THE ENVIRONMENTAL APPROACH FROM THE EVALUATION OF ECO-EFFICIENCY IN THE CONTEXT OF LATIN AMERICAN EDUCATIONAL INSTITUTIONS

Miriam Riveros-Davalos1
Pedro Antonio Pérez-Arboleda2
Jorge Alberto Aparicio-Ballena3
Percy Lima-Román4
Rosa Mabel Contreras-Julían5
Carmen Luisa Aquije-Dapozzo6

ABSTRACT

Purpose: Therefore, the objective of this literature review is to analyze the environmental approach through the assessment of eco-efficiency in educational institutions.

Method: Following the PRISMA methodology, 60 scientific articles were identified based on specific criteria and sourced from databases and virtual libraries such as Scopus, Scielo, Redalyc, Dialnet, ProQuest, IOP Science, and Taylor & Science. The analysis comprehends the evaluation methodology that focuses on institutional objectives, learning achievements, tools, actions, performance indicators, and monitoring and assessment—integral elements of schools' educational management and pedagogy.

Results and Conclusion: This is due to environmental issues negatively affecting people's well-being and quality of life. Education represents a significant means for disseminating knowledge and shaping responsible habits toward the environment, a subject that is currently one of the most addressed in the scientific field.

Research implications: This is crucial because while there might be an initiative to incorporate environmental social responsibility, without the necessary conditions, the implementation may not occur as desired.

Originality/value: This literature review article aims to contribute to the scientific field by providing an overview of how education has served as a tool to increase environmental knowledge and awareness, leading to behaviors that protect ecosystems' welfare.

Keywords: Environmental Literacy, Eco-Efficiency in Schools, Environmental Approach, Educational Management, Ecological Pedagogy.

1 Universidad César Vallejo, Lima, Perú. E-mail: mriverosd@ucvvirtual.edu.pe
Orcid: https://orcid.org/0000-0001-9842-5637
2 Universidad César Vallejo, Lima, Perú. E-mail: pedrozpereza1@gmail.com
Orcid: https://orcid.org/0000-0002-8571-4525
3 Universidad Tecnológica del Perú, Lima, Perú. E-mail: jorge_alberto91@hotmail.com
Orcid: https://orcid.org/0000-0001-7107-5964
4 Universidad César Vallejo, Lima, Perú. E-mail: p.limaroman@gmail.com
Orcid: https://orcid.org/0000-0001-8104-3632
5 Universidad César Vallejo, Lima, Perú. E-mail: contrerasmabel@hotmail.com
Orcid: https://orcid.org/0000-0002-0196-1351
6 Universidad Nacional Tecnológica de Lima Sur, Villa el Salvador, Perú.
E-mail: dapozzocarmenluisa@ucvvirtual.edu.pe Orcid: https://orcid.org/0009-0000-3174-5345
A ABORDAGEM AMBIENTAL A PARTIR DA AVALIAÇÃO DA ECOEFICIÊNCIA NO CONTEXTO DAS INSTITUIÇÕES DE EDUCAÇÃO LATINO-AMERICANA

RESUMO

Objetivo: Portanto, o objetivo desta revisão de literatura é analisar a abordagem ambiental por meio da avaliação da ecoeficiência em instituições de ensino.

Método: Seguindo a metodologia PRISMA, foram identificados 60 artigos científicos com base em critérios específicos e provenientes de bases de dados e bibliotecas virtuais como Scopus, Scielo, Redalyc, Dialnet, ProQuest, IOP Science e Taylor & Science. A análise compreende a metodologia de avaliação que se concentra nos objetivos institucionais, nos resultados de aprendizagem, nas ferramentas, nas ações, nos indicadores de desempenho e no monitoramento e avaliação – elementos integrantes da gestão educacional e da pedagogia das escolas.

Resultados e Conclusão: Isto se deve às questões ambientais que afetam negativamente o bem-estar e a qualidade de vida das pessoas. A educação representa um importante meio de difusão de conhecimentos e formação de hábitos responsáveis em relação ao meio ambiente, tema que é atualmente um dos mais abordados no campo científico.

