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Scientific articles

La sostenibilidad medioambiental en el ámbito de las instituciones educativas: una revisión de modelos teóricos y empíricos

***Environmental sustainability in educational institutions: a review of
theoretical and empirical models***

***Sustentabilidade ambiental no âmbito das instituições de ensino: uma
revisão de modelos teóricos e empíricos***

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Resumen

Este artículo presenta una revisión bibliográfica sobre la sustentabilidad en el ámbito de la educación. El método de estudio empleado fue la revisión bibliográfica a nivel exploratorio en las bases de datos de mayor reconocimiento internacional, como son Scopus y la Web of Science. El criterio de inclusión de la muestra fue que analizaran modelos teóricos y conceptuales y que usaran constructos de sostenibilidad medioambiental en el ámbito de la educación que fueran estadísticamente probados por la modelación de ecuaciones estructurales (SEM-por sus siglas en inglés), en los últimos cuatro/cinco años. Ello implicó una revisión narrativa y crítica a fin de encontrar brechas de investigación y variables de fronteras que pudieran ayudar a crecer en el conocimiento científico. Los principales hallazgos de la literatura reportan como una relación causal es explicada y se fortalece a



través de las variables exógenas (variables independientes), ya sea con efectos directos o indirectos (mediación, o moderación).

Palabras clave: sostenibilidad, medioambiental, SEM.

Abstract

This article presents a literature review on sustainability in the field of education. The study method used was an exploratory literature review in the most internationally recognized databases, such as: scopus and the web of science. The sample inclusion criterion was to analyze theoretical and conceptual models that use constructs of environmental sustainability in the field of education and statistically tested by Structural Equation Modeling (SEM) in the last four/five years. This involved a narrative and critical review, in order to find research gaps and boundary variables that could help to grow scientific knowledge. The main findings of the literature report how a causal relationship is explained, and strengthened through exogenous variables (independent variables), either with direct effects, or indirect effects (mediation, or moderation).

Keywords: Sustainability, environmental, SEM.

Resumo

Este artigo apresenta uma revisão bibliográfica sobre sustentabilidade no campo da educação. O método de estudo utilizado foi a revisão bibliográfica em nível exploratório nas bases de dados mais reconhecidas internacionalmente, como Scopus e Web of Science. O critério de inclusão da amostra foi que analisassem modelos teóricos e conceituais e utilizassem construtos de sustentabilidade ambiental na área de educação que foram testados estatisticamente por modelagem de equações estruturais (MEE), nos últimos quatro/cinco anos. Isto envolveu uma revisão narrativa e crítica a fim de encontrar lacunas de pesquisa e variáveis de fronteira que pudessem ajudar a aumentar o conhecimento científico. Os principais achados da literatura relatam como uma relação causal é explicada e fortalecida por meio de variáveis exógenas (variáveis independentes), sejam elas com efeitos diretos ou indiretos (mediação ou moderação).

Palavras-chave: sustentabilidade, ambiental, SEM.

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Introduction

In 2015, the United Nations (UN) proposed the 17 sustainable development goals that comprise the 2030 Agenda, whose purpose was to make a universal call to action by business organizations, the government and universities in order to develop strategies that allow us to achieve a more sustainable society before the year 2030 (Lim *et al.* , 2022).

In the business field, sustainability focuses on organizations not only emphasizing economic and financial profit, but also focusing on generating social benefits, as well as caring for the environment. Generally speaking, sustainability refers to long-term environmental, economic and social health, which to some extent is difficult to achieve (Asmelash *et al.* , 2019).

On the other hand, in the field of public or government universities, their focus is not on the economic dimension, but on providing education to society in the hope of promoting a benefit for the care of the environment. In other words, sustainable universities are those whose priority is to apply sustainability in the essential field of teaching, cutting-edge research, art, culture and university extension, as well as being sustainable in their administrative processes, such as management university.

This approach, to which universities must transition, poses a paradigmatic challenge to reorient new practices that educate future generations towards a sustainable university. Therefore, the practical and effective approach to sustainability policies in universities will largely depend on the culture, willingness and commitment of management and students to participate in sustainable activities (Mohammadi *et al.* , 2023). This is a call for higher education institutions (HEIs) to be able to integrate sustainable development together with the university community, where leaders emphasize efforts for a transition policy towards sustainability.

