti (2019) illustrated how students, when working on real situations involving natural hazards, acquired skills for identifying, analyzing, and proposing preventive measures, thereby strengthening their environmental commitment.

Pérez Báez (2019), in a Mexican context, reported an increase in motivation and environmental awareness among basic education students, although he emphasized the importance of teacher support and guidance to ensure the sustained impact of PBL. Ayerbe López & Perales Palacios (2020, 2023), in two studies conducted in Colombia and Peru respectively, highlighted how PBL fostered the development of social skills (such as empathy, leadership, and cooperation) and favored attitudes of care and respect toward the environment.

Regarding comparative impact, Fuentes & Pérez Villalobos (2013) found that students who participated in PBL experiences exhibited higher levels of motivation, independent research, and environmental problem-solving compared to those exposed to traditional methodologies. In the study by Nawi et al. (2019), conducted in Malaysia with primary school students, PBL supported by digital tools showed a significant improvement in understanding topics such as carbon footprint and climate change, contributing to the development of sustainable habits in their daily lives.

Finally, the studies by Loera-Balenzuela et al. (2023) and Paredes-Curin (2016) agreed that PBL not only enhances environmental knowledge but also strengthens students' autonomy, intrinsic motivation, and active engagement with their surroundings. Both studies emphasized the teacher's role as a facilitator of learning and a mediator in the environmental reflection process.

In summary, the collected results demonstrate that PBL is an effective pedagogical strategy for promoting environmental culture, achieving both cognitive and attitudinal transformation in students. Furthermore, a pattern of transversal effectiveness is observed, regardless of educational level or geographic context, reinforcing the validity and transferability of this methodology to various educational settings committed to sustainability and the formation of environmentally responsible citizens.

Various aspects of PBL application were considered, including its educational objectives and practical nature, which require students to apply knowledge to diagnose, interpret, and propose solutions to real problems. According to Martínez Valdés (2021), its implementation also enhances collaborative work, self-learning, trust, responsibility, and group integration.

The reviewed studies also address fundamental topics to ensure the effectiveness and sustainability of PBL, such as the long-term evaluation of its impact on environmental awareness, the identification of key elements in successful projects, its adaptation for inclusive and diverse contexts, teacher training in its use, and the development of rigorous methods to measure environmental competencies. The influence of PBL on local communities, inter-institutional collaboration, comparisons between educational systems, and its transfer to different cultural contexts are also examined. These approaches provide a holistic and enriching perspective on capacity of PBL to foster environmental awareness and sustainability across various educational levels, in line with the objectives of this research.

Discussion

Environmental education is presented as an essential pillar in the training of future educators, especially in a global context marked by numerous environmental issues generated by human activity. Guerra Torres et al. (2023) emphasize the need for educators in training to possess a solid cultural background that enables them not only to understand the environmental impact of human actions but also to develop students who are conscious and capable of acting as agents of change. This perspective becomes particularly relevant when considering that the classroom serves as a strategic space to foster environmental values and promote sustainable solutions.

In this vein, higher education faces the challenge of training well-rounded professionals capable of adapting to social and technological changes and developing competencies such as self-learning, critical thinking, and teamwork. Yoon-García et al. (2024) underscore that these capabilities are essential for meaningful learning, which transcends mere knowledge acquisition, also involving the formation of attitudes and skills that impact the personal and professional development of students.

PBL has positioned itself as an active methodology that effectively responds to these challenges. Gil-Galván et al. (2021) demonstrate that PBL not only increases academic performance but also enhances interpersonal competencies and facilitates the appropriation of knowledge in a dynamic and contextualized manner. The systematic implementation of PBL in the classroom allows students to develop practical skills, critically utilize information sources, and strengthen attitudes that favor collaborative work and real problem-solving.

Regarding environmental culture, it is understood as the set of beliefs, values, and behaviors oriented towards the responsible use of the environment. Pérez-Vásquez & Arroyo-Tirado (2022) highlight that environmental awareness results from a transformative educational process, where learning is contextualized and promotes both behavioral changes and shifts in sociocultural values. In this sense, PBL emerges as a pertinent pedagogical methodology for incorporating new paradigms of sustainable development from the classroom, facilitating critical reflection and conscious action regarding the environment.

Overall, the findings of this review indicate that PBL is not only effective in improving learning and educational competencies but also serves as a key resource for strengthening environmental awareness in school contexts. Its implementation contributes to the formation of responsible citizens who are committed to the environment and capable of facing the challenges of sustainable development.

Conclusions

Adopting the PBL methodology fosters student participation and motivation toward problem-solving and environmental care. For educators, significant challenges range from acquiring the necessary knowledge to being creative in developing environmental contexts and well-defined problems. They must align socio-environmental education content with curricular objectives, understand how to integrate them, and evaluate their transversal competencies. Sometimes, schools have multidisciplinary groups to address common environmental problems, interdisciplinary or integrated environments, and preventive programming.

Students and teachers should be motivated to research, plan, intervene, evaluate, raise awareness, and assess alternative proposals. Environmental conflicts require a system of negotiation/mediation and convincing arguments based on scientific, sociopolitical, and ethical knowledge.

