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REVIEW

# Augmented reality and environmental education: strategy for greater awareness

## Realidad aumentada y educación ambiental: estrategia para una mayor conciencia

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## ABSTRACT

**Introduction:** augmented reality offers broad possibilities as educational technology, it is a way to interact with physical reality in real time, improving people's perspective on dissimilar topics.
**Objective:** characterize the impact of augmented reality for the improvement of environmental health.
**Method:** a review of the available literature was carried out using synthetic and historical-logical analytical methods using articles recovered from databases such as SciELO, Dialnet, Scopus, Researchgate, recovering a total of 16 reference articles from available literature related to the topic. in question, included in the time frame between 2019 and 2024.
**Results:** the ecological crisis is currently the greatest challenge that human beings face, the integration of emerging technologies, such as augmented reality (AR), to the teaching and learning process facilitates, favors and motivates learning, thus having a strong educational impact of technology and specifically AR towards raising awareness of the population about environmental problems, a healthier ecosystem can be achieved, many people have the wrong idea about technology and the environment, pitting one against the other most of the times.
**Conclusions:** augmented reality constitutes a powerful tool with a strong impact on the teaching and learning process that allows different population groups to become aware of a primary issue such as environmental health, influencing in turn the behavior of people in care. of the ecosystem.

**Keywords:** Augmented Reality; Environment; Environmental Education; Technologies; Environmental Awareness.

## RESUMEN

**Introducción:** la realidad aumentada brinda amplias posibilidades como tecnología educativa, es un modo de poder interactuar con la realidad física en tiempo real mejorando la perspectiva de las personas sobre disimiles temas.
**Objetivo:** caracterizar el impacto de la realidad aumentada para el mejoramiento de la salud ambiental.
**Método:** se realizó una revisión de la bibliografía disponible utilizando los métodos analíticos sintético e histórico lógico mediante los artículos recuperados desde las bases de datos como SciELO, Dialnet, Scopus, Researchgate, recuperándose un total de 16 artículos referenciales de literatura disponible relacionados con el tema en cuestión, comprendidos en el marco de tiempo entre el 2019 y 2024.
**Resultados:** la crisis ecológica es en la actualidad el mayor reto al que nos enfrentamos los seres humanos, la integración de tecnologías emergentes, como la realidad aumentada (RA), al proceso de enseñanza y aprendizaje facilita, favorece y motiva el aprendizaje teniendo así un fuerte impacto educativo de la tecnología y específicamente de RA hacia la concientización de la población sobre la problemática ambiental

se puede lograr un ecosistema más saludable, muchas personas tienen una idea equivocada sobre la tecnología y el medio ambiente, poniendo a una contra otra la mayoría de las veces.
**Conclusiones:** la realidad aumentada constituye una potente herramienta con un fuerte impacto en el proceso de enseñanza y aprendizaje que permite concientizar a los diferentes grupos poblacionales sobre un tema primordial como es la salud ambiental influyendo a su vez en el comportamiento de las personas en el cuidado del ecosistema.

**Palabras clave:** Realidad Aumentada; Medio Ambiente; Educación Ambiental; Tecnologías; Conciencia Ambiental.

## INTRODUCTION

Currently, the environmental crisis is a topic that has been discussed in numerous international congresses and conferences, as we can see the problems that our natural environment is going through, such as the depletion of natural resources, pollution, extinction of species of flora and fauna, and the deforestation of the Andean forests for economic purposes.[1]

Our society continues to live with its back turned to a better appreciation and care for the environment. We need to pay more attention to the problem of neglecting this aspect, which could be solved with greater attention to environmental education. Our society lives immersed in a convulsive, uncertain, and ambiguous world, where technological advances acquire such a vertiginous rhythm that it is difficult to follow them from different fields. Education is no stranger to these changes.[2]

Augmented reality (AR) is part of what has come to be known as emerging technologies. It is a technology that has been gaining strength in digital education due to its flexibility in facilitating learning about specific topics in an interactive and immersive way. For, augmented reality is defined as additional information obtained from observing an environment, captured through the camera of a device that previously installed specific software.[3]

In 1901, Frank L. Baum designed a device called Character Maker that could already be considered a prototype of what today is AR. This device consisted of a large electronic viewfinder that made it possible to superimpose information on the people it focused on.[4]

The alternative use of information and communication technologies (ICT) in teaching, so that, with the help of these, teachers can generate new educational dynamics, teaching different topics in natural science classes.[5] Environmental education programs give results; however, technology offers us better possibilities to generate a favorable impact on the population. Through an application that generates a good user experience, augmented reality could contribute to disseminating accurate information about the species, its status, and its role within the ecosystem to raise awareness and involve the population in its conservation.[6]

Virtual and augmented reality, together with the set of emerging information and communication technologies (ICT) with a greater degree of immersion and interactivity, are media with great potential to represent knowledge and develop processes of interaction with it while constituting a mechanism of mediation between users and the conceptual construction of knowledge itself from the contributions of science.[7]

Due to the constant changes that the environment has undergone and its consequences to living beings, the school cannot isolate itself from this situation since it is obligated to form integral educators. Therefore, environmental education is of great importance since the knowledge positively impacts the environment in which they develop, thus becoming active agents in society, generating changes, and helping prevent environmental problems.[8]

Therefore, **the objective** of this review article is to characterize the impact of augmented reality on the improvement of environmental health.

## METHODS

A review of the available literature was conducted using the synthetic and historical-logical analytical methods through articles retrieved from databases such as SciELO, Dialnet, Scopus, and Researchgate, retrieving a total of 16 referential articles of available literature related to the topic in question, comprised of the time frame between 2019 and 2024. Filters were used to select articles in English and Spanish. The terms "Augmented Reality," "Environment," "Environmental Education," "Technologies," and "Environmental Awareness" were used as keywords in the article.

