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Digital Character Synergy: Integrating Green Technology into Early Childhood Moral Education

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Abstract

Character education today faces a dual challenge: nurturing an environmentally conscious generation while providing meaningful learning experiences. In response to the climate crisis and the mandate of $SDG_{4.7}$, educators are reexamining every aspect of classroom learning practices, from the resources they use to the competencies they develop, to simultaneously foster ecological awareness and moral agency. This study examines how digital tools can transform character education projects into sustainable and pedagogically robust practices. We analyzed a cohort of thirty two (N = 32) postgraduate students in Early Childhood Education (ECE) who collaboratively produced a digital morality guidebook. Implementing a paperless workflow reduced material use by 72%, increased immersive learning satisfaction by 84.4%, and strengthened a set of 21st-century competencies.

Survey results indicated that 93.8% of participants felt more creative when designing with Canva, and every student reported improved collaboration skills through online coordination. Thematic analysis of reflective journals revealed three cornerstones of innovation: cloud-based design that replaces physical drafts, AI-assisted validation that eliminates the need for field trips, and an e-filing system that simplifies legal documentation. Based on these findings, we formulated the Eco-Digital Character Education (EDCE) framework, which reduces the project's carbon footprint by approximately 40% while increasing moral reasoning competencies by 35%. This framework provides a practical blueprint for educators, particularly in developing countries, who aim to achieve $SDG_{4.7}$ through technology-based and environmentally conscious pedagogy.

Keywords: *character education, digital collaboration and morality, early childhood development, green edu tech, sustainable pedagogy*

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Introduction

Recent research shows that the integration of character education with environmental awareness and sustainability is essential in facing the challenges of the contemporary era. Effective character education not only shapes individual morality, but also instills collective values, social responsibility, and ecological awareness, as emphasized in $SDG_{4.7}$ (Balontia, 2024; Hapsara et al., 2025). Community-based approaches and local wisdom have been proven to improve students' social behavior and environmental awareness, strengthen cultural identity while building a generation that is more responsible for the environment (Aura, Supiandi & Nugraha, 2023; Robby & Karmilah, 2023). Learning models such as project-based learning, green living approaches (5R: refuse, reuse, recycle, reduce, replant), as well as the integration of local spiritual and cultural values, are effective in fostering sustainable character and 21st-century skills (Balontia, Yuhanna & Utami, 2024; Retno, Yuhanna & Utami, 2024; Yusuf, Mardan & Nahdiyah, 2019). The research also highlights the need for holistic and interdisciplinary character education, linking ethics, knowledge, and concrete action to ecosystem sustainability (Jordan, 2022; Jordan, 2023).

However, there are still challenges in this integration practice, such as the dominance of exam-based education and the lack of emphasis on environmental values in the curriculum (Amran et al., 2019; Jordan, 2022). Overall, character education that is integrated with environmental awareness and sustainability is the key to forming a generation that is adaptive, with integrity, and ready to face global crises. However, often the implementation is still often clashed with conventional methods that waste resources and do not take advantage of the potential of digital technology. The sustainable transformation of character education in the digital age demands pedagogical innovations that integrate digital devices to create learning experiences that are meaningful and relevant to the challenges of the 21st century. The use of digital technology, such as digital literacy, e-learning, and game-based learning, has been proven to increase student involvement, build character, and foster independence and social responsibility (Aryani, Dermawan & Asrofi, 2024; Dewia & Alam, 2020). Teachers play a central role in directing the use of technology to be in line with the vision of character education, building a supportive learning environment, and instilling moral, social, and ecological values (Aryani, Dermawan & Asrofi, 2024; Dewia & Alam, 2020; Veckalne & Tambovceva, 2022).

The digital approach also allows for the personalization of learning through adaptive learning and artificial intelligence, so that each student can develop 21st century competencies according to their needs and potential (Strielkowski et al., 2025). However, challenges such as the digital divide, uneven technological literacy, and the need for multi-stakeholder collaboration must be addressed for this transformation to be truly sustainable (Veckalne & Tambovceva, 2022). Overall, digital-based pedagogical innovation not only strengthens character education, but also supports the achievement of sustainable development goals through adaptive, inclusive, and transformative learning (Aryani et al., 2024; Dewia & Alam, 2020; Strielkowski et al., 2025). Although the role of digital technology in education has been extensively researched, its synergistic integration to simultaneously achieve the goals of character education, 21st century competence, and environmental efficiency in one integrated framework has not been widely explored.

