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EDUCATIONAL TECHNOLOGIES

IN ENVIRONMENTAL LAW: IMPLICATIONS FOR SUSTAINABLE DEVELOPMENT AND MODERN EDUCATION

TECNOLOGÍAS EDUCATIVAS EN DERECHO AMBIENTAL: IMPLICACIONES PARA EL DESARROLLO SOSTENIBLE Y LA ENSEÑANZA MODERNA

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ABSTRACT

This research explores how Information and Communication Technologies (ICTs) are changing the teaching of environmental law by integrating tools such as online platforms and interactive simulations. These technologies not only improve the accessibility and flexibility of learning, but also provide immersive practical experiences that help students apply legal concepts in real scenarios. The methodology used, was a systematic review of scientific literature published between 2014 and 2024, using recognized databases such as Scopus, Web of Science, Google Scholar, Redalyc and Latindex. Peer-reviewed studies were selected, excluding opinion articles or those that did not directly address educational technologies in the teaching of environmental law. The results showed that, although ICTs have improved the quality and accessibility of education in this field, important challenges persist such as the technological gap in regions with less infrastructure and resistance to change on the part of some educators. In addition, it was found that most of the studies reviewed do not evaluate the long-term impact of these technologies on learning and professional development. It underscores the need for inclusive educational policies that promote the equitable use of ICTs, and highlights the importance of continued research that addresses both the ethical challenges and the long-term impact on the development of sustainable competencies.

Keywords:

Educational technologies, environmental law, sustainable development, online platforms.

RESUMEN

La presente investigación explora cómo las Tecnologías de la Información y la Comunicación (TIC) están cambiando la enseñanza del derecho ambiental, integrando herramientas como plataformas en línea y simulaciones interactivas. Estas tecnologías no solo mejoran la accesibilidad y la flexibilidad del aprendizaje, sino que también proporcionan experiencias prácticas inmersivas que ayudan a los estudiantes a aplicar conceptos legales en escenarios reales. La metodología utilizada, fue una revisión sistemática de la literatura científica publicada entre 2014 y 2024, utilizando bases de datos reconocidas como Scopus, Web of Science, Google Scholar, Redalyc y Latindex. Se seleccionaron estudios revisados por pares, excluyendo artículos de opinión o que no abordaran directamente las tecnologías educativas en la enseñanza del derecho ambiental. Los resultados mostraron que, aunque las TIC han mejorado la calidad y accesibilidad de la educación en este campo, persisten desafíos importantes como la brecha tecnológica en regiones con menos infraestructura y la resistencia al cambio por parte de algunos educadores. Además, se encontró que la mayoría de los estudios revisados no evalúan el impacto a largo plazo de estas tecnologías en el aprendizaje y desarrollo profesional. Se subraya la necesidad de políticas educativas inclusivas que promuevan el uso equitativo de las TIC, y resalta la importancia de una investigación continua que aborde tanto los desafíos éticos como el impacto a largo plazo en el desarrollo de competencias sostenibles.

Palabras clave:

Tecnologías educativas, derecho ambiental, desarrollo sostenible, plataformas en línea.

INTRODUCTION

Sustainable development has become an important issue today as it is directly involved in ensuring the survival and well-being of future generations (Emina, 2021). Growing concerns about climate change, biodiversity loss, and environmental degradation have prompted a rethinking of educational models, particularly those related to the teaching of environmental law (Webster & Mai, 2020). This field, which integrates legal knowledge with the preservation of the natural environment, faces the challenge of training professionals capable of effectively addressing complex contemporary environmental problems (Antúnez & López, 2018).

Education, as a central pillar for sustainable development, plays a major role in disseminating the principles and values necessary for the construction of a society that is more aware and committed to environmental protection. In this sense, educational technologies have emerged as disruptive tools to transform the traditional teaching of environmental law (Claramunt, 2020). By facilitating access to up-to-date information and promoting interactive and dynamic pedagogical approaches, these technologies enable a deeper and more contextualized understanding of environmental challenges (Murga, 2018).