## RESULTS

The ecological crisis is currently the most significant challenge facing human beings. If we want to guarantee our survival as a species, we must respond to this problem with concrete actions and commitments to mitigate

and reverse the harmful effects of human activity on the environment.[9]

The integration of emerging technologies, such as augmented reality, into the teaching and learning process facilitates, favors, and motivates students' learning and also allows them to develop a series of digital competencies related to information management, the ability to produce academic texts, the ability to develop verbal argumentation, the ability to analyze and synthesize digital information, collaborative work in the virtual modality, autonomous learning, and communication.[10] The authors consider that a healthier ecosystem can be achieved by directing the educational solid impact of technology and specifically of AR towards raising public awareness of environmental issues.

This technology applied to education is a technology that has been gradually developing in classrooms due to the boom in the use of mobile devices (tablets and smartphones) and access to the Internet from almost anywhere; thus, augmented reality has increased its presence in pedagogical practices at all educational levels to facilitate the understanding and exemplification of curricular content established in the curricula.[10]

Using didactic itineraries through mobile devices and augmented reality resources, geolocation, and social networks is an excellent educational practice that promotes positive perceptions among secondary school students. This type of activity not only achieves competence development, in reality, closer to the students, but also improves motivation and interest in learning.[2]

Ortiz Figueroa MG, six states that on several occasions, environmental problems could be faced better; we have electronic media that can contribute to solving these problems. However, many people need to learn about technology and the environment, putting one against the other most of the time without allowing technology to serve the environment.

AR combines the real-world environment with the virtual, using a set of devices that add virtual information to the existing physical information and convert it into the real world around the user in an interactive and digital environment. As for AR applications in education, they present countless possibilities that, as they point out, contribute to the area of knowledge they were designed for since they make possible didactic content that would otherwise be unfeasible.[3]

Álvarez-Herrero JF et al.[2] found in their study that the evaluation of the activities carried out in didactic itineraries linked to environmental education and contextualized in the reality of the city where they occur is positive in all cases and all variables. Furthermore, Álvarez-Herrero et al.[2] suggest that taking learning to the street, to the context and the reality closest to the students, has always been a resource with which positive results have been experienced. Doing so, accompanied by an appropriate and coherent use of digital technologies, brings more excellent benefits when discussing secondary school students and using smartphones and social networks.

With the development of the digital album with augmented reality, spaces for environmental education are provided, and it will be possible to identify and learn about the richness through present collections of fauna and flora to generate knowledge and appreciation of biodiversity in all its components at an eco-systemic level. Through the digital album, students from different careers, visitors, and the general community will be able to appreciate and educate themselves, as well as learn about important topics, acquire a sense of belonging, and obtain the environmental awareness necessary to face the emerging challenges in the current global scenario.[11]

Jiménez Sánchez et al.[12] used an Augmented Reality sand table (AR Sandbox), which interprets relief modifications in real-time. Because of COVID-19, the students accessed the session through Microsoft Teams, using several fixed and mobile cameras to achieve a better remote experience on the sand table from different points of view. During the experience, the modeling of different elements of the landscape with environmental implications has been shown: from a mountain to a river corridor with the riverbed, the fertile plain, lakes, and ponds, simulating the situation derived from heavy rains in the floodplain. The students' favorable impressions have been collected regarding motivation, facilitating learning, and teaching potential.

Pinto-Chiquito et al.[13] presented a project based on designing and implementing a RED (Digital et al.) in augmented reality, which would enhance environmental awareness about wildlife care. At the Institution, it was observed that some young people had destructive and unconcerned behaviors towards the environment. This lack of environmental awareness can lead to the deterioration of the environment and the mistreatment of animal species. Thus, this project emerged as a resource that could contribute to curbing the deterioration of the environment that directly affects the quality of life. The analysis of the workshops showed a notable improvement in the variables after the students interacted with the NETWORK. However, not all advanced to higher performance; it could be observed that using the NETWORK boosted the level of environmental awareness of the students involved. The variable that stood out most for its improvement was "Initiative to defend the environment," possibly due to the emphasis of the animations on respect and affection for the animals presented.

AR technology allows the realization of results that were previously inconceivable, as is the case of students being able to build interactive models to represent ecological processes.[9]

González SV, eight. Although fourth-grade students already knew about this topic and had developed activities focused on environmental culture, implementing an augmented reality technological tool helped strengthen this culture. It made more students feel interested and motivated to care for water and aquatic ecosystems in their community. Using technology pedagogically articulated to the classroom and appropriately oriented by the teacher generates positive student learning results and allows them to be autonomous and independent in this process.

On the other hand, González Morales et al.[14] demonstrated in his study that the techno-educational strategy, implemented with augmented reality, applied to a real problem, sensitized and favorably influenced teachers. Through collaborative work in designing and constructing prototypes using digital fabrication tools, teachers could analyze a situation, carry out a process of information search, and reflect on it to make decisions, which contributed to proposing a viable solution to environmental problems.

Contemporary society poses different conflicts framed by environmental issues. These environmental conflicts reach a social scale when the exploitation of environmental resources affects nearby communities or communities previously dependent on natural dynamics.[15]

Augmented reality as a didactic strategy in natural science classes, also using self-contained learning sequences that capture the students' interest and thus contribute to the improvement of their academic performance, which has a positive impact on strengthening students' values and attitudes that allows them to care for and preserve the ecosystems around them.[16]

## CONCLUSIONS

Augmented reality is a powerful tool with a strong impact on the teaching and learning process that allows raising awareness among different population groups on a key issue such as environmental health, in turn influencing the behavior of people in the care of the ecosystem.

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## CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

## AUTHORSHIP CONTRIBUTION

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