Curricula: Journal of Curriculum Development *- e-ISSN 2830-7917 & p-ISSN 2964-7339*
Volume 3 No 2 (2024) 391-404

Curricula:
Journal of Curriculum Development
https://ejournal.upi.edu/index.php/CURRICULA/

The utilization of technology in environmental education

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ABSTRACT

Environmental education is crucial for constructing public awareness regarding environmental issues and realizing Sustainable Development Goals (SDGs). Digital technology has enhanced connectivity between learners and the natural environment to create innovative digital learning tools. Therefore, the identified technology can be used to optimize the environmental education process. The methodology employed in this research is the literature review. The results demonstrated that augmented reality, virtual reality, the Internet of Things (IoT), and ICT (Information and Communication Technology) based technologies enhance learners' comprehension and engagement with environmental issues in their immediate surroundings. However, specific challenges to the utilization of technology were identified, including disparate technology infrastructure, a shortage of resources for training, and the high costs associated with implementation. This study can serve as a reference point for future research efforts aimed at addressing barriers and facilitating more productive integration of environmental education across educational contexts.

ARTICLE INFO

Article History:
Received: 26 Sep 2024
Revised: 5 Dec 2024
Accepted: 10 Dec 2024
Available online: 27 Dec 2024
Publish: 27 Dec 2024

Keywords:
digital technology; environmental education; implementation challenges; sustainable development

Open access
Curricula: Journal of Curriculum Development is a peer-reviewed open-access journal.

ABSTRAK

Pendidikan lingkungan hidup penting untuk membangun kesadaran masyarakat terhadap isu-isu lingkungan dan mencapai tujuan pembangunan berkelanjutan (SDGs). Adanya teknologi digital telah mempermudah peserta didik terhubung dengan lingkungan dan menciptakan alat digital untuk pembelajaran. Sehingga identifikasi penggunaan teknologi penting untuk memaksimalkan proses pendidikan lingkungan. Metodologi yang digunakan dalam penelitian ini adalah studi pustaka. Hasil kajian menunjukkan bahwa teknologi berbasis augmented reality, virtual reality, Internet of Things (IoT), dan ICT (Information and Communication Technology) digunakan dalam meningkatkan pemahaman dan keterlibatan peserta didik pada isu-isu lingkungan di sekitarnya. Namun, beberapa tantangan dalam penerapan teknologi ditemukan, seperti infrastruktur teknologi belum merata, kurangnya pelatihan sumber daya, serta biaya implementasi yang tinggi. Studi ini dapat berfungsi sebagai titik rujukan bagi upaya penelitian masa depan yang bertujuan mengatasi hambatan dan memfasilitasi integrasi pendidikan lingkungan yang lebih produktif di seluruh konteks pendidikan.

Kata Kunci: *pembangunan berkelanjutan; pendidikan lingkungan; tantangan implementasi; teknologi digital*

How to cite (APA 7)
Azizah, H. N. (2024). The utilization of technology in environmental education. *Curricula: Journal of Curriculum Development, 3*(2), 391-404.

Peer review
This article has been peer-reviewed using the journal's standard double-blind peer review, in which the reviewers and authors are anonymized during the review.

https://doi.org/10.17509/curricula.v3i1.000000

INTRODUCTION

Environmental education has a very central role in building awareness in the community towards environmental problem issues (Ginardi et al., 2021; Liu et al., 2019). Environmental education also plays a role in finding effective strategies to address environmental issues so that it can ultimately bring about positive changes (Küçükaydın & Ulum, 2023; Matsekoleng et al., 2022; Rybakova et al., 2021). In addition, environmental education also makes an essential contribution to achieving the Sustainable Development Goals (SDGs) (Shang et al., 2024; Vakaliuk et al., 2020). Especially in terms of reducing socio-ecological problems and promoting inclusive and equitable sustainable development (Noga et al., 2021). Thus, environmental education is essential to ensure that young people have the skills to sustainably manage natural resources and the environment (Ryazanova et al., 2021).

Environmental education should be integrated into all school education programs to permeate all learning aspects (Ruman et al., 2020). Implementing technology can help increase environmental awareness and *self-efficacy* in environmental education (Guo et al., 2020). The use of technology enables learners to collect and interpret environment-related data, which in turn increases their environmental awareness (Küçükaydın & Ulum, 2023). The importance of technology in environmental education also relates to its ability to improve learners' motivation and cognitive activity) (Pinchuk & Sokolyuk, 2022). Thus, integrating technology and environmental education can help learners become more aware of and responsible for the environment, an essential aspect of modern education and the adaptive education system (Matsekoleng et al., 2022; Kuzmenko et al., 2022).