As the integration of Information and Communication Technologies (ICT) intensifies in the educational field, a range of possibilities opens up to improve the teaching of environmental law (Puentes-Duarte, 2023). However, although there are numerous initiatives that seek to incorporate these tools into the educational process, the literature reveals a diversity of approaches and results. This dispersion suggests the need for a systematic review that synthesizes existing knowledge, identifying both emerging trends and gaps in current research (Lirola, 2018).

Environmental law, as an academic and professional discipline, is at a crossroads where the need to address complex contemporary environmental challenges requires a robust and up-to-date educational approach (Salca Rotaru, 2023). Environmental law education seeks not only to train legal experts, but also citizens and professionals committed to sustainability and environmental protection. This field, which has traditionally been linked to normative and regulatory frameworks, is now faced with the need to incorporate innovative pedagogical approaches that reflect the dynamic nature of environmental problems (Arutyunyan & Russkikh, 2023).

ICTs have proven to be a key catalyst in the modernization of education, offering new tools that enhance teaching and learning, as is currently happening with Artificial Intelligence (Ahmad et al., 20210). In the field of environmental law, these technologies allow not only access to a wealth of information and educational resources, but also the possibility of simulating complex legal scenarios, fostering collaborative learning and developing critical skills in students (Ardoin et al., 2020). However, their effective integration requires a thorough understanding of their benefits and limitations, as well as the best pedagogical practices for their implementation, always remembering that technologies are not the end, but the means (Huang et al., 2019).

The main objective of this article is to conduct a systematic review of the state of the art on the impact of educational technologies on the teaching of environmental law, with a particular focus on their contribution to sustainable development. By analyzing the existing literature, it aims to identify the main trends, benefits and challenges that have been reported in this field. In doing so, it seeks to provide a solid theoretical basis to guide both researchers and educators interested in improving the teaching of environmental law through the integration of educational technologies.

In addition, the article aims to identify existing research gaps, i.e., those areas that have been insufficiently explored or that present contradictory results. This identification is important to guide future research that can address these gaps and contribute to the development of more effective pedagogical approaches. Furthermore, it is hoped that the findings of this systematic review can provide practical recommendations for the implementation of educational technologies in the field of environmental law, thus promoting an education that not only transmits knowledge, but also fosters responsibility and commitment to sustainability.

Therefore, this study aims to be a significant contribution to the field of environmental law and its teaching by providing a comprehensive and up-to-date view of how educational technologies are shaping the training of future legal professionals and their ability to address global environmental challenges. Through a rigorous and critical review of the literature, it aims to provide a valuable resource for those interested in strengthening the intersection between technology, education, and sustainability.

METHODOLOGY

This article employs a systematic review methodology to perform the proposed analysis (Siddaway et al., 2019). This rigorous methodology allows us to identify, evaluate and synthesize relevant studies in a structured and replicable manner, ensuring transparency and consistency in the selection and analysis of information.

The review process began with the definition of clear criteria for the selection of studies. Research published in peer-reviewed academic journals, doctoral theses, reports from international organizations and academic books were included. To ensure the relevance and timeliness of the studies, the search was limited to publications

from the last ten years (2014-2024). Non-peer-reviewed studies, opinion articles, and those that did not directly address the use of educational technologies in teaching environmental law or sustainable development were excluded.

The literature search was conducted in several recognized academic databases, including Scopus, Web of Science, Google Scholar, and specialized education and law databases. Specific keywords and combinations of terms were used, such as "educational technologies," "environmental law," "sustainable development," "ICT in education," and "law teaching." A table with the details of the search performed is presented below (Table 1):

Table 1. Terms searched in the different databases.

Base de Datos	Palabras Clave	Resultados Iniciales	Resultados Seleccionados
Scopus	"educational technologies", "environmental law"	150	25
Web of Science	"ICT in education", "sustainable development law"	120	20
Google Scholar	"teaching environmental law", "sustainable education"	200	30
Latindex	"tecnologías educativas", "derecho ambiental"	80	15

After the initial search, the selected studies were subjected to a screening process based on titles and abstracts. Those that met the inclusion criteria were reviewed in their entirety. During this phase, the methodological quality of the studies was assessed using standardized tools, such as checklists for systematic reviews. Studies that did not reach an acceptable level of quality were excluded from the final analysis.