Implicações da investigação: Isto é crucial porque embora possa haver uma iniciativa para incorporar a responsabilidade social ambiental, sem as condições necessárias, a implementação pode não ocorrer como desejado.

Originalidade/valor: Este artigo de revisão de literatura pretende contribuir para o campo científico ao fornecer uma visão geral de como a educação tem servido como ferramenta para aumentar o conhecimento e a consciência ambiental, conduzindo a comportamentos que protegem o bem-estar dos ecossistemas.


RGSA adota a Licença de Atribuição CC BY do Creative Commons (https://creativecommons.org/licenses/by/4.0/).

1 INTRODUCTION

In recent years, the planet has been facing a series of environmental problems caused by the so-called global warming. This has drawn attention to initiatives promoting responsible use of resources, leading to an environmental approach that encourages human behaviors responsible for the environment, benefiting both the current population and future generations (Mashaba et al., 2022; Castellanos et al., 2020). It is crucial that the use of resources like energy and water results in optimization of the impact on other ecosystems. This involves combining economic and environmental indicators (eco-efficiency) in a way that minimizes harmful consequences for both direct and indirect environments, without compromising the satisfaction of living organisms' needs. Rather, it encourages practices of reusing, reducing, and recycling resources, facilitating a conscious utilization of resources of all kinds (García, 2021; Vasquez-Reino, 2022; Pacheco et al., 2022). The existence of environmentally responsible behaviors or practices involves individuals having knowledge and awareness of the potential impact of their actions. Education stands as a valuable tool to aid in this. As part of its formative purpose, education integrates the development of environmental themes in a dynamic and understandable manner, conveying clear and objective information. Additionally, a series of activities or experiences within the
teaching-learning process leads to sensitization and the creation of a rapidly diffusing and imitating chain, causing a significant impact initially within the educational community and then throughout society (Artunduaga et al., 2021; Castillo et al., 2022). The successful involvement of education as a disseminator of the environmental approach has shown the imperative need to make adaptations in the curricula of all educational levels to promote environmental care (Mirmozaffari et al., 2020; Kovách et al., 2021).

Educational institutions, such as buildings, are being subject to the application of eco-friendly construction methodologies. It has been demonstrated that schools, on average, represent 13% of electric energy usage when combined with all public and private buildings. Not having the responsibility to allocate part of their budget to paying for the service of potable water means that conservation practices in its consumption are not prioritized. Therefore, the responsible use of electric energy and water resources is not being fully implemented by institutions, leading to the implementation of programs, projects, workshops, and the incorporation of didactic tools with an environmental focus within class subjects. However, this is still insufficient as there is a lack of prepared teachers in environmental matters, adapted curriculum plans, conditioned learning environments, among other factors (Da Costa Lima & Torres, 2021; López-Alcarria et al., 2021; Mammadova et al., 2021).

This literature review article aims to contribute to the scientific field by providing an overview of how education has served as a tool to increase environmental knowledge and awareness, leading to behaviors that protect ecosystems' welfare. Furthermore, the necessity of action in response to the environmental issues observed encourages an understanding of the initiatives forged in and from educational institutions, guided by indicators like eco-efficiency. These initiatives have produced positive and negative outcomes that can be replicated and reformulated in other contexts, considering the specific cultural aspects that environmental culture exhibits as part of the idiosyncrasies, customs, and beliefs of a human group. Undoubtedly, promoting learning and teaching (education) as a means opens a communicative channel with empathy and respect, facilitating interaction, especially with the purpose of caring for the planet.

Therefore, the general objective is to analyze the environmental approach through the evaluation of eco-efficiency in the context of educational institutions. The specific objectives are to: a) analyze the environmental approach developed by educational institutions and b) analyze eco-efficiency as an indicator of sustainability in educational institutions.