Previous research suggests integrating digital technology with natural environment-based learning to create a more immersive and meaningful learning experience (Edwards et al., 2021). However, these technologies must be governed by clear pedagogical guidelines to be effective in environmental education (Buchanan et al., 2019). However, teachers' professional preparation of teachers in dealing with interdisciplinary themes and reluctance to introduce environmental issues in schools need to be considered adequate (Hadiapurwa et al., 2024b; Noga et al., 2021). In addition, there needs to be a more in-depth exploration of the implementation of interactive technologies that can be effectively integrated into continuing education (Guo et al., 2020; Ruman et al., 2020). Especially in higher education, primary education has become an issue in using technology in environmental education (Rybakova et al., 2021; Buchanan et al., 2019).

To overcome these problems, it is necessary to analyze the type of technology that effectively improves learners' understanding of environmental issues and how the technology can be implemented by considering the various challenges that occur. This research is expected to provide a reference for related parties to prepare themselves to face obstacles in implementing technology and identify the potential of technology that broadly supports environmental education.

https://doi.org/10.17509/curricula.v3i2.75805

LITERATURE REVIEW

Environmental Education

Environmental education is forming the world's human population to be aware of and care about the environment and environmental issues (Nugroho, 2022). In simple terms, environmental education is an effort to address global issues through awareness and skills needed to face global environmental challenges (Vakaliuk et al., 2020). Such as the importance of conservation and preservation of the environment, pollution issues and the importance of environmental protection, global warming, sea level rise, and plastic waste, which require collective and individual efforts to maintain and restore ecosystems (Ginardi et al., 2021; Tortoriello & Veronesi, 2021; Buchanan et al., 2019).

Environmental education also bridges the gap between the sciences and the humanities (Rybakova et al., 2021). Environmental education helps individuals become sensitive to natural, historical, and socio-aesthetic values and actively encourages people to solve environmental problems (Küçükaydın & Ulum, 2023). Environmental education is essential to ensure people understand the environmental implications of technological choices. Schools and universities encourage teachers and lecturers to deliver CCE in learning by including related topics (Hadiapurwa et al., 2024a). This education encourages using energy-efficient living devices and sustainable digital practices (Shang et al., 2024). In

Environmental education plays a role in shaping pro-ecological attitudes among learners. It aims to transfer knowledge and support intellectual and moral development so that learners can develop creative potential and responsibility for the natural environment (Liu et al., 2019; Ruman et al., 2020). This is important to ensure that young people have the skills to manage natural resources sustainably and the environment (Ryazanova et al., 2021). Environmental education also changes children's relationship with nature or the environment (Noga et al., 2021). Environmental education helps an individual develop and maintain a deep attachment to the place where they live from an early age (Buchanan et al., 2019). This age is necessary to instill a connection with nature (Edwards et al., 2021).

Technology in Education

Technology involves using knowledge, skills, values, and resources to meet human needs, encompassing investigation, design, manufacture, evaluation, and communication activities that can increase human awareness of the environment (Matsekoleng et al., 2022). This includes theory and practice, software and hardware. In education, technology can be a learning design model. In environmental education, a development model is used to design lessons that enable learners to learn project management in natural resources and environmental management (Ryazanova et al., 2021). Technology integration is one of the keys to improving the quality of education (Kurniawan et al., 2024). In addition, technology in education is also useful for providing easy access to various learning resources (Isti'ana, 2024).

https://doi.org/10.17509/curricula.v3i1.000000

Technology is essential in modernization through teaching methods, supporting problem-based learning approaches, and enhancing 21st-century digital literacy (Guo et al., 2020). Technology in education aims to form professional competencies relevant to the needs of industry and society (Kuzmenko et al., 2022). Technology can improve the quality of teaching and learning by providing learners with more interactive and engaging tools (Denadi & Sopyan, 2022; Noga et al., 2021; Rosyiddin et al., 2021). Moreover, it can support more in-depth learning (Küçükaydın & Ulum, 2023).

