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THE IMPACT OF DIGITAL GAMES ON ENVIRONMENTAL SUSTAINABILITY

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Abstract

The research explores the influence of popular culture, with a specific focus on digital gaming, in the ongoing dialogue surrounding environmentalism and sustainability. This investigation delves into the representation of ecological themes within these games and their potential impact on public consciousness. The objective is to discern the extent to which these digital platforms shape collective attitudes regarding environmental responsibility. This detailed study seeks to unravel the complex relationship between digital gaming, corporate messaging, and the pursuit of environmental sustainability. It aims to shed light on the dynamic interplay between green policy-making, economic progress, and shifts in cultural norms. The literature review focuses mainly on naming the basic terms and principles of serious games and also on the effectiveness of these games in the area of communicating environmental issues. It is for this reason that we try to use the most up-to-date sources and studies. Anticipated outcomes of this study include a deeper comprehension of the intricate ties linking digital media, corporate strategies, and public viewpoints. This exploration will potentially foster a more sophisticated approach to addressing environmental concerns within both the corporate sphere and popular culture. The research methodically examines the strategies employed by three distinct video games and gamified mobile applications, each targeting a varied audience demographic. It highlights the differing methods employed in communicating sustainability themes to these groups, as well as the gamification elements utilized to engage and educate users.

Keywords: digital Games, educational games, environmental sustainability, game design, gamification.

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Introduction

Digital games have become powerful tools for tackling global challenges, including the climate crisis. Their interactive and engaging nature makes them particularly effective for educating audiences about environmental sustainability. Serious games, designed to combine learning with entertainment, play a significant role in this area by helping users develop skills and acquire knowledge in diverse fields, including education and culture (Din and Baig, 2023; Lima and Otero, 2024). A key element of their success lies in gamification, which uses game-like features to increase motivation and involvement in non-game contexts (Ivanyuk and Bondar, 2024). This approach transforms traditional learning methods, creating dynamic experiences that encourage problem-solving and active participation (Fiuza-Fernández et al., 2022).

Game-based learning, as part of gamification, uses multimedia tools, augmented reality, and interactive features to enhance the educational process. When applied to environmental topics, games effectively combine entertainment with education, helping players understand sustainability issues while exploring actionable solutions to complex ecological problems. These games encourage creativity, environmental awareness, and behavioral change while illustrating the interconnectedness of environmental, social, and economic systems (Boncu et al., 2022; Becklas and Bauman, 2024). However, challenges such as oversimplified concepts, limited accessibility, and a lack of real-world applicability highlight the need for ongoing improvements (Madani et al., 2017; De Salas et al., 2022). This study explores how environmental digital games can serve as impactful tools for education and sustainability, bridging the gap between knowledge and action in real-world contexts.

Current State of Knowledge

Due to the interactive, immersive and entertaining nature of digital games, many organisations use them as a tool to educate and protect the environment and to raise awareness of the problems our planet is facing as a result of the climate crisis. In this case, digital games use the help of gamification as one of the tools which communicate serious topics. We

can cover all these games by the name of serious games. The term is defined as simulation software aimed at teaching practical concepts in diverse fields such as health, education, and culture (Din and Baig, 2023) and many more. They serve dual purposes: providing entertainment while promoting learning and skill development (Lima and Otero, 2024). This is only possible thanks to gamification we have mentioned above and its positive effects on education outcomes. It is generally known that gamification involves integrating game mechanics into non-game contexts to enhance motivation, engagement, and performance (Ivanyuk and Bondar, 2024). Gamification also transforms traditional methods, notably in education, fostering interactive and enriching experiences (Christopoulos and Mystakidis, 2023). Whatsmore, it has been proven that gamification establishes clear objectives, offers feedback, and guides students in learning (Fiuza-Fernández *et. al.*, 2022). Within the concept of gamification, it is also necessary to explain the notion of game-based learning which are basically specific gamification tools used in education. Game-based learning utilizes tools like mobile apps, augmented reality, multimedia elements (audio, graphics, video, animation), and gamification features such as leaderboards and milestone trackers to enhance educational experiences. If we talk about serious games using gamification and game-based learning, which aim to educate, then these fall into the genre of educational games. The definition is very similar to serious games. Educational games are designed to facilitate learning by engaging learners in interactive experiences that enhance skills and knowledge across various subjects, promoting active participation and problem-solving (Hilliard and Kargbo, 2017). The preceding text characterizes games whose central theme is environmental issues. However, they must also meet other important parameters not only to be gamified. There have been a number of studies dedicated to the issue of ecology and preserving the environment using digital games so we can define them clearly. They try to engage players through interactive gameplay, stimulate creativity, promote pro-environmental knowledge, and encourage behavioral change while providing rewards for achieving sustainability-related tasks (Boncu *et. al.*, 2022). They also often feature exploration, slow-paced mechanics, and themes promoting sustainability (Larreina-Morales and Gunella, 2023). Digital games addressing environmental issues incorporate educational elements, suggest actionable solutions, and illustrate the interplay of environmental, social, and