2 METHOD

The research approach undertaken is qualitative, known for allowing a thorough analysis of a subject. It aims to comprehend the phenomenon, identifying its causes and consequences from a holistic perspective, encompassing all aspects that condition its manifestation (Guzmán-Brand, 2021). Within this approach, systematic or literature reviews represent the study of scientific bibliography from previously identified and listed sources. It involves a detailed and critical examination of information published in various databases, compiled to address a research question (Quispe et al., 2021; Pardal-Refoyo & Pardal-Peláez, 2020). Consequently, this approach was adopted in the form of a systematic literature review focused on the environmental perspective, specifically in evaluating eco-efficiency in educational institutions.

The information collection procedure involved applying the PRISMA methodology (Preferred Reporting Items for Systematic Review and Meta-Analysis). This approach was used to search and select information based on previously established eligibility criteria. The criteria were structured around identification, screening, eligibility, and relevance to the research topic.
They encompassed: a) bibliography covering the last four years, from 2020 to the current year, to ensure current relevance; b) publications in reputable scientific journals indexed in reliable databases and virtual libraries, ensuring original and relevant information; c) publications in multiple languages such as Spanish, English, and Portuguese to broaden the volume of information; d) bibliography containing words or phrases associated with the environmental focus and eco-efficiency.

In this process, the handling involved eliminating documents that: a) came from years earlier than 2020, considering such evidence slightly outdated due to the significant scientific production in this field; b) were published by scientific journals not indexed in prestigious databases or virtual libraries; c) belonged to databases or virtual libraries with limited access due to link expiration at the time of the review; c) had no relevance to the object of study, in this case, referring to educational institutions. Following these criteria, the determined information sources were Scopus, Redalyc, Scielo, Dialnet, ProQuest, IOP Science, and Taylor & Francis Online.

The initial step involved the use of keywords and phrases such as "environmental approach," "environmental care in schools," "environmental approach in schools," "eco-efficiency in schools," all of which were translated into English, resulting in more extensive outcomes. Additionally, to further refine the information, Boolean operators were employed to include phrases like "[environmental responsibility and awareness in educational institutions"], ["economy and environment"], and ["eco-efficiency and schools"]. Subsequently, the criterion of the documents' age was applied, discarding those before the year 2020.

The process identified 92 articles, which, after being segmented based on criteria such as containing keywords in line with the environmental focus and eco-efficiency, alongside inclusion in prestigious databases and virtual libraries, resulted in 60 articles. They comprised 30 for each studied category, detailed as follows: Scopus with 32 documents (20 for eco-efficiency and 12 for environmental focus), Taylor & Francis with 4 documents (2 for each category), Redalyc and Dialnet with 9 documents (2 for eco-efficiency and 7 for environmental focus), Scielo with 8 documents (3 for eco-efficiency and 5 for environmental focus), IOP Science with 3 documents (1 for eco-efficiency and 2 for environmental focus), and ProQuest with 4 documents (2 for each category).

All documents were compiled using the Zotero bibliographic manager, ensuring organized storage of the 60 articles. They were verified for active insertion via URL or DOI to proceed with the critical reading of each article, extracting the most relevant information to address the research objectives and to structure the categorization matrix of the environmental focus and eco-efficiency categories. Subsequently, documents were described by year, language, country, and type of publication, followed by a comprehensive analysis of their content based on the stipulated objective.

3 RESULTS AND DISCUSSION

The databases and virtual libraries resulted in the selection of 92 scientific research studies, which, upon being subjected to the selection criteria, concluded in 60 articles, 30 per category: environmental approach and eco-efficiency. Among these, 53.33% were found in Scopus, 13.33% in Scielo, 11.67% in Dialnet, 6.67% in ProQuest, 6.67% in Taylor & Francis Online, 5% in IOP Science, and 3.33% in Redalyc. Concerning publication years, 43.33% were published in 2021, 30.00% in 2020, 23.33% in 2022, and 3.33% in 2023. In terms of publication language, 63.33% were in English, 35.00% in Spanish, and 1.67% in Portuguese.