In addition, technology can also play a role in energy transformation and human development and help understand the relationship between environmental and ecological elements and Science-Technology-Society (STS) relations (Noga et al., 2021). Technology can make abstract environmental concepts more concrete and relevant to learners. Digital technology can play an essential role in environmental education by connecting learners with their environment through project-based learning (Edwards et al., 2021). Using technology in environmental education allows learners to collect and interpret environment-related data, increasing public awareness (Küçükaydın & Ulum, 2023).

Technology Linkages to Environmental Education in the Context of SDGs

Sustainable Development Goals (SDGs) is a program created to build a world that aims to improve the welfare of people in the world (Andriyani, 2021). Sustainable Development Goals (SDGs) are a global agenda consisting of 17 goals set by the UN to guide countries to achieve sustainable, inclusive, and equitable development by 2030 (Anggraeni & Yanti, 2024). Environmental education is considered an essential tool for promoting environmentally responsible behaviors and supporting the achievement of the SDGs, particularly regarding climate action and ecosystem conservation (Buchanan et al., 2019). By engaging learners in environmental-based projects and using digital technologies, this education can increase pro-environmental awareness and actions, including moral development and environmental responsibility, which are essential elements in achieving the SDGs (Ruman et al., 2020).

The critical role of information technology in environmental education, especially in cooperation between schools in different countries, is to facilitate international dialogue and collaboration in ecology and to raise ecological awareness among learners. Using information technology, learners can participate in joint ecological workshops, compare ecological awareness across countries, and develop creative ideas to protect the environment (Ruman et al., 2020). This technology-integrated environmental education supports a change in the focus of scientific education from a traditional approach to one that is more orientated toward citizen empowerment. It aims to increase citizen participation in decision-making regarding technoscientific issues (Noga et al., 2021).

Digital technology is a system whose existence is very important in helping to meet human needs today, not only in meeting clothing or food needs but has begun to enter the realm of education in the form of learning media (Dahria et al., 2023). Digital technology tools, such as computers, allow learners to model various environmental processes and prepare them to apply knowledge in real-life situations (Pinchuk & Sokolyuk, 2022). This is part of a sustainable development strategy that aims to improve necessary social skills and provide equitable quality education, including vocational and technical skills for decent work

https://doi.org/10.17509/curricula.v3i2.75805

(Vakaliuk et al., 2020). Countries can promote more efficient and sustainable resource management by integrating sustainability principles into education policies and practices. Sustainable education also contributes to increased awareness and adoption of green energy alternatives, which aligns with the SDGs' goal to address climate change and environmental degradation (Shang et al., 2024).

METHODS

The methodology used in this research is qualitative methods, and data collection is done using a literature review. The literature review is a technique for collecting information related to literature of a bibliographic nature. The literature review was conducted to identify the types, implementation, and challenges of technology utilization in environmental education. The research approach uses qualitative techniques because the generated data is a descriptive narrative. This research was conducted through various local and international scientific journal literature. The chosen literature study method is more practical in analyzing multiple problems in the field and providing explainable explanations. The research began with collecting research data sources by utilizing the collections contained in the scientific article database in less than ten years. The research was limited to scientific research materials related to the use of technology in environmental education. Furthermore, the data obtained was analyzed and presented in a text description, and then a conclusion was drawn.

RESULTS AND DISCUSSION

In this section, the research results on the utilization of technology in environmental education will be presented with a focus on three main aspects: the types of technology used, for example, Augmented and Virtual Reality, Internet of Things (IoT), and ICT (Information and Communication Technology), the implementation of technology in the learning process, and the challenges faced in its application. Through in-depth literature analysis, this research aims to provide a comprehensive picture of how technology can improve the effectiveness of environmental education while identifying the obstacles that need to be overcome to achieve this goal.

Implementing Augmented and Virtual Reality in Environmental Education Technology

Augmentation is the process of enriching or expanding existing information with additional context or details from the retrieval process (Tribber et al., 2024). Meanwhile, virtual reality is a media that produces a virtual area that makes the user feel the events or incidents that are happening in the media (Darojat et al., 2022). Virtual reality technology is essential in environmental education, which aims to promote environmental morality (Liu et al., 2019). AR and VR technologies in environmental education can facilitate explanation through visualization and simulation. AR and VR help improve the educational effectiveness of complex issues such as climate change and sustainability, thus facilitating learners' understanding (Rybakova et al., 2021). Virtual and Augmented Technologies offer immersive experiences for learners without leaving the classroom, enabling an understanding of human

https://doi.org/10.17509/curricula.v3i1.000000

activities' impact on the environment (Buchanan et al., 2019). In addition, augmented reality combined with interactive infographics is considered to increase environmental literacy and awareness (Küçükaydın & Ulum, 2023).