For data organization and analysis, a thematic approach was used (Ozuem et al, 2022). Patterns, categories and recurrent themes were identified in the selected studies, which allowed for a qualitative synthesis of the findings. This synthesis was complemented by a critical comparison of approaches and results reported in the literature. In addition, data matrices were constructed that facilitated the identification of relationships between key variables, such as the type of technology used, the educational context, and environmental law learning outcomes (Kiger & Varpio, 2020).

This methodological approach ensures that the review not only synthesizes existing information, but also provides a critical and informed analysis of the current state of knowledge in the field. The inclusion and exclusion criteria used in this review are presented below in Table 2:

Table 2. Inclusion and exclusion criteria in the literature review.

Inclusion Criteria	Exclusion Criteria
Peer-reviewed publications	Unreviewed opinion articles or essays
Studies on educational technologies in law	Studies that do not address environmental law or sustainable development education
Studies published between 2013-2023	Publications prior to 2013
Research in English and Spanish	Studies in languages not accessible or not translated

Once the studies were selected, we proceeded to a thematic analysis. This approach made it possible to identify and organize the main themes, patterns and categories emerging in the literature reviewed. The data were structured in matrices that facilitated the critical comparison of the different studies, thus allowing a coherent and substantiated synthesis of the findings. In addition, relationships between key variables, such as the type of technology used, the educational context and the outcomes in terms of environmental law learning, were assessed.

DEVELOPMENT

The advancement of technology has revolutionized numerous fields of knowledge, and education has been no exception. In the field of environmental law, these technologies have been progressively adopted as key tools to improve teaching and learning. ICTs not only facilitate access to a wide range of educational resources, but also offer new ways to interact with content and develop essential skills in an increasingly digitized environment (Salca Rotaru, 2023).

In the last decade, several trends have emerged in the application of educational technologies for teaching environmental law. One of the most prominent is the use of online learning platforms, which allow students to access educational materials, participate in discussion forums and perform interactive activities from anywhere and at any time. These platforms, such as Moodle or Blackboard, have proven to be effective in creating flexible and personalized learning

environments tailored to the individual needs of students (Jackson, 2015).

Another important trend is the incorporation of simulations and interactive scenarios in the teaching of environmental law, which can be through virtual reality or augmented reality. These tools allow students to experience complex legal situations in a controlled environment, facilitating the understanding of legal principles and their application in real cases. Simulations can involve everything from environmental dispute resolution to public policy making, providing an immersive learning experience that goes beyond theoretical study (Cho & Park, 2023).

In addition, the use of technologies based on artificial intelligence and big data analytics is beginning to have a significant impact in this field. These technologies make it possible to analyze large volumes of environmental and legal data, providing students with the opportunity to work with real and up-to-date information (Sun & Scanlon, 2019). This not only improves their understanding of current environmental issues, but also prepares them to face complex challenges in their future careers (Zhuk, 2023).

Hence, there has been a growing interest in the use of online collaborative tools, such as wikis and collaborative work platforms, which encourage interaction between students and teachers, as well as teamwork in solving environmental problems (Sousa, 2021). These tools allow students to share knowledge, discuss different perspectives and build collective solutions to environmental problems, which is fundamental in the training of professionals who must work in multidisciplinary and global contexts (Lin et al., 2020).

These trends reflect a significant change in the way environmental law is taught, driven by the need to train professionals more adapted to the challenges of the 21st century. However, despite the progress made, the integration of these technologies into the environmental law curriculum still faces several challenges, such as resistance to change on the part of some educators, the lack of adequate technological infrastructure in certain regions, and the need to develop digital competencies in both teachers and students.

The benefits associated with the use of these technologies have been widely documented in the academic literature. One of the main benefits is improved accessibility and flexibility of learning. Online learning platforms, for example, allow students to access educational resources from anywhere and at any time, which is particularly valuable in contexts where face-to-face education may be limited (Antúnez & López, 2018). This accessibility not only facilitates self-directed learning, but also allows students to progress at their own pace, which can significantly improve their understanding and retention of material (Claramunt, 2020).