The place of origin of the scientific articles included countries from the Americas such as Ecuador, Chile, Colombia, Brazil, Mexico, and Peru; from Europe, there were articles from...
Italy, Spain, and Portugal; in Asia, articles were from China, Vietnam, Turkey, Indonesia, and Russia; and from Africa, there were contributions from Nigeria, Ghana, and South Africa. This diverse geographic distribution demonstrates the global perspective on the topic of environmental approach and eco-efficiency implemented in educational institutions worldwide.

In Figure 1 presents the PRISMA methodology applied for the selection of the 60 articles, outlining the stages of the systematic review methodology.

The first specific objective, to analyze the environmental approach developed by educational institutions, involves considering the school management and pedagogy carried out by educational centers at different levels. Within school management, a continuous and standardized process is established to generate actions aimed at implementing, supporting, and monitoring practices contributing to the good performance of the student community. As part of promoting environmental care, schools create projects with the formation of school committees, which assume several functions, primarily ensuring compliance with eco-friendly objectives, often focusing on the responsible use of resources such as water and solid waste management. However, most of these committees are established as part of the protocol to follow rather than adequately monitoring the project, resulting in it being evident as a proposal, not in actual execution, undeniably impacting the project's expected outcomes (Shimabukuro et al., 2022; Montes, 2021).

In the realm of school management instruments, programs, projects, and workshops of all kinds, such as orchards or biodiverse gardens, have been an alternative implemented by educational institutions to generate self-sustaining resources. These initiatives aim to enable students to learn about planting and harvesting food, contributing to the preservation of biodiversity and food security (Rodríguez-Marín, 2021; Basilio et al., 2021). These initiatives have shown student approval, demonstrating an open and interested approach, indicating the successful assimilation of shared knowledge, largely due to the method employed to integrate the environmental approach with didactic support, making it easier for teachers to explain and represent concepts clearly and easily (Sousa, 2022; Bravo et al., 2020).

Nevertheless, evidence indicates that school management does not achieve the desired reach from the proposed environmental approach. Elements such as environmental literacy, awareness, and behaviors seem to be attained in the short term but vanish in the medium to long term, severely undermining all initial efforts. Environmental literacy, aimed at providing reliable information or the theoretical position of constructs associated with the environment, is initially transmitted and received by the student body. However, due to a lack of updating or permanence in its dissemination, it is forgotten; in some cases, the media truly contribute to environmental literacy rather than the educational environment (Lee et al., 2022; Martínez-Molina & Solís-Espallargas, 2020; Collado et al., 2020). Regarding environmental awareness and behaviors, students become sensitized to the issues of neglecting the ecosystem, even communicating it within their homes and communities. However, these changes are short-lived, and previous practices resume.
3.1 The environmental approach developed by educational institutions

In terms of pedagogical management, focusing on methodologies, learning objectives, and curriculum management to achieve valuable educational processes, limitations and weaknesses are observed in educational institutions' ability to adapt and incorporate environmental topics within the curriculum. Teachers integrate this into their classes as allowed by courses such as geography, biology, technology, and environment, among others (Anggraeni et al., 2023; Valverde & Molina, 2022). However, this is insufficient since there is no requirement for clearly aligned content that demands teacher preparation, adaptation of learning environments, or access to resources and infrastructure improvements within educational centers. These aspects have hindered the continuous development and significant impact of the environmental approach within academic formation (Aguilar, 2022; Capelo & Barros, 2021; Rahmayanti et al., 2020). Below, the categorization matrix synthesizing the analysis of the environmental approach is presented.