Technology can expand learning, and contact with nature can be enhanced to promote the environment's moral quality and form good environmental protection habits (Liu et al., 2019). This way, digital technology can improve student engagement and promote pro-environmental behavior (Buchanan et al., 2019). Virtual reality technology creates simulated environments that bring together real and virtual images. Users can view and interact with objects in a highly realistic three-dimensional environment. Using VR in environmental education effectively increases learner interaction and engagement in the learning process (Liu et al., 2019).

Utilization of this technology in environmental education includes mobile apps and augmented reality in a project-based learning project. In this case, learners at a school developed an app that users could download via QR codes installed along a riverside walkway. The app was designed to provide users with information about the path. Furthermore, the app was designed to connect with augmented reality features that could display past neighborhoods on top of current neighborhoods, allowing users to "visit" pre-colonial times and explore traditional land use by Indigenous peoples (Buchanan et al., 2019).

Figure 1. Illustration of environmental education with AR
Source: Author's Documentation 2024

Implementing the Internet of Things (IoT) in Environmental Education Technology

The Internet of Things (IoT) is one of the pillars of Industry 4.0, whose concepts and practices are useful in today's technological era (Arif et al., 2023). In addition, the Internet of Things

https://doi.org/10.17509/curricula.v3i2.75805

is a growing science. It is very promising to optimize life based on smart sensors and smart devices that work together through the internet network (Hidayat & Sari, 2021). The use of digital tools and IoT increases the effectiveness of environmental education. Learners can conduct hands-on experiments and research relevant to environmental issues. Data from IoT devices help to understand ecosystem interactions and the impact of human activities, ultimately raising awareness about environmental issues (Pinchuk & Sokolyuk, 2022). These technologies connect learners with their environment and increase their engagement in project-based learning focusing on environmental issues (Edwards et al., 2021). IoT is used in projects that involve designing, constructing, and programming prototypes related to environmental protection. These projects utilize mathematics, physics, science, and computer science skills (Tortoriello & Veronesi, 2021).

Utilizing Internet of Things (IoT) technologies, such as sensors and apps, are used to increase awareness of plant needs and stimulate sensory engagement. For example, the Digital Boggarts project utilizes Microbit sensors to explore microclimate by linking hands-on experience and temperature and humidity data. The Arduino Uno, designed using the N.F.C. Shield and Tag, creates audio stories and digital boggart characters. This allows learners to monitor the needs of plants and the environment, sensitizing them to non-human responses and environmental impacts (Edwards et al., 2021). In addition, projects such as a robotic arm with sensors to detect indoor air pollutants and a buoy with sensors to monitor water quality in the Sarno River emphasize the cost-effectiveness and real-time data transmission to inform authorities of pollution levels. This educational experience demonstrates the effectiveness of a practical, transdisciplinary learning approach in addressing real-world issues and preparing learners to become active and informed citizens in the face of environmental challenges (Tortoriello & Veronesi, 2021).

Implementing the Internet of Things (IoT) increases learners' awareness of environmental issues by collecting and analyzing real-time environmental data through connected devices and sensors (Pinchuk & Sokolyuk, 2022). IoT implementation steps involving learners can be done as follows.