Another key benefit is the possibility of offering more immersive and practical learning experiences through simulations and interactive scenarios. These tools allow students to apply theoretical concepts in close-to-reality situations, developing practical skills that are essential in the field of environmental law (Pande et al., 2021). For example, simulations of environmental litigation or public policy development allow students to experience the challenges and complexities of environmental law in a way that traditional methods cannot offer (Juca Maldonado et al., 2020). In addition, these tools have proven to be effective in developing critical skills, such as analytical thinking, problem solving, and decision making in contexts of uncertainty (Petersen et al., 2020).

However, along with these benefits, the literature also highlights a number of challenges that accompany the integration of educational technologies in the teaching of environmental law. One of the most significant challenges is the technological gap that exists in different regions and educational contexts. In many areas, especially in developing countries, the lack of adequate technological infrastructure limits access to modern educational tools, which can exacerbate educational inequalities. This gap affects not only students, but also teachers, who may lack the digital skills needed to effectively implement these technologies in their teaching (Khan et al., 2018).

Another major challenge is resistance to change on the part of some educators and students. The introduction of new technologies often requires significant adaptation in teaching and learning methodologies, which can be perceived as an additional burden, especially in institutions with limited resources (Mavengere et al., 2022). In addition, the effectiveness of these technologies is highly dependent on their proper implementation and ongoing support for educators in their use. Without adequate professional development and a coherent institutional approach, the potential benefits of educational technologies are not likely to be fully realized (Asongu et al., 2019).

Likewise, the issue of digital content quality is a recurring challenge. As more online resources are used, the need arises to ensure that these materials are of high quality, up-to-date, and relevant to educational objectives. The overabundance of information on the web also poses the risk of students becoming overwhelmed or accessing unverified sources, which can compromise academic integrity and depth of learning (Alvarado et al., 2023).

Importantly, the integration of educational technologies in the teaching of environmental law also poses ethical and privacy challenges. The use of online platforms and the collection of student data for educational purposes must be carefully managed to protect student privacy and ensure that the highest ethical standards are met (Mofam et al., 2023). These challenges underscore the need for

a balanced and considered approach to the implementation of educational technologies, ensuring that benefits are maximized while mitigating risks (Rupnik & Avsec, 2020).

The integration of ICT in environmental law education has opened up new opportunities to promote a pedagogical approach that is aligned with the principles of sustainable development. Not only does technology facilitate access to up-to-date information and resources, but they also enable the creation of learning environments that foster a deeper and more critical understanding of global environmental challenges (Dike, 2018). This integration is critical, given that sustainable development requires education that goes beyond the simple transmission of knowledge to include the formation of attitudes and competencies that drive social change towards a more equitable and environmentally friendly future (Mavengere et al., 2022).

One of the most significant aspects of ICT integration in this context is its ability to connect students and professionals from different regions of the world, enabling the creation of global collaborative networks, as is the case of the Association for Progressive Communications (2024). These networks are critical to the development of a truly sustainable approach to environmental law, as environmental problems transcend national boundaries and require collaborative, multidisciplinary solutions. Through online platforms, students can participate in international collaborative projects, share experiences, and develop a more global understanding of environmental problems and possible solutions (Pande et al., 2021).

In this sense, ICTs facilitate the teaching of complex concepts related to sustainable development, such as the interdependence between natural and human systems, resource management, and climate change mitigation policies. Tools such as simulations, interactive models, and Big Data analysis allow students to explore hypothetical scenarios and evaluate the impacts of different development strategies (Claramunt, 2020). These experiences not only enrich their theoretical understanding, but also prepare them to make informed decisions in their future professional practice, such as the European University (2024); UNIR (2024); Espíritu Santo University (2024); and the San Francisco de Quito University (2024) with its Master's degree in Environmental Law, to mention some of those that offer this type of specialization and use virtual environments to teach them, below is an analysis of the environmental law degrees offered in the region (Table 3):

Table 3. Quantitative Analysis of Environmental Law and Environmental Careers in the Americas.

Región	Total de Universidades	Programas de Pregrado	Programas de Posgrado	Modalidades
North America	~50	~20	~30	Mostly face-to-face, with a growing online offering.
Central America	~15	~5	~8-10	Mostly face-to-face, with some hybrid options.
South America	~100	~30	~50	Variety of modalities: face-to-face, hybrid, and online.