For this reason, the objective of this research was to carry out a bibliographic review study at an exploratory level in the most internationally recognized databases (Scopus and the Web of Science). To this end, special emphasis was placed on theoretical and conceptual models that use environmental sustainability constructs, and that are statistically validated and reliable through structural equation modeling, in the period from 2020 to 2023. Specifically, this seeks to understand the boundary constructs that explain how environmental sustainability is strengthened in educational institutions. In this regard, it should be noted that a frontier construct has to do with cutting-edge knowledge, that is, knowledge that is innovative, novel and adds value to science.

Conceptual theoretical framework and literature review

Structural equation modeling (SEM) is a second-generation multivariate statistical technique designed to evaluate conceptual and theoretical models, especially in social science research. Currently, there are two main methods: (1) CB-SEM, covariance-based structural equation modeling, and (2) PLS-SEM, partial least squares structural equation modeling. Generally speaking, CB-SEM is mainly used to confirm or refute theories, while PLS-SEM is considered a causal predictive method (Hair *et al.*, 2022). However, today, PLS-SEM has evolved to carry out both causal and confirmatory studies that allow theory testing (Henseler, 2018).

In addition to the above, it is crucial that works that use this methodology include a theoretical framework based on theory. For example, Cho *et al.* (2020) conducted research exploring how corporate strategic resource attributes affect product and process innovation patterns, based on resource theory. This theory maintains that resources constitute a source of sustainable competitive advantage, and their origin lies in those valuable resources that the organization possesses (Barney, 1991; Barney *et al.*, 2011; Wernerfelt, 1984). Wernerfelt (1984) was the first to postulate this theoretical perspective in *Strategic Management Journal* under the title “A Resource-based View of the Firm”. Over the years, Barney *et al.* (2011) has consolidated this view in resource theory.

Systematic review of scientific literature

In recent years, there has been a notable interest among researchers in the topic of environmental sustainability. For example, Mohammadi *et al.* (2023) focused on exploring the sustainability of universities by analyzing the pro-environmental behavior of students and the management system. The purpose was to unravel the university sustainability process to highlight the crucial influence of students and the management system. The results of the study explain university sustainability through six key dimensions: (1) university culture, (2) university leadership, (3) education for sustainability, (4) knowledge about sustainability, (5) attitudes towards sustainability and (6) commitment to sustainability. The methodology of the study incorporated the comprehensive participation of the main university actors, specifically the leaders and students, who are fundamental in the university dynamics, belonging to the Bu-Ali Sina University, Hamedan, Iran.

On the other hand, Sharma *et al.* (2021) focused on examining the relationship between green culture adoption, innovation, green performance, and sustainability with

environmental commitment as a mediator. Although this work focused on the textile industry, its relevance lies in the fact that universities play a crucial role in education under sustainability principles. The study addresses persistent challenges in the textile sector, such as water pollution, emissions and increasing carbon footprint. These issues underline the prevailing need to cultivate an ecological culture, drive innovation in ecological processes, improve ecological performance and foster environmental commitment within organizations, thus highlighting the importance of raising awareness about the responsibility of preserving our organizational environment. and prevent future problems that affect society.

In parallel, Xu *et al.* (2020) conducted their research in business in China, where they explored environmental leadership and its impact on financial and environmental performance, considering green innovation practices and the learning of environmental knowledge. The results indicate that environmental leadership acts as an antecedent variable, which benefits environmental knowledge and ecological innovation practices. These findings have significant practical implications for business management and government authorities. Furthermore, Zhong *et al.* (2022) propose that a crucial task of the university is to transform its teachers and students into sustainable entrepreneurs, which is why they highlight the urgency of addressing the global ecological crisis (Sulphey *et al.*., 2023).