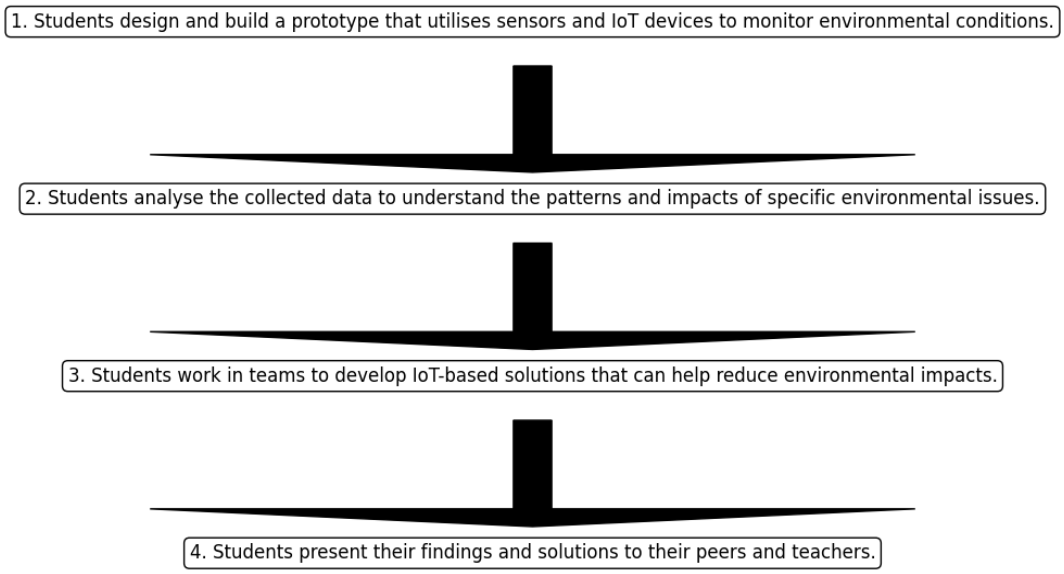

Figure 2. Implementation steps for IoT utilization in environmental education
Source: Author's Documentation 2024

https://doi.org/10.17509/curricula.v3i1.000000

Learner's design and build prototypes involving sensors and IoT devices, such as air quality or pollution levels. Then, learners analyze the data collected to understand the patterns and impacts of a particular environmental issue. This involves using maths and computer science skills. In the next stage, learners work in teams to develop IoT-based solutions that can help reduce environmental impacts. The project promotes transdisciplinary learning by combining different fields of study. Finally, learners present their findings and solutions to peers and teachers, which helps raise awareness and understanding of environmental issues among learners (Tortoriello & Veronesi, 2021).

In addition, using IoT digital measuring systems such as Einstein, LabDisc, and Pasco allows learners to conduct experiments and hands-on learning, which improves learners' motivation and skills (Pinchuk & Sokolyuk, 2022). Through IoT projects, learners can design and develop prototypes focusing on environmental solutions. The experience provides practical experience in applying theoretical concepts learned in the classroom, such as maths, science, and technology, to real-world situations (Tortoriello & Veronesi, 2021).

Implementing ICT (Information and Communication Technology) in Environmental Education Technology

Information and Communication Technology (ICT) is a medium that can help carry out an activity, starting from managing, processing, changing, and even transferring information (Rahayu et al., 2021). Information and Communication Technology (ICT) is a computer technology that has several devices, including hardware and software (Wahyuni & Hidayati, 2020). ICT includes technologies such as computers, the internet, mobile phones, communication networks, and various digital applications used in multiple sectors, including education, business, health, and Government. ICTs are used in environmental education to increase awareness and knowledge through digital platforms, interactive simulations, and online collaborative tools (Matsekoleng et al., 2022; Shang et al., 2024). Information and communication technology (ICT) can facilitate social interaction and support a more flexible approach to education, essential for communicating complex environmental concepts (Rybakova et al., 2021). ICT helps learners to be ready to use their knowledge in real-life situations by modeling various environmental processes. In addition, these technologies enable the self-development of learners in the environment (Pinchuk & Sokolyuk, 2022). These digital technologies can also be used to collect and analyze environmental data in real time, thus providing immediate insights into environmental conditions and the impact of human activities on them (Matsekoleng et al., 2022).

ICT in multimedia enables interactive learning, explains complex environmental concepts, and increases learner participation in protecting the environment. In addition, it helps the understanding of geographical concepts visually and practically (Guo et al., 2020). This also applies to digital ICT technologies such as learning videos, interactive simulations, and e-learning platforms (Matsekoleng et al., 2022). In practice, using ICT through social media can be integrated into the SMENA (Social Media for Environmental Awareness) model for learners in South Africa. The model uses platforms like Facebook and Twitter to raise environmental awareness, videos for legal understanding of endangered species, and Web 2.0 tools such as Canva, Visme, Padlet, Blogger, and Facebook to support sharing,

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discussion, and evaluation. The model was found to increase self-efficacy in teaching environmental issues (Küçükaydın & Ulum, 2023).