In conclusion, PBL presents itself as a promising strategy for fostering environmental culture among students. However, its successful implementation depends on a series of interrelated factors, including teacher training, the socioeconomic context of students, time management, evaluation, and the learning environment. This systematic review seeks to identify and analyze these key factors, providing a solid foundation for future research and practices in the field of PBL and environmental education. As we face increasingly complex environmental challenges, it is imperative for educators to adopt innovative approaches that prepare students to be responsible and committed citizens in sustainability.

References

Albarrán Torres, F. A., & Díaz Larenas, C.H. (2021). Metodologías de aprendizaje basadas en problemas, proyectos y estudio de casos en el pensamiento crítico de estudiantes universitarios. *Revista de Ciencias Médicas de Pinar del Río, 25*(3). http://www.revcmpinar.sld.cu/index.php/publicaciones/article/view/5116

Ayerbe López, J., & Perales Palacios, F. J. (2020). Reinventa tu ciudad: aprendizaje basado en proyectos para la mejora de la conciencia ambiental. Enseñanza de las Ciencias, 38(2), 181-204. http://dx.doi.org/https://doi.org/10.5565/rev/ensciencias.2812

Ayerbe López, J., & Perales Palacios, F. J. (2023). Evaluating a Secondary Education Urban Ecology Project within the Framework of a Problem-Based Learning Methodology. *Educ. Sci., 13*(915). https://doi.org/10.3390/educsci13090915

Borja-Sánchez, J. A., García-García, J. L., & Velázquez-Cigarroa, E. (2024). El rol de la educación ambiental frente a los desafíos de la enseñanza tradicional. *Revista Eduscientia,* 7(14), 176-184. https://www.eduscientia.com/index.php/journal/article/view/497

Camargo, F., & Daros, T. (2021). *A sala de aula digital: estratégias pedagógicas para fomentar o aprendizado ativo, on-line e híbrido.* Penso Editora. https://n9.cl/eq6dy1

Chassot, A. (2007). Haciendo educación en ciencias en los estudios de Pedagogía con la inclusión de saberes populares en el currículum. *Educación química, 18*(1), 12-15. https://doi.org/10.22201/fq.18708404e.2007.1.65972

Espinoza Freire, E. E. (2021). El aprendizaje basado en problemas, un reto a la enseñanza superior. *Conrado, 17*(80), 295-303. http://scielo.sld.cu/scielo.php?pid=S1990-86442021000300295&script=sci_arttext&tlng=pt

Fuentes, V., & Pérez Villalobos, C. (2013). Estudio comparativo entre metodologías Aprendizaje Basado en Problemas y tradicional en Módulo de Enseñanza. *Revista de Educación en Ciencias de la Salud, 10*(2), 5. https://dialnet.unirioja.es/servlet/articulo?codigo=6287553

Gayá Reig, M. A., & Martínez Agut, M. P. (2025). Análisis de las metodologías docentes en Educación para el Desarrollo Sostenible. *Revista De Estilos De Aprendizaje, 18*(35), 59–76. https://doi.org/10.55777/rea.v18i35.7104

Gil-Galván, R., Martín-Espinosa, I., & Gil-Galván, F. J. (2021). Percepciones de los estudiantes universitarios sobre las competencias adquiridas mediante el aprendizaje basado en problemas. *Educación XX1, 24*(1), 271-295. https://www.redalyc.org/journal/706/70666127011/70666127011.pdf

Goes Sampaio, C., & Silva de Araújo, A. F. (2024). El aprendizaje basado en problemas (ABP) como metodología de enseñanza para la contaminación ambiental. *Tecné, Episteme Y Didaxis: TED,* (56), 301–316. https://doi.org/10.17227/ted.num56-19380

Guamán Gómez, V. J., & Espinoza Freire, E. E. (2022). Aprendizaje basado en problemas para el proceso de enseñanza-aprendizaje. *Revista Universidad y Sociedad, 14*(2), 124-131. http://scielo.sld.cu/scielo.php?pid=S2218-36202022000200124&script=sci_arttext&tlng=en

Guerra Torres, L. D. L. A., Pérez Ramírez, F., & Tamayo Espinosa, Y. (2023). Fundamentos teóricos de la Educación Ambiental y el tratamiento al riesgo de desastres naturales (Revisión). *Roca: Revista Científico-Educacional de la Provincia de Granma, 19*(1). https://portal.amelica.org/ameli/journal/440/4403729006/4403729006.pdf

Jiménez Espinosa, R. E., Heras Calle, N. A., Cambisaca Cajamarca, C. I., Guaraca Paucar, E. J., & Palacios Zumba, E. M. (2025). Educación para el desarrollo sostenible en Ecuador: Integración curricular en la educación general básica. *MENTOR Revista De investigación Educativa Y Deportiva, 4*(10), 81–94. https://doi.org/10.56200/mried.v4i10.8918