Education for sustainability

Park and Savelyeva (2022) focused their attention on the sustainable development goals (SDGs) in the university context. These authors propose that universities adopt a triple mission focused on teaching, research and knowledge transfer on these sustainable objectives. The purpose is to promote sustainable values among the university community through various forms of sustainability: 1) ecological initiatives in order to promote the culture of reduce, reuse and recycle, as well as energy savings through the implementation of eco-certified buildings. They also focus on promoting community projects and outreach activities; 2) sustainability sciences, which involve the promotion of sustainability science through research projects that benefit the planet. This approach aims to put into practice sustainable values and sustainable strategies and 3) curricular sustainability to integrate sustainability in new generations through its inclusion as a transversal topic in the teaching-learning process, which must be aligned with a sustainable leadership approach.

Materials and method

The research design was non-experimental with a transectional or transversal scope, with an exploratory nature. The methodology consisted of the analysis of articles evaluated statistically through structural equation modeling. The analyzed sample included six articles, in which twenty-four operationalized constructs were identified.

Results

To identify the environmental constructs that have been the subject of study in the field of sustainable education in university institutions, an exhaustive analysis of the literature between 2019 and 2023 was carried out. This examination revealed the presence of various constructs that, in turn, At the same time, they offer the possibility of structuring new research models. These models can incorporate moderating or mediating constructs, providing a more precise understanding of how to shape the profile of sustainable universities. This approach is particularly relevant in emerging economy contexts, such as the specific case of Mexico.

Table 1 . Empirical studies: environmental constructs

Year	Authors	Article title	Investigated/environmental constructs
2023	Mohammadi et al.	Explaining the Sustainability of Universities through the Contribution of Students' Pro-Environmental Behavior and the Management System (Iran).	<ul style="list-style-type: none"> • University leadership of sustainability-oriented services University Culture. • Participation in Sustainability Activities. • Commitment to Sustainability. • Sustainability oriented Education. • Knowledge of Sustainability. Attitude toward Sustainability.
2022	Avelar et al.	The relationship between the incorporation of sustainability in higher education and the student's behavior: self-reported sustainable behavior scale.	<ul style="list-style-type: none"> • Sustainable behavior • Economic attitude. • knowledge sustainability. • Environmental attitude. • Environmental social attitude. • Self-reported sustainable behavior.
2021	Sharma et al.	Analyzing the relationship of adaptation of green culture, innovation, green performance for achieving sustainability: Mediating role of employee commitment.	<ul style="list-style-type: none"> • Adaptability culture. • Green performance. • Innovation. • Commitment environmental.
2020	Xu et al.	Environmental Leadership, Green Innovation Practices, Environmental Knowledge Learning, and Firm Performance.	<ul style="list-style-type: none"> • Environmental Leadership. • Green innovation strategy. • Green innovation actions. • Environmental knowledge learning. • Environmental performance.
2019	Govindaraju et al.	A Structural Equation Model for the Study of Sustainable Performance by Private Universities in Malaysia.	<ul style="list-style-type: none"> • Sustainable Performance • Economic factor. • Environmental factor. • Social factor
2018	Varela-Candamio et al.	The importance of environmental education in the determinants of green behavior: A meta-analysis approach.	<ul style="list-style-type: none"> • Green behavior. • Environmental education. • Awareness.

Source: Elaboration own

The results of Mohammadi *et al.* (2023) offer a detailed understanding of university sustainability. This approach goes beyond the sole adoption of sustainability-oriented education, leadership and university culture, as it highlights the importance of promoting sustainable knowledge, attitudes and values. Therefore, university authorities must implement management strategies that generate commitment, attitudes and sustainable values, which, in turn, must influence participation in sustainability activities to achieve the desired objective of university sustainability.

For their part, Avelar *et al.* (2022) explore sustainable behavior in relation to incorporating sustainability in education, research and outreach. They introduce the construct called *economic attitude*, since they found that environmental and social attitudes did not affect sustainable behavior. This finding is significant as one would think that students would show a paradigm shift towards environmental and social, suggesting the need to further address these aspects in the curriculum to counter various environmental issues.

In their proposed model, Sharma *et al.* (2021) examine the relationship between consumers' environmental awareness and green performance, innovation and commitment, with innovation emerging as the key to a green culture and green performance. Their findings highlight that commitment acts as an essential mediating variable to strengthen the causal relationship. This underlines the need for a strategic plan that develops environmental awareness to strengthen innovation and ecological performance as key elements of environmental sustainability.