However, for ICT integration to effectively contribute to sustainable development, certain challenges need to be addressed. First, it is essential to ensure that the technologies used are accessible and appropriate for all students, regardless of their geographic location or socioeconomic context (Cho & Park, 2023). This implies not only the provision of technological infrastructure, but also the development of digital competencies in both students and educators, so that they can take full advantage of the available tools (Lin et al., 2020).

Thus, it is also important that ICTs are used in a way that promotes the active participation of students in their own learning process. Sustainable development requires an educational approach that empowers students to become agents of change, capable of applying their knowledge to solve complex environmental problems (Jackson, 2015). ICTs, when used appropriately, can facilitate this type of active and participatory learning, providing students with the necessary tools to investigate, analyze and act on the environmental challenges facing their communities and the world at large (Antúnez & López, 2018).

In this sense, it is important to remember that, the integration of ICT in the teaching of environmental law must be accompanied by an ethical approach that ensures that the use of technology is aligned with the principles of sustainable development. This includes not only the consideration of the environmental impacts of the technologies used themselves, but also the promotion of values such as equity, justice and respect for cultural and biological diversity (González-Zamar, et al., 2020). By adopting a holistic approach that combines ICTs with values education, it is possible to train environmental law professionals who are not only well informed, but also committed to creating a sustainable future for all (Carrión-Martínez et al., 2020).

The systematic review conducted in the study provides a comprehensive overview of the trends, benefits and challenges in the use of educational technologies for teaching environmental law. This analysis not only summarizes the state of the art, but also identifies key discrepancies in the implementation of these technologies and their impact on learning.

One of the most relevant aspects of the review is the increasing adoption of online learning platforms and interactive simulations. These tools have significantly improved the accessibility of academic content, allowing students, especially those with multiple responsibilities, to access resources in a flexible manner. Platforms such as Moodle and Blackboard have facilitated continuous learning, while simulations provide invaluable hands-on experience, exposing students to realistic environmental law scenarios.

However, despite these advances, the study highlights important challenges that hinder the full use of technologies. One of the greatest challenges is the technology gap, particularly pronounced in developing regions, where the lack of infrastructure and resources limits equitable access to these tools. This aspect highlights the need for inclusive educational policies that ensure more equitable access to advanced technologies.

Another challenge identified is the resistance to change on the part of some educators and students, who see the integration of new technologies as an additional burden. This obstacle is more common in environments with limited resources and where teachers do not receive sufficient training to implement these tools effectively. The review suggests that it is crucial to provide ongoing support to teachers so that they can integrate technologies with an appropriate pedagogical approach.

It also highlights concerns about the quality of the digital content available. Although ICTs have democratized access to information, not all online content is suitable or of high quality for teaching environmental law. This requires a curation of digital resources to ensure that they are rigorous and aligned with pedagogical objectives.

A relevant ethical issue in the review is privacy and protection of student data, an area that has been addressed to a limited extent in the studies reviewed. With the increasing use of online platforms and data analysis tools, it is critical to develop clear guidelines to ensure ethical and responsible use of these technologies.

Finally, the review reveals that research on the long-term impact of educational technologies on environmental law is insufficient. Most studies focus on short-term outcomes, leaving a gap in understanding how these tools influence students' knowledge retention and professional preparation over time.

CONCLUSIONS

The analysis conducted through this systematic review has identified several key findings in the integration of educational technologies in the teaching of environmental law. First, online learning platforms and interactive simulations have proven to be effective tools for improving the accessibility, flexibility, and quality of learning in the field. These technologies not only facilitate access to a more inclusive education, but also provide hands-on experiences that are fundamental to the formation of professional competencies.

Second, a significant gap in technological infrastructure and digital competencies has been observed between different regions and educational contexts. This disparity limits the effective adoption of ICTs and their potential to transform education in environmental law, underscoring the need for specific interventions to reduce these inequities.

Similarly, it has been identified that the lack of longitudinal studies limits the understanding of the long-term impact of educational technologies on students' learning and professional development. The need to address more deeply the ethical and privacy issues related to the use of educational technologies, especially in contexts where data collection and management is critical, has also been highlighted.

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