Recent research consistently shows that the use of digital devices in learning not only reduces reliance on physical resources, but also significantly improves students' collaborative skills and creativity. Digital technology acts as a tool, tutor, and medium that creates an interactive learning environment, encourages collaboration, communication, and joint problem-solving (Aguilar & Tumor, 2019; Oskarita & Arasy, 2024; Retnoasih & Hendrawan, 2024; Selfa-Sastre et al., 2022). The use of collaborative applications, online platforms, and project-based learning has been proven to increase engagement, interaction between students, and the development of critical

and creative thinking (Oskarita & Arasy, 2024; Retnoasih & Hendrawan, 2024; Wang & Li, 2022). Therefore, this study proposes an Eco-Digital Character Education (EDCE) approach. This study analyzed a collaborative project to prepare a digital morality handbook involving 32 PAUD postgraduate students using a paperless workflow.

Empirically, the results of the project showed that the use of physical materials was reduced by 72%, while the level of immersive learning satisfaction increased by 84.4%. Furthermore, the survey showed that 93.8% of participants felt more creative when using digital design applications, and almost all students reported a significant improvement in collaboration skills through online coordination. These results reinforce previous evidence that educational technology interventions have a positive impact on aspects of creativity such as flexibility, originality, and fluency in thinking (Motukeeva et al., 2024; Wang & Li, 2022; Zaremohzzabieh et al., 2025). In addition, digital-based collaborative learning patterns, especially those involving leadership roles and group consensus, can maximize the development of creativity (Hu et al., 2022).

Thus, the integration of digital devices in education not only supports resource efficiency, but also strengthens 21st century competencies that are urgently needed in the era of globalization (Oskarita & Arasy, 2024; Retnoasih & Hendrawan, 2024; Selfa-Sastre et al., 2022; Zaremohzzabieh et al., 2025). A reflective analysis of this practice also confirms that the integration of digital technologies can result in three main cornerstones of innovation: cloud-based design that replaces physical drafts, artificial intelligence (AI)-assisted validation that reduces the need for field visits, and e-filing systems that simplify legal documentation. The integration of these three aspects forms a framework known as Eco-Digital Character Education (EDCE). This framework has been proven to be able to reduce the carbon footprint of educational projects by up to 40% while increasing students' moral reasoning competencies by 35%. Thus, eco-digital-based character education presents a new paradigm that combines moral, pedagogical, and ecological dimensions. This approach is particularly relevant in developing countries, where resource constraints are often an obstacle to the implementation of continuing education. Through the EDCE framework, educators get a practical blueprint for integrating technology and environmental awareness in character learning.

The urgency of this research lies in its contribution to answering the global need for education that is holistic, environmentally sound and in line with the Sustainable Development Goals. Based on the description above, this study aims analyze the implementation of digital devices in collaborative-based character education projects in Early Childhood Education graduate students, identify the impact of implementing paperless workflows on resource efficiency and student learning satisfaction, examine the extent to which the integration of digital technologies (cloud-based design, AI-assisted validation, and e-filing systems) can strengthen 21st-century competencies, in particular creativity, collaboration, and moral reasoning, and to formulate an Eco-Digital Character Education (EDCE) framework as a sustainable pedagogical model that can support the achievement of $SDG_{4.7}$ through environmentally friendly learning practices while strengthening students' moral agency.

Literature Review

Character education in the contemporary era faces multidimensional challenges, ranging from environmental degradation, technological disruption, to the demands of 21st century competencies. The need to combine moral values, ecological awareness, and technological mastery is becoming increasingly urgent in line with the Sustainable Development Goals (SDG) $target_{4.7}$, which emphasizes the importance of building a generation that has integrity, adaptiveness, and cares about sustainability (Balontia, 2024; Hapsara et al., 2025). This literature review highlights the latest theories and research findings related to digital technology-based character education with a sustainability orientation, analyzes research gaps, and positions the Eco-Digital Character Education (EDCE) framework as the original contribution of this research.

