Exploring the Role of Game-Based Learning in Enhancing Sustainability Knowledge: A Qualitative Study

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Abstract This paper explores the potential of digital games as a tool for promoting sustainability education. A deductive, qualitative research approach using a descriptive research design was employed, with a focus on document analysis on selected digital games already used in education. The study aims to identify key factors that make digital games effective in teaching sustainable topics and to examine the transferability of skills and experiences from the game to real life. The findings indicate that digital games have the potential to be a valuable tool in promoting sustainability education, providing an engaging, interactive, and effective learning experience. The implications, challenges, and opportunities for games-based sustainability education are discussed. The study concludes that further research is needed to explore the most effective ways of integrating digital games into educational curricula and to assess the long-term impact of digital games on sustainability knowledge and behaviour change.

Keywords:
digital games, sustainability education, learning transfer, game-based learning, qualitative study

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1 Introduction

Digital games provide an engaging and interactive way to explore socially relevant topics such as sustainability, particularly in classrooms. Recent research shows that digital games enhance student engagement and motivation, facilitate active learning, and promote sustainability knowledge and skills sustainability (Chen et al., 2019). Game designers can effectively coordinate game content, rules, and mechanics to teach sustainability topics. Therefore, further exploration of digital games' potential to promote sustainability is worth considering (Wang et al., 2022).

This exploratory study with its research question 'What are the key factors of a digital game that can be effectively applied in an educational context?' aims to identify the key factors of digital games that can enhance sustainability knowledge in an educational context. Objectives include analyzing existing games on sustainability, identifying player motivation mechanisms, and exploring how real-life experiences can be incorporated into gameplay to promote transferability of skills and knowledge.

This study explores how digital games can enhance sustainability education, identifying player motivation mechanisms and potential classroom applications. The findings could support the development of future games to promote sustainability knowledge and practices. The study provides a unique perspective on the role of digital games in fostering sustainability education and promoting sustainable practices.

2 Literature Review

2.1 Game based learning

Digital game creators excel at coordinating important elements of teaching and learning such as motivation, content presentation, and interaction. Even as gaming becomes more complex, Callois's principles of play, such as voluntary participation, a distinct space from reality, and non-predetermined outcomes, remain relevant. Dicheva et al. (2015) found that gamification strategies in education still incorporate these principles and can promote successful learning outcomes such as autonomy,

competence, and relatedness. Successful learning depends on ensuring learners experience autonomy, competence, and acceptance.

2.2 Serious games and gamification

Digital games have influenced game theory and games studies, and serious games are digital games designed for learning. Gamification uses game principles, such as progress bars, badges, and ranking lists, to increase motivation and promote learning. Successful gamification requires elements such as points, badges, and leaderboards, as well as cooperation, competition, and timely feedback. Gamification elements can be added to learning management systems, including quests, progress bars, badges, leaderboards, avatars, and feedback mechanisms (Deterding et al., 2011; Michael & Chen, 2006; Salen & Zimmermann, 2004).

2.3 Sustainability education and digital games

Digital games are ideal for sustainability education due to their immersive and interactive nature, allowing learners to experiment with strategies and explore complex issues in a risk-free environment. They can also foster emotional connections with sustainability issues, motivating learners to act (Janakiraman et al., 2021; Janakiraman, 2021).

3 Methodology

3.1 Research design and approach

This study employs a qualitative approach with a descriptive research design and utilizes document analysis as the primary research method. It focuses on game theory, game design, gamification, and play and learning, and examines a selection of digital games used in education. The study analyzes the mechanisms that motivate players to engage with the game, the incorporation of real-life experiences, and the transferability of skills.

3.2 Data collection and analysis

This study analyzes how digital games can enhance sustainability education by examining game mechanics, design, and player motivation in educational settings. Over 30 popular games are analyzed based on their potential for learning and reviewed through manuals, design documents, and online forums to identify mechanics that motivate players, such as rewards and challenges. Researchers interviewed players to explore skill transferability to real-world situations, specifically in problem-solving, decision-making, and collaboration. Thematic analysis is used to draw conclusions. The data collected provides insights into the factors of digital games that can enhance sustainability knowledge in education, including the transferability of skills and experiences from games to real-world contexts. The study also reviews relevant literature on game theory, design, gamification, and play and learning to identify key concepts and frameworks.

4 Results

4.1 Using educational games as a tool for sustainability learning

Recent years have seen a growing recognition of digital games as an educational tool. Gee (2018) cites successful educational game projects and the benefits of game-based learning. However, the key consideration in using digital games for educational purposes is the selection of appropriate games and the development of meaningful pedagogical strategies for their use (Rieck, 2022; Schell, 2016).

4.1.1 Analysis of selected games

Recent years have seen a rise in digital games dedicated to teaching sustainability topics, including games like 'The Sims 4 - Live Sustainably' and 'PhoneStory'.