ICT development also has a complex impact on fossil fuel efficiency, potentially decreasing efficiency by 0.16%. Curricula that integrate sustainability principles aim to improve ecological literacy, encouraging the exploration of practical solutions for sustainable living with a deep understanding of environmental systems, social dynamics, and economic interdependence (Shang et al., 2024). On a broad scale, ICT is even used in education through QR codes, which are used as a medium for information technology interaction at the Botanical Garden. The QR Codes installed are connected to the plant collection information database. Learners can access environmental information digitally and interactively by scanning QR codes on plants. QR Codes aims to increase the effectiveness of information delivery and overcome the limited number of education guides. The evaluation showed that most learners were satisfied with the technology, signaling good acceptance and successful implementation of environmental education at all school levels (Ginardi et al., 2021).

In the field of geography, ICT is used in the form of a geographical information system (GIS). GIS is a system for storing and analyzing geographic data through digital maps. GIS can integrate various data types, allowing users to understand patterns, trends, and relationships through maps, reports, and graphs. GIS database can be obtained from field surveys, satellite images, and census data. So, GIS can be used in various environmental and planning applications (Noga et al., 2021). GIS in environmental education can help learners understand complex geographical and ecological concepts more visually and practically (Guo et al., 2020).

ICT is not always complex; Google Docs and email are also part of ICT and are used to provide individual and group feedback, reinforce learning, and customize courses. Digital technologies facilitate access to relevant resources and information for in-depth environmental research projects (Ryazanova et al., 2021). ICT technologies include e-books that can showcase various intra-school projects, even inspiring other schools. E-books in environmental education contain scenarios of ecological encounters for children and ecological games. This facilitates the dissemination of information and ideas on environmental protection to a broader audience, including other schools that may wish to adopt similar practices. Information technology facilitates international cooperation, reducing travel costs and environmental impacts (Ruman et al., 2020).

ICT is also implemented through Green IT, which refers to a sustainable computing approach to reduce the environmental impact of information and communication technology. It is used to design sustainable learning environments in higher education, focusing on cloud technology. Green IT in education helps reduce environmental impact, such as using Cloud LMS. Cloud LMS can store educational materials, conduct online assessments, and develop learners' competencies. By reducing the need for hardware and paper, Cloud LMS helps reduce the carbon footprint of educational institutions. Research shows that integrating cloud technologies like Green Data Centres can foster sustainable and efficient educational practices (Vakaliuk et al., 2020).

Integrating ICT in physics education in innovative STEM-based education environments is also critical, mainly to modernize teaching methods, improve the quality of interactive learning, and provide virtual learning environments. Using technologies such as cloud

https://doi.org/10.17509/curricula.v3i1.000000

computing can improve STEM teaching efficiency, support environmentally-focused education, and enrich learners' learning experience, with statistical results showing significant improvements in knowledge and skills (Kuzmenko et al., 2022). Using ICT on digital computerized measuring systems such as Einstein, LabDisc, Pasco, Relab, L-micro, FourierEdu - NOVA Link, NOVA 5000, and COBRA 4 enables learners to conduct laboratory experiments and environmental research projects. Teachers and learners use digital sensor technology connected to relevant software to measure and analyze data in real time, compare data, and draw conclusions to deepen their understanding of environmental issues (Pinchuk & Sokolyuk, 2022).

Environmental Education Technology Implementation Challenges

Implementing technology in green education faces various challenges, including limited school resources, lack of access to technology, and inadequate teaching materials (Pinchuk & Sokolyuk, 2022). In addition, integrating local environmental knowledge into the formal curriculum requires creative and innovative approaches from teachers (Matsekoleng et al., 2022). While technology can connect learners to global issues, it is necessary to ensure that locally relevant content can also be a pathway to global issues such as food security and climate change (Edwards et al., 2021). The use of technology in environmental education must also be done carefully to ensure that the learning experience is not disconnected from direct interaction with the natural environment. This raises concerns that technology may hinder the learning experience by reducing direct interaction with nature (Küçükaydın & Ulum, 2023).

Furthermore, there is a need to develop relevant and engaging content that fully utilizes the potential of technologies such as virtual reality. This is problematic due to the unequal access to these advanced technologies, especially in less developed regions (Liu et al., 2019). Curriculum and educational resources must be ensured to support the use of these technologies, including the development of learners' and teachers' digital competencies (Pinchuk & Sokolyuk, 2022). Ensuring that the technologies used are accessible and engaging for learners from different levels of education is also a significant challenge to ensure their acceptance and effectiveness (Ginardi et al., 2021).