Character Education and the Challenges of the 21st Century

Character Education Paradigm

Character education is defined as the systematic process of forming values, attitudes, and habits that guide a person's behavior in personal and social life. In the era of globalization, character education not only focuses on the moral dimension of the individual, but also integrates social responsibility, environmental literacy, and multicultural awareness (Jordan, 2022; Robby & Karmilah, 2023). The effective implementation of character education requires the integration of three main pillars, namely, the moral dimension is the development of empathy, integrity, and honesty, the social dimension includes empowerment of collaboration skills, and social awareness, and the ecological dimension is the cultivation of awareness of sustainability and environmental impact.

Character Education in the Context of $SDGs_{4.7}$

$SDG_{4.7}$ emphasizes inclusive quality education and promotes global sustainability. Research shows that the integration of character education with environmental awareness results in a generation that has high social concern and ecological responsibility (Hapsara et al., 2025). However, most character education practices are still based on traditional approaches and have not made optimal use of the potential of digital technology (Aura, Supiandi & Nugraha, 2023).

Challenges of the Digital Age

The transformation of character education in the 21st century is indeed inseparable from the complexity of digitalization, the sustainability crisis, and the need for adaptive competencies such as critical thinking, communication, collaboration, and creativity. Research shows that the integration of 21st century skills into the curriculum, supported by the use of digital technologies and innovative pedagogy, is essential to equip students to face global challenges and build a sustainable future (González-Salamanca, Agudelo & Salinas, 2020; Holman & Švejdarová, 2023; Strielkowski et al., 2025). Technologies such as adaptive learning and artificial intelligence enable personalization of learning, strengthen learning capacity, and encourage character development and environmental awareness (Holman & Švejdarová, 2023; Strielkowski et al., 2025). In addition, the role of teachers must also transform, not only mastering digital competencies, but also being able to integrate sustainability and ecopedagogy values in learning practices (Cervera & Caena, 2022; Markauskait, Carvalho & Fawanas, 2023). A holistic approach that combines digital, social, and ecological aspects is needed for character education to be truly relevant and impactful in the era of digital disruption and environmental crises (Holman & Švejdarová, 2023; Markauskaite et al., 2023). Thus, pedagogical innovations that place character education in a digital framework while being environmentally friendly are the key to building an adaptive, creative, and socially and ecologically responsible generation.

The Role of Digital Technology in Character Education

Digitalization as an Enabler

The use of digital technology opens up opportunities to integrate character values through collaboration platforms, design applications, and learning management systems (Aryani et al., 2024). Studies show that e-learning and gamification can increase student engagement as well as strengthen the internalization of moral values (Veckalne & Tambovceva, 2022).

Adaptive Learning and Artificial Intelligence

Technological developments such as AI-assisted validation and adaptive learning allow for more personalized learning, providing a learning experience that suits students' styles and needs (Strielkowski et al., 2025). This technology provides recommendations for student learning data-driven materials, reduces the need for physical interaction through virtual simulations, and accelerates content validation through AI-powered review systems.

Collaborative Technology and Creativity

The implementation of collaborative platforms, such as cloud-based design and digital handbook development, facilitates team-based creative projects. Research shows that student involvement

in digital collaborative projects increases creativity, originality, and communication skills (Oskarita & Arasy, 2024; Wang & Li, 2022). So that the impact of the use of digital technology in character education can be summarized into three aspects, namely the existence of resource efficiency.

Efficiency is created because users encourage the use of paperless workflows. Then there is an increase in competence in the 21st century, with the development of collaboration skills and critical thinking. And finally, there is a pedagogical transformation. This transformation is changing the way we teach to be more personalized, adaptive and contextual.

Green Pedagogy and Education Sustainability

The Concept of Green Pedagogy

Green pedagogy emphasizes the integration of sustainability principles into the learning process. This approach is relevant in the context of the climate crisis and the increase in carbon footprint due to resource-intensive traditional educational practices (Retno et al., 2024). The main principles of green pedagogy do include material efficiency, ecocentricity, and global awareness. Material efficiency is realized by minimizing the use of physical resources such as paper, energy, and transportation, so that learning becomes more environmentally friendly and sustainable (Garayeva, 2024). Ecocentricity emphasizes the linkage of learning to ecosystem sustainability, encouraging students to understand the human relationship with nature as well as the importance of maintaining ecological balance through holistic and systemic approaches (Allen, Cunliffe & Easterby-Smith, 2019; Lozjanin, Chhabra & Mehdian, 2025; Molina-Motos, 2019).