---

**Figure 1.** Selection process of studies identified in the databases.
As part of the second specific objective, the analysis of ecological efficiency as an indicator of sustainability in educational institutions begins by conceptualizing ecological efficiency as an indicator that aims to minimize the use of resources, thus reducing the impact on ecosystems. Among the resources, water stands out as a fundamental source of life, and in recent decades, concerns have been raised about its supply. In the educational context, the promotion and implementation of activities for responsible water use have involved installing water-saving faucets and toilets in school bathrooms, along with educational experiences aimed at raising awareness about water consumption and providing eco-friendly alternatives. This approach has focused on shaping a water culture, which has become a fundamental pillar in educational institutions, particularly due to the mechanisms it offers for understanding water sources that meet needs associated with water without negatively affecting its use (Flores & Ghisi, 2022; Wang & Chermak, 2021; Seguido et al., 2020).

On the other hand, the use of electrical energy also emerges as a resource that must be taken care of and utilized according to the technologies that provide it. These technologies must be optimized to avoid overexploiting the energy service. Educational institutions have implemented energy-saving bulbs, alternative energy sources from natural radiation, among others. Additionally, they address topics in class associated with the identification of renewable energy sources and how to use them responsibly, such as choosing less environmentally harmful means of transportation. All of the aforementioned actions seek to be disseminated by educational institutions, meaning that the information is shared with the community or environment of the students, encouraging active participation, not only from educational stakeholders but also from the families, friends, and social circles of the learners (Cho et al., 2023; Drosos et al., 2021; Englund et al., 2020). Based on the resolution of specific objectives, the linkage of the identified subcategories is summarized in figure 2.
population, engaging in activities with environmental responsibility, considering the physical, biological, and anthropological variables of the environment (Coacalla et al., 2022).

- **Efficient use of energy**
  - emphasis on source segregation to contribute to the valorization of reusable waste.
  - The institution raises awareness and involves family members and/or the local community in the proper management of solid waste, the application of the 3Rs at the institution and at home, with an emphasis on source segregation.
  - The institution collaborates with the local government, allied institutions, community organizations, and/or associations to raise awareness among the educational community about the proper management of generated solid waste, particularly those generated during times of health emergencies.

- **Efficient use of water resources**
  - The educational institution has included institutional measures in its management tools for the efficient use of water, such as using water-saving taps and toilets, among others, as well as promoting actions for the efficient use of water in households.
  - The institution includes pedagogical activities in its learning experiences about the consumption and responsible management of water.
  - The institution includes pedagogical activities in its learning experiences about water culture (water conservation and watersheds, safe water, ancestral practices of water harvesting and cultivation, among others).
  - The educational institution raises awareness among family members and/or the local community and coordinates actions with them for the efficient use of water resources.

**Source:** Prepared by the author, (2023)

Education’s role, particularly in the proper use of energy, is explained because by involving younger age groups, they are the ones who can truly guide and motivate older generations to incorporate lasting energy consumption habits. Although knowledge is important, raising awareness among those who occupy buildings or homes is crucial. It is also noted that in recent years, educational institutions have significantly increased energy consumption. Therefore, in conjunction with the aforementioned points, it is consistent for these formative spaces to initiate the development of responsible practices regarding electrical energy and the environment (Schibuola & Tambani, 2021; Pietrapertosa et al., 2021; Moazzen et al., 2020).

Regarding the management of solid waste, which is equally relevant to energy and water resources but involves greater care due to the management of waste it entails, some more delicate than others, it is observed that the majority of educational institutions opt to implement practices related to the 3Rs (reduce, reuse, recycle). However, they do so without prior...
preparation of the student community, where information on methods, tools, and protocols for solid waste management should be addressed. This leads to an incomplete or inadequate management of waste since there is a lack of sustainability in the practices adopted or omissions or faults in the process (Hoang & Kato, 2020; Olukanni et al., 2020).

Additionally, it has been identified that the implementation of solid waste management involves having appropriate physical environments that allow for correct classification and storage. For example, it was observed that urban schools condition their infrastructure adequately to handle waste, allowing their students to adopt responsible behaviors and attitudes towards the environment. In contrast, those located in remote areas lack the required equipment and spaces. Therefore, even though they desire to include an environmental approach in their school management, it represents a major problem for them instead of a contribution to the ecosystem (Barudin et al., 2021; Mkhonto & Mnguni, 2021; Martinez, 2022; Debrah et al., 2021). The details of the categorization formulated regarding Ecological Efficiency follow.