The components of an innovative, scientific, educational environment (ECO environment), systematically integrated and determined by the general goals of the educational process, include a transdisciplinary, systemic, and professionally orientated approach (Kuzmenko et al., 2022). Another challenge is that teachers need more professional preparation to deal with interdisciplinary themes and the reluctance to introduce environmental issues in schools (Noga et al., 2021). For example, limited technological skills among teachers and the complexity of using technologies such as GIS are also recognized as barriers that must be addressed (Guo et al., 2020).

On the other hand, e-waste management is an important issue, as increased use of technological devices can lead to an increase in e-waste that requires specialized management. Therefore, it must be ensured that the technology used in environmental education supports sustainability goals, such as energy efficiency and sustainable digital practices (Shang et al., 2024). However, energy-efficient digital practices such as the cloud

https://doi.org/10.17509/curricula.v3i2.75805

require special attention to data security and privacy, which is a challenge in ensuring that learner and institutional data are well protected (Vakaliuk et al., 2020). The various challenges identified also raise the possibility of resistance from those accustomed to traditional teaching methods, which can hinder the adoption of new technologies (Ruman et al., 2020; Tortoriello & Veronesi, 2021).

Discussion

Effective environmental education uses digital technology to engage learners in global issues such as food security and climate change. Learners can create digital tools to enhance their understanding of local environmental impacts and reflect on experiences, thereby improving their ability to recognize non-human responses (Edwards et al., 2021). In addition, digital technologies enable learners to collect and interpret environment-related data, which can increase awareness of their surroundings (Küçükaydın & Ulum, 2023).

Technology in environmental education should be used through an approach that combines technological knowledge with environmental awareness, using locally available and culturally relevant resources (Matsekoleng et al., 2022). With a localized approach, environmental education will help learners understand abstract concepts such as biodiversity and threats to habitats in a concrete and hands-on way. For example, using digital recorders in the project helped participants listen to bird calls and develop identification skills through coding interactive bird prints. Projects such as "Digital Boggarts" and "The Lost Sounds" successfully link learners' local experiences with global issues (Edwards et al., 2021).

Science, Technology, and Society (STS) education in environmental education is essential in resolving complex socio-ecological problems. Research results show that an interdisciplinary approach can improve understanding of environmental issues in teaching coral reef conservation and phytoplankton ecology (Noga et al., 2021). In addition, models that utilize cloud-based learning management systems (Cloud LMS) can enhance the educational process by providing tools such as electronic journals, online assessments, and collaborative tools. This helps enhance learners' cognitive abilities and professional competencies and supports sustainable development goals (Vakaliuk et al., 2020).

So, environmental education strongly supports the SDGs' goal of ensuring inclusive and quality education and promoting lifelong learning opportunities for all (Edwards et al., 2021). By increasing individuals' understanding and engagement in environmental issues, education can encourage more sustainable actions and support the overall achievement of the SDGs (Liu et al., 2019). Overall, environmental education can help steer technological development in a more environmentally friendly and sustainable direction (Shang et al., 2024). Using technology, learners can develop intelligent ideas to create tools and objects to protect the environment and build prototypes for their projects (Tortoriello & Veronesi, 2021).

CONCLUSION

It is essential to identify the application of technology in environmental education. Understanding the potential of various technological tools, including Augmented Reality, Virtual Reality, the Internet of Things (IoT), and ICT (Information and Communication

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Technology), is crucial in enhancing environmental awareness and facilitating effective learning. By utilizing these technologies, learners can collect and interpret environmental data, thus fostering higher environmental awareness. However, it is essential to recognize the challenges associated with integrating technology in environmental education, such as limited school resources, the need for relevant and engaging content, and resistance from individuals who are used to conventional teaching methodologies. Considering the critical role of environmental education in advancing the Sustainable Development Goals (SDGs), the authors suggest additional research to address the challenges of implementing technology in environmental education.

AUTHOR'S NOTE

The authors declare that there is no conflict of interest related to the publication of this article and confirm that the data and content of the article are free from plagiarism. This article was presented at the International Conference on Education and Regional Development (5th ICERD) held on 25 - 27 September 2024.

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