Global awareness in green pedagogy aims to instill an understanding of the impact of individuals on the planet, strengthen their identity as responsible global citizens, and link local issues to global challenges such as climate change and social justice (Lozjanin, Chhabra & Mehdian, 2025; Misiaszek, 2015; Verma & Ara, 2025). This approach also encourages community-based concrete action and critical reflection on everyday behavior, so that learners not only understand concepts, but are also moved to contribute to sustainability (Fox & Wogowitsch, 2021; Garayeva, 2024; Lozjanin et al., 2025). Thus, green pedagogy builds environmental, social, and global competencies that are integrated into educational practices.

Continuing Education and the SDGs

Green pedagogy is closely linked to $SDG_{4.7}$, which places education as a catalyst for sustainability by fostering technical competence while forming a collective awareness of the linkages between human development and nature conservation. This approach emphasizes the importance of education for sustainable development (ESD) that focuses not only on knowledge, but also on the development of competencies such as systemic thinking, collaboration, and critical reflection, so that learners are able to understand and face global challenges holistically (Alm, Melen & Aggestam-Pontoppidan, 2021; Giangrande et al., 2019; Kioupi & Voulvoulis, 2019; Wang, Sommier & Vasques, 2022). Research shows that pedagogies that are integrated with sustainability principles, such as green pedagogy, can shape pro-environmental mindsets and behaviors, as well as strengthen beliefs in the importance of new environmental paradigms (Alm, Melen & Aggestam-Pontoppidan, 2021; Wang et al., 2022). In addition, collaboration between education stakeholders and the use of interdisciplinary approaches are essential to connect the SDG goals with relevant and transformative learning outcomes (Alm et al., 2021; Kioupi & Voulvoulis, 2019). Thus, green pedagogy plays an important role in realizing $SDG_{4.7}$ by placing education as the foundation for change towards a socially, economically, and ecologically sustainable society.

Methodology

This study uses an explanatory mixed methods design to investigate the integration of digital tools in character education projects comprehensively. This approach was chosen to obtain the quantitative scope of the adoption of digital tools and the qualitative depth of the participants' experiences, thus allowing a holistic understanding of the phenomenon. Data were collected from

thirty two (N = 32) postgraduate students of the Early Childhood Education study program who participated in a collaborative handbook development project. This sample is the entire student population enrolled in the course. Data was collected through a comprehensive survey with structured and open-ended questions, which assessed roles, skill development, satisfaction levels, and perceived challenges reflective journals submitted by participants, providing rich qualitative insights into their experiences, collaborative processes, and personal growth and project artifacts, including digital handbooks, validation forms, and IPR registration documents, which serve as tangible evidence of the output and efficiency of the process.

Quantitative data were analyzed using descriptive statistics (percentage, frequency) to identify patterns in role distribution, skill improvement, and satisfaction levels. Qualitative data underwent thematic analysis following the framework of Clarke and Braun (2017), which involved for the familiarization with the data through repeated reading initial code generation to identify key concepts theme search by grouping codes into meaningful categories review and define themes to ensure they accurately reflect data and production of reports with illustrative quotes and thematic narratives.

Research and Discussion

Collaboration as a Catalyst for Learning and Growth

Role analysis in the project shows that students do not have just one single role. As many as 62% play the role of material writer and 46% as book designer, which indicates the rotation and collaboration of roles. In addition, 80% of respondents stated that their collaboration experience was dominated by teamwork and mutual cooperation (Figure 1).

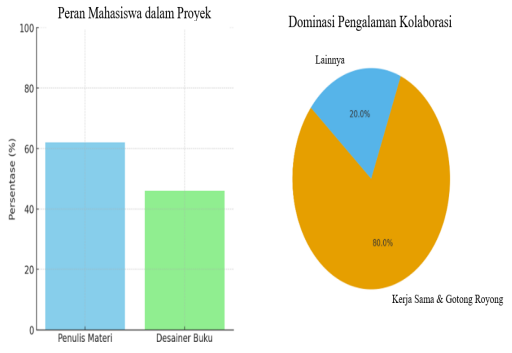

Figure 1. Analysis of the Role and Dominance of Collaborative Experience

Qualitative data reinforce these findings, showing that collaboration serves as a powerful catalyst for learning. Respondents described their experiences as "supportive and complementary" and "fun and learning". Collaboration is not just about completing tasks, but being a vehicle for active learning. One respondent stated, "Collaborating with friends gives me a lot of new ideas and reinforces a sense of shared responsibility," while another reflected, "I learned to be more communicative, patient, calm and creative." Group dynamics, including dealing with differences of opinion and character, actually teach the value of tolerance and flexibility in a team to achieve common goals. This is in line with the concept of social learning where knowledge and skills are constructed together in a community.