Llanos, F. P. (2023). La Educación Ambiental como Base Cultural y Estrategia para el Desarrollo Sostenible de Medio Ambiente. *Ciencia Latina Revista Científica Multidisciplinar, 7*(6), 2242-2258. https://ciencialatina.org/index.php/cienciala/article/view/8849

Loera-Balenzuela, D. M., Sumarriva-Bustinza, L. A., Hinojo Jacinto, G. N., Pumacayo-Sánchez, Z., Zela-Payi, N. O., & Chávez-Sumarriva, N. L. (2023). Aprendizaje basado en problemas para la formación de actitudes ambientales en estudiantes de la Perla El Callao, Lima. Horizontes. *Revista De Investigación En Ciencias De La Educación, 7*(31), 2318–2332. https://doi.org/10.33996/revistahorizontes.v7i31.665

Martínez Valdés, M. G. (2021). Aprendizaje basado en proyectos como estrategia de formación profesional. *RIDE. Revista Iberoamericana para la Investigación y el Desarrollo Educativo, 12*(23). https://doi.org/10.23913/ride.v12i23.1093

Nawi, N. D., Phang, F. A., Mohd Yusof, K., Abdul Rahman, N. F., Zakaria, Z. Y., Syed Hassan, S. A. H., & Musa, A. N. (2019). Instilling Low Carbon Awareness through Technology-Enhanced Cooperative Problem Based Learning. *International Journal of Emerging Technologies in Learning (iJET), 14*(24), 152–166. https://doi.org/10.3991/ijet.v14i24.12135

Occhipinti, S. (2019). A Problem-Based Learning Approach Enhancing Students' Awareness of Natural Risks and Hazards in Italian Schools. *Geosciences, 9*(7), 283. https://doi.org/10.3390/geosciences9070283

Paredes-Curin, C. R. (2016). Aprendizaje basado en problemas (ABP): Una estrategia de enseñanza de la educación ambiental, en estudiantes de un liceo municipal de Cañete. *Revista Electrónica Educare, 20*(1), 1-26. http://dx.doi.org/10.15359/ree.20-1.6.

Pérez Báez, J. M. (2019). El Aprendizaje Basado en Problemas: aplicación en un ambiente real de aprendizaje. *Revista criterios, 26*(2), 13-33. https://dialnet.unirioja.es/servlet/articulo?codigo=8736365

Pérez, D., Suárez, R. B., & Reyes, E. T. (2021). Educación ambiental mediante tecnologías de la información y la comunicación en San Vicente, El Salvador. *Revista Iberoamericana Ambiente & Sustentabilidad*, (4), 4. https://doi.org/10.46380/rias.vol4.e056

Pérez-Vásquez, N. D. S., & Arroyo-Tirado, J. A. (2022). Cultura ambiental desde la proyección social comunitaria para la comprensión colectiva de la sustentabilidad. *Tecné, Episteme y Didaxis: TED,* (52), 283-302. http://www.scielo.org.co/scielo.php?pid=S0121-38142022000200283&script=sci_arttext

Raviolo, A., & Garritz, A. (2008). Analogias no ensino do equilíbrio químico. *Química Nova na Escola*, 27, 13-25. https://www.cabecadepapel.com/sites/colecaoaiq2011/QNEsc27/04-ibero-3.pdf

Román, F. (2021). Román, F. (2021). La Neurociencia detrás del aprendizaje basado en problemas (ABP). *Journal of Neuroeducation, 1*(2), 50-56. https://revistes.ub.edu/index.php/joned/article/view/33695

Saldaña-Almazán, M., Maldonado-Astudillo, Y. P., Sampedro-Rosas, M. L., Carrasco-Urrutía, K. A., Rosas-Acevedo, J. L., & Juárez-López, A. L. (2020). Comportamiento proambiental de los estudiantes de la Universidad Autónoma de Guerrero, México. *Controversias y Concurrencias Latinoamericanas, 11*(20), 307-320. https://www.redalyc.org/articulo.oa?id=588663787018

Tarapues-Quiroz, A. C., Zúñiga-Escobar, O., & Osorio-Marulanda, C. A. (2023). Aproximaciones a una educación ambiental desde la complementariedad del ser ye ambiente. *Tecné, Episteme y Didaxis: TED,* (54), 102-117. http://www.scielo.org.co/scielo.php?pid=S0121-38142023000200102&script=sci_arttext

Veracierto Delgado, R. D., Ormaza Cevallos, M. G. ., y Armas, V. H (2021). Educación ambiental y ruralidad: Reflexiones para el contexto ecuatoriano. *Revista EDUCARE-UPEL-IPB-Segunda Nueva Etapa 2.0, 25*(2), 446-465. https://revistas.investigacion-upelipb.com/index.php/educare/article/view/1528

Yoon-García, N. G., Solórzano-Álava, W. L., & Moreira-Cantos, P. S. (2024). Gestión de proyectos en el desarrollo de habilidades blandas en estudiantes de la Educación Superior. *Revista Científica Arbitrada de Investigación en Comunicación, Marketing y Empresa REICOMUNICAR, 7*(14), 193-207. https://reicomunicar.org/index.php/reicomunicar/article/view/304