The Sims 4 - Live Sustainably[1] is a digital game that promotes sustainable living by managing a Sims household with eco-friendly items to reduce waste and carbon footprint. Players receive rewards for making sustainable choices, which increases income and reduces bills. The game provides feedback and notifications on

[1] URL: https://www.ea.com/de/games/the-sims/the-sims-4/store/addons/the-sims-4-eco-lifestyle#related-news

sustainable practices and uses graphics and animations to engage players. It also features a point system that rewards players for their progress and encourages experimentation with different sustainable strategies. Overall, the game is an effective educational tool that showcases how digital games can teach sustainable practices.

PhoneStory[2] is a digital game that exposes the unethical practices of the smartphone industry, including child labour and toxic waste dumping. It takes players through the four stages of a smartphone's lifecycle, promoting critical thinking and awareness of the social and environmental impacts of technology consumption. Players are motivated to complete all levels and learn more about the industry's impact, making the game a fun and engaging way to encourage positive change in technology consumption. The game aims to encourage players to think critically about the impact of their technology consumption and act towards positive change.

4.1.2 Mechanisms that motivate players

Players are motivated by different factors when playing games. Progression and rewards give a sense of achievement, while competition motivates players to beat other players' scores. Social interaction in multiplayer games drives players to collaborate or compete with others. Immersive environments, compelling narratives, and engaging characters create emotional attachment and escapism. Challenge and skill-building motivate players to master a game, while exploration and discovery motivate players to uncover new content. Customization options and creative tools let players personalize their experience, while cooperative games motivate players to work together towards a common goal.

4.1.3 Real-life experiences incorporated in games

Digital sustainability games provide a more engaging and relevant learning experience for players by simulating real-life experiences such as energy conservation, waste reduction, and sustainable transportation. Players can experiment with different strategies and solutions in a safe environment while real-world data such as carbon emissions and energy consumption can be incorporated

[2] URL: https://phonestory.org/

to help them understand the impact of their actions. These games can also promote empathy and understanding of different perspectives by simulating experiences like living in a low-income community with limited access to sustainable resources. Incorporating real-life experiences and data can not only educate players on sustainable practices but also deepen their understanding of social and environmental sustainability issues.

4.1.4 Transferability of skills and experiences from games to real world

Digital games have the potential to transfer skills and knowledge from virtual worlds to real-world scenarios, particularly in sustainability education games. These games can teach practical skills related to sustainable living, such as reducing energy consumption and using public transportation. They can also enhance cognitive skills like problem-solving, critical thinking, creativity, and innovation as players strategize to manage resources sustainably. Sustainability education games can also create emotional connections to environmental and societal issues, motivating players to act towards sustainability in their daily lives. By transferring skills and experiences from virtual to real-world contexts, digital games can contribute to a more sustainable future.

4.2 Areas of use for sustainability games

Digital games provide an immersive and interactive learning experience for sustainability education, offering a safe space for learners to explore complex issues, experiment with different strategies, and receive immediate feedback. Games can transfer skills and foster emotional connections, motivating players to act towards sustainability.

5 Discussion

5.1 Implications of the findings for sustainability education

Digital games provide a unique opportunity for interactive sustainability education, as shown by the study's findings. Key game factors can enhance sustainability education and promote sustainable practices among students. They could be applied

in various subjects, providing educators with multiple options for incorporating them into teaching.

5.2 Challenges and opportunities for games-based sustainability education

Digital games have many opportunities for sustainability education, but there are also challenges to overcome. The lack of appropriate digital games addressing sustainability issues makes it difficult for educators to find suitable games. Additionally, educators need adequate training and resources to effectively use digital games in the classroom. Nevertheless, games-based sustainability education provides an engaging and interactive way to teach sustainability concepts and promote sustainable practices, and stimulate critical thinking and problem-solving skills, essential for addressing complex sustainability challenges.

5.3 Future research directions

This study offers insights into using digital games for sustainability education. However, more research is needed to better understand the best practices for designing and using digital games in the classroom. Future studies can explore effective game mechanics and content, digital games in various educational contexts, and the impact of digital games on student outcomes and behaviour change. Addressing these gaps can help educators enhance sustainability education and promote sustainable practices among students.

6 Conclusions

6.1 Summary of key findings

Digital games have potential for enhancing sustainability knowledge in education through effective game mechanics, incorporation of real-life experiences, and transferability of skills to real life. Furthermore, digital games have the potential to address sustainability concerns and promote sustainable practices.

6.2 Contributions of the study

This study highlights the potential of digital games for sustainability education and identifies key factors that enhance their effectiveness in an educational context. It contributes to both the field of sustainability education and educational game design.

6.3 Limitations and suggestions for future research

The study is limited by the lack of empirical data, but future research can explore digital games' effectiveness in sustainability education using virtual and augmented reality. New games can be developed and tested, and different game types' effectiveness can be studied. Overall, the study emphasizes digital games' potential as an innovative and engaging platform for sustainability education. Further research can build on these findings to create effective and engaging digital games that promote a sustainable future.

6.4 What comes next?

Future research can focus on addressing the limitations identified in the previous section to improve the effectiveness of digital games for sustainability education. This includes empirical studies to investigate their impact on enhancing sustainability knowledge and promoting sustainable practices among students, as well as exploring the potential of incorporating virtual reality and augmented reality technologies.

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