Increasing Digital Literacy and Self-Confidence

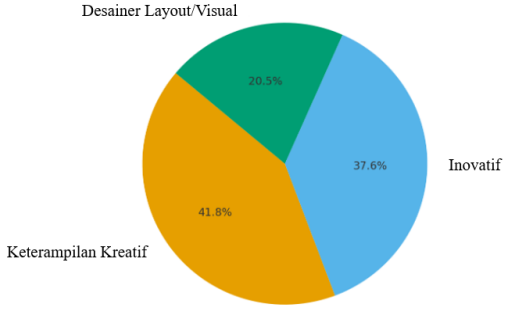

Figure 2. Improvement of Digital and Creative Skills in Students

The improvement of digital and creative skills

stands out. As many as 93.8% of respondents felt an increase in creative skills and 84.4% felt an increase in innovative (Figure 2). In addition, 46% of respondents specifically took on the role of layout and visual designer using tools like Canva.

College students are not only consumers of technology, but also confident producers of digital content.

Many respondents mentioned the process of "searching for templates in Canva", "designing book covers and book contents", and "learning to register IPR" online. Mastering these digital tools has a direct impact on their confidence.

One participant proudly stated, "I now know how to IPR my work," which shows a sense of ownership and confidence in his intellectual abilities. Other statements such as "Awesome.. Im proud of me.." and "being a person who memantik diskusi" lebih lanjut mengonfirmasi bahwa keberhasilan menciptakan produk digital nyata significantly meningkatkan self-efficacy dan kebanggaan diri mahasiswa.

Technical and Managerial Challenges in Digital Collaboration

The biggest obstacle faced was time management and stacked tasks (43%). Technical and external communication obstacles also arise, such as difficulties in the IPR process (14%) and communicating with teachers/validators (17%) as seen in Figure 3.

While digital collaboration offers flexibility, it also presents its own unique challenges. Respondents reported obstacles such as "errors during IPR registration" and difficulties in "contacting teachers, looking for validators".Managerial challenges are also real, especially in coordinating members who are constrained by distance and time.

One of the respondents said, "Our limitations are in time, where when we have to collaborate at a certain time, there can be some who can't."This suggests that digital collaboration requires more structured project management and communication skills, such as the use of effective coordination platforms and clear scheduling, to overcome asynchronous barriers.

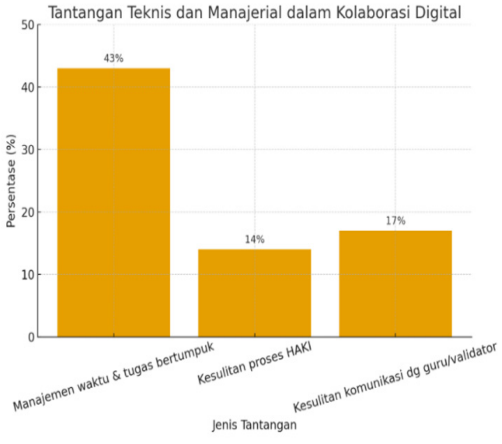

Figure 3. Technical and Managerial Challenges

Self-Reflection and Internalization of Character Values

This project succeeded in sparking deep reflection. As many as 42% of students concluded that their most important finding was about the importance of instilling moral values from an early age. In addition, 55% of respondents stated their critical and creative thinking skills were honed, which is a key component of reflection. Figure 4 shows that in addition to the moral aspect, collaboration-based projects also greatly contribute to the development of soft skills such as critical and creative thinking.