Likewise, Xu *et al.* (2020) identify a moderating construct, *environmental knowledge learning*, in the relationship between environmental leadership and green innovation practices. This moderator positively strengthens the causal relationship, pointing out the importance of environmental leadership as a predictor of ecological innovation practices. Furthermore, it must be taken into account that although the The economic growth presented by emerging markets has served to reduce the poverty of millions of people, at the same time it has increased the environmental problem (OECD, 2017).

Along the same lines, Govindaraju *et al.* (2019) conclude that sustainable practices in education explain sustainable performance through economic and environmental factors, excluding the social factor. Therefore, they highlight the need to balance the various dimensions of sustainability in organizational strategy.

Finally, Varela-Candamio *et al.* (2018) confirm the importance of environmental education in the development of green or ecological behaviors, for which they consider

intrapersonal, motivational, interpersonal and educational factors. The results of the structural equation models analyzed show various constructs with significant implications to support managers and strategic decision makers in the adoption of sustainable representations in which organizations must operate, especially in the educational field.

Now, in order to clarify the concepts of mediation and moderation, an explanation is offered below. A “mediator” variable is considered a third variable that intervenes between two related constructs. Its main function is to provoke, from a change in an exogenous construct (independent variable), a positive effect on the mediating variable. In turn, this mediating variable will have a positive effect on the endogenous construct (dependent variable), which strengthens the cause-effect relationship. In other words, it follows a trajectory of positive spillovers. In contrast, a “moderator” construct allows the strength or direction of a relationship between two constructs to depend on a third moderating variable. This means that the relationship varies depending on the values of this third variable (Hair *et al.*, 2022).

Discussion

As shown in Table 1, various environmental constructs have been identified that can be explored in different contexts. However, simple replication of studies lacks substantial contributions to scientific knowledge. It is imperative, therefore, to adopt theoretical approaches that enable the construction of structural relationships to allow the formulation and testing of new models that contribute to the understanding of sustainability in university environments. This approach should be aligned with the taxonomy of theoretical contributions applicable to scientific articles (Colquitt and Zapata-Phelan, 2007).

In this context, I consider that one of the first constructs to analyze is *environmental leadership*, given that universities require leaders committed to sustainability, capable of aligning organizational profiles with this new paradigm. Secondly, I would choose the *sustainable knowledge construct*, whose integration should be transversal in the educational programs of the institution. Thirdly, I highlight the importance of investigating the *culture of adaptability to sustainability in the educational field*, specifically in the university context. Finally, based on the above, research models related to environmental behavior, environmental attitudes, environmental performance, environmental innovation, environmental commitment, among other constructs, could be proposed, which could provide significant explanations through relationships. structural.

Conclusions

It is a priority that higher education institutions (HEIs) in Mexico join the call for environmental care and promote this awareness within the university community, especially among students, who represent the present and the future of the new generations that inevitably They will face an environment affected by environmental problems. These challenges not only impact natural resources, but also the health, life and nutrition of living beings.

When universities support initiatives aimed at addressing this problem and, more importantly, monitor to ensure their implementation, they can contribute to the formation of a green or ecological organizational culture, which could have a significant impact on sustainable behavior of the students. This behavior not only benefits the industry, the community and the economy, but also becomes essential for the employability of university students, especially when they seek to enter companies with green or ecological practices.

In this context, as awareness of sustainable practices and the achievement of the 17 UN Sustainable Development Goals (SDGs) grows globally, universities must incorporate learning units that address this in their plans and curricula. type of sustainable practices.

Future lines of research

Various studies have been developed on sustainable behaviors in university students (Chih-Hsing *et al.* , 2023). However, several gaps remain in the scientific literature that could contribute to mitigating environmental problems. Consequently, this research proposes future lines of research aimed at consolidating university sustainability, with a primary focus on the establishment of a green or ecological culture , since this culture constitutes the foundation for the formulation of strategic objectives aligned with the initiatives of the OECD and the UN on university sustainability.

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