**Figure 2.** Interconnection of the subcategories within both categories

The environmental approach from the evaluation of eco-efficiency in the context of educational institutions.

In response to the overall objective of this literature review article, the environmental approach from the assessment of eco-efficiency carried out by educational institutions follows the following methodology.
The Environmental Approach from the Evaluation of Eco-Efficiency in the Context of Latin American Educational Institutions

Table 3. Environmental approach through eco-efficiency evaluation

<table>
<thead>
<tr>
<th>Methodology</th>
<th>Environmental approach from eco-efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Institutional objectives</td>
<td>Educators trained in environmental topics. Institutions with necessary and sufficient infrastructure to develop the environmental approach. Learning about management and increased institutional operational capacity to achieve eco-efficiency.</td>
</tr>
<tr>
<td>Actions</td>
<td>Creation of sessions with a balance between theory and practice. Active involvement of the entire educational and local community</td>
</tr>
<tr>
<td>Performance indicators</td>
<td>Sustainability over time of what is applied/implemented. Increased frequency of environmentally responsible practices. Engagement of the student body.</td>
</tr>
<tr>
<td>Monitoring and evaluation</td>
<td>Fulfillment of objectives, achievements, and indicators. Continuous feedback</td>
</tr>
</tbody>
</table>

**Source:** Prepared by the author,(2023)

As part of the methodology involving evaluation, first, there are the institutional objectives aimed at enhancing the human and operational resources of the educational center. This is crucial because while there might be an initiative to incorporate environmental social responsibility, without the necessary conditions, the implementation may not occur as desired. Second, there are learning achievements, integral to the formative process, essential for outlining the academic path, ensuring improvement among both educators and students.

Thirdly, instruments play a crucial role as they serve as the means to formalize and achieve the objectives and accomplishments. It's vital to identify each one and its components (Díaz-López et al., 2022); (Santos, 2020); (Mantilla-Falcón et al., 2020).

Fourthly, actions stem from the execution of instruments, mainly focused on curricular adaptation. Without this, integrating the environmental focus into class sessions, linking study units with environmental perspectives, and ensuring sustainability with the eco-efficiency indicator becomes complicated. Moreover, active involvement of educational stakeholders and the entire community is pivotal. Choosing educational institutions as managers of the environmental approach is pertinent due to their significant socializing and disseminating power.

Fifthly, performance indicators represent the quantification of progress achieved over time, frequency, and participation. Finally, monitoring and evaluation oversee the fulfillment of objectives, achievements, and indicators, involving continual feedback to adjust or adapt actions as required by the educational center's context (Visser et al., 2021; Odell et al., 2020; Reid et al., 2021; Yuriananta et al., 2023)

The diagram below summarizes the environmental approach from the evaluation of eco-efficiency, based on the explained methodology.
Figure 3. The methodology in evaluating eco-efficiency from an environmental approach.

4 CONCLUSION

The environmental approach developed by educational institutions has been based on school and pedagogical management, aspects that require the operational and institutional involvement of schools. However, to date, they display weaknesses and limitations. This is explained by the fact that human and administrative resources lack an optimal state to achieve the environmental approach comprehensively.

Eco-efficiency as an indicator of sustainability in educational institutions has been demonstrated through solid waste management, energy usage, and water resource management. These areas need to be addressed considering the specific context of each educational center. Thus, there is still a need for improvement in implementing actions related to these indicators.

The environmental approach through the evaluation of eco-efficiency in the context of educational institutions has been analyzed considering a methodology comprising six components: institutional objectives, learning achievements, instruments, actions, performance indicators, and monitoring and evaluation.
REFERENCES


buildings in Azerbaijan. *IOP Conference Series, 1030*, 012063. [https://doi.org/10.1088/1757-899x/1030/1/012063](https://doi.org/10.1088/1757-899x/1030/1/012063)