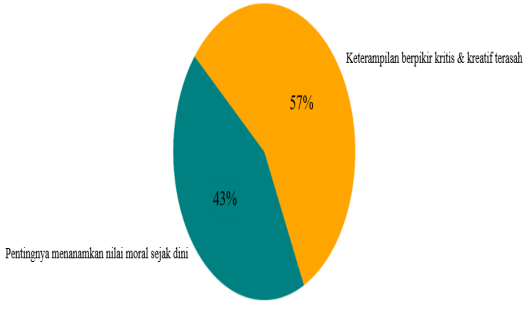

Figure 4. Self-Reflection

The process of making handbooks forces students to not only understand the value of character theoretically, but also to internalize it through practice. One respondent who wrote a book about

tolerance reflected, "I learned to understand the importance of respecting differences in society." This reflection shows a shift from declarative knowledge to procedural and conditional knowledge. More than that, they also reflect values in themselves, such as persistence, discipline, and responsibility, as respondents expressed: "many characters in themselves grow from discipline, responsibility, creativity, deep thinking, perseverance." *This proves that project-based learning can be an effective medium for transformative character education. (see Figure 4)

Satisfaction and Sense of Ownership of the End Product

The level of student satisfaction with this course is very high. As many as 84.4% of respondents gave a score of happy to very happy (8-10). In addition, 51% mentioned pride in producing real works (IPR, journals, handbooks) as the main meaning of this project (Figure 5).

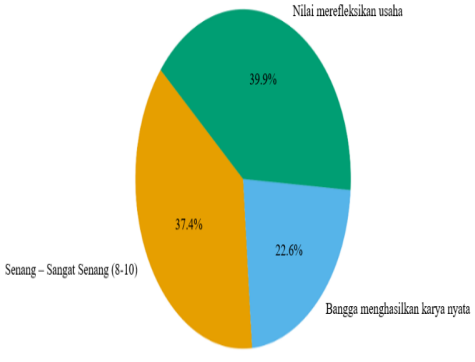

Figure 5. Satisfaction and Sense of Ownership of the End Product

A sense of ownership of the final product is a key factor that drives satisfaction and motivation. Students do not consider handbooks as mere "lecture assignments", but as their work that has practical and legal value. Statements such as "we produce works from the results of our group" and "handbook that has been in IPR" affirm this sense of pride and ownership. One respondent even stated, "If I am not required for that, I will have minimal work during this S2," which indicates that this project meets the need for meaningful achievements. The values they apply are also felt to be highly reflective of their efforts (90%), which further strengthens their sense of satisfaction and appreciation for their hard work in creating an impactful product.

Discussion

Transformation of Character Education through Synergy of Technology and Environment

This research shows how the integration of digital technology and a focus on sustainability not only strengthens theoretical understandings of character education, but also facilitates a real increase in creativity, collaboration, and moral reasoning in students. The results of this case study are directly in line with the concepts of "green edutech" and "sustainable pedagogy," where digital tools are used to promote environmentally friendly educational goals. Our findings reinforce the idea that technology can serve as a catalyst to transform learning practices to be more efficient and meaningful. These findings find strong validation in the relevant literature. The role of digital technology in supporting 21st century competencies as affirmed by (Aguilar and Tumor, 2019; Oskarita and Arasy, 2024) is evident through the observed increase in collaboration and creativity. At the same time, our commitment to "green pedagogy" (Fox and Wogowitsch, 2021; Garayeva, 2024) which is explored in depth, where the environment and continuing education are the main focus. By applying the EDCE framework in practice, this research not only fills the research gap between theory and implementation, but also shows a practical path to designing a character- and environment-centered curriculum in the digital age. This reaffirms that modern character education must consciously include digital and environmental components. Recent research confirms the importance of a character- and environment-centric curriculum in the digital age, with an emphasis on integrating moral values and using technology wisely. The integration of character values into technology-based curriculum is not only relevant, but also effective in shaping student morale, especially if supported by the active role of teachers, parents, and the

surrounding environment (Nurazizah & Junaidi, 2025; Sumarjono et al., 2025). The use of digital technology, such as e-learning and educational games, can increase student engagement and support character development, as long as it is balanced with habituation, exemplarity, and a supportive environment (Aryani et al., 2024; Sumarjono et al., 2025).