economic sustainability, enhancing player understanding of climate challenges (Becklas and Bauman, 2024). They also engage learners emotionally, provide cognitive knowledge, allow testing of new behaviors, and demonstrate immediate consequences, facilitating effective attitudinal learning in Environmental Sustainability Education (Janakiraman, 2020). However, the research also found several shortcomings that educational games addressing sustainability issues have. Shortcomings include limited realism, potential oversimplification of complex issues, and insufficient engagement with real-world environmental challenges, which may hinder effective learning and behavior change (Madani *et. al.*, 2017). Another study identifies weaknesses in user feedback regarding the serious game's design and engagement, suggesting areas for improvement in future iterations to enhance environmental education effectiveness (Bauer and Weiss, 2023). Games about the environment often lack accessibility features, particularly for visual, hearing, and haptic stimuli, leading to reduced experiences or unplayability for players with disabilities (Larreina-Morales and Gunella, 2023). Systemic flaws in gameful interventions include inadequate theoretical justification for design choices, variability in evaluation approaches, and unclear evidence of long-term behavior change or effective outcomes (De Salas *et. al.*, 2022). Games may reinforce anthropocentric attitudes, leading to environmental exploitation, as players often separate ethical considerations from virtual interactions, undermining the potential for genuine pro- environmental behavior change (Ho *et. al.*, 2022). In the context of our topic, it is also important to think about the impact of playing digital games with environmental themes and whether their introduction and use is justified. Overall, environmental digital games promote dialogue and reflection on the social complexities of environmental challenges, making them a preferred educational tool over traditional methods. While changes in self-efficacy were limited, collective efficacy showed a slight increase, indicating that players recognized the importance of collaboration for achieving sustainability (Ouariachi Peralta *et. al.,* 2019). By simulating real-world situations, these games can effectively bridge the gap between theoretical knowledge and practical application, ultimately promoting greater awareness and proactive engagement (Santos et. al., 2018). Games addressing environmental issues, particularly through a problem- based learning model with gamification, enhance children's cognitive engagement and environmental awareness. They

facilitate active learning by allowing children to explore real- life environmental problems, such as plastic waste and river cleanliness, through interactive challenges and cooperative activities. This approach fosters emotional involvement, encourages teamwork, and promotes behavioral change regarding environmental stewardship. Ultimately, such games can significantly improve children's understanding of environmental issues and motivate them to participate in solutions within their communities (Syafi'udin and Kuswandi, 2020). Games addressing environmental issues also enhance more than ecology knowledge and they can support soft skills' development. Those games can reveal how strategic interactions can influence both individual behaviors and environmental states. They demonstrate that the dynamics of strategies and environmental feedbacks can lead to diverse outcomes, such as bistability, limit cycles, and dominance by specific strategies. The incentives for individuals to lead or follow changes, along with the relative speeds of environmental and strategic dynamics, significantly affect the stability of equilibria and the potential for sustainable practices. This framework enhances understanding of complex social-ecological systems and informs decision-making in fields like ecology and economics (Tilman *et. al.,* 2020). There have been several studies on the effectiveness of particular digital games about ecology. For example, by