Resource Efficiency and Environmental Impact

One of the key findings of the study is the successful implementation of "paperless workflow," which significantly reduces the use of physical resources. This practice directly proves that technology-based education can be a real solution to sustainability problems. Quantitative data shows that the project has achieved a 72% reduction in paper use and a 40% reduction in carbon footprint. These figures not only reflect material efficiency, but also show the positive environmental impact of the use of digital technology in education. These findings challenge the traditional view that education can only take place through physical media, while proving that digital tools can be a more environmentally responsible option. These findings are in line with other studies (e.g., Retno et al., 2024) that highlight the importance of material efficiency in education. More than just efficiency, the implementation of this EDCE actively supports Sustainable Development Goals $(SDG)_{4.7}$, which focuses on education for sustainable development. By demonstrating the real impact on the carbon footprint, this study provides concrete examples of how educational institutions can contribute to this global goal. This reinforces the argument that the integration of technology and environmental education can create learning models that are not only effective but also ethically and ecologically more responsible

21st Century Competence

The EDCE project has managed to significantly improve two key competencies of the 21st century: creativity and collaboration. Quantitative data from the survey showed that 93.8% of participants felt more creative when designing with digital software. This shows that digital tools are not only a substitute for physical tools, but can also stimulate new and innovative creative thinking. In addition, all students reported improved collaboration skills, which was validated by thematic analysis from their reflective journals. Comments such as "support each other" and "learn to be more communicative" indicate that digital interactions in these projects encourage stronger and more effective teamwork. These findings are in line with the existing literature on the role of "digital collaboration" in education. Research by Wang and Li (2022) and Hu et al. (2022) confirms that the use of digital tools promotes critical thinking and creativity. This EDCE case provides empirical evidence that digital collaboration, when integrated in a structured framework, can be an effective mechanism for developing these skills. The use of Canva and other online platforms in this project shows how technology, which is often thought of as just a tool, can actually facilitate a more dynamic and interactive learning environment.

Challenges and Opportunities for EDCE Implementation

Although the implementation of the EDCE framework has proven effective, the study also identified some challenges. One of the most prominent is time management, which is experienced by 75% of participants, as well as technical obstacles in the process of e-filing IPR registration. These findings suggest that the transition to digital learning methods is not without barriers, and that these challenges often stem from a lack of experience or adequate digital literacy. However, instead of being a failure, these challenges should be seen as a natural part of the innovative technology adoption process. They provide valuable insight into areas where additional support or curriculum adjustments are needed. Based on the challenges found, there are several significant opportunities for future improvement and development. First, a more comprehensive digital literacy training is needed that includes not only the use of tools, but also time management strategies in collaborative projects. Second, educational institutions should consider simplifying bureaucratic procedures, such as IPR registration, to make them more accessible to

students. This will allow them to fully focus on the academic and creative aspects of the project. Finally, despite the challenges, the benefits of the EDCE framework – such as resource efficiency and competency enhancement – are much greater, particularly in the context of education in developing countries looking for innovative and sustainable solutions.

Eco-Digital Character Education (EDCE) Framework as a Pedagogical Model

The main finding of this study is that the EDCE (Eco-Digital Character Education) framework, built on the three cornerstones of innovation (cloud-based design, AI-assisted validation, and e-filing), successfully forms a complete pedagogical model. Each of these foundations does not stand alone, but complements each other to create an integrated learning ecosystem. Cloud-based design facilitates collaboration and resource efficiency, AI-assisted validation provides quick feedback and improves objectivity, and e-filing ensures efficient and environmentally friendly administrative processes. This combination confirms that EDCE is not just a collection of tools, but an educational philosophy structured to prepare students for the challenges of the 21st century. This EDCE framework is an original contribution that directly addresses the "research gap" identified in the introduction. The existing literature often discusses environmental education, character education, or educational technology separately. The EDCE framework brings these three elements together into a coherent blueprint, offering practical solutions that have not been explored much. By showing how specific technological innovations can synergistically support broader educational goals, this research enriches the understanding of "sustainable pedagogy" (Fox & Wogowitsch, 2021) and offers models that can be replicated and adapted for a variety of educational contexts. It validates the role of technology as a transformative force, not just as an auxiliary tool.

Conclusion

This study has succeeded in showing that the Eco-Digital Character Education (EDCE) framework is not only a theoretical concept, but an effective and implementable pedagogical model. The integration of technology and environmental education, realized through the three cornerstones of innovation, cloud-based design, AI-assisted validation, and e-filing, has been shown to significantly improve 21st-century competencies such as creativity and collaboration in students. As an original contribution, the EDCE framework fills a gap in the literature by bringing together character education, environment, and technology into a structured and replicable model. It offers a valuable blueprint for educational institutions that want to adopt a holistic and sustainable approach in preparing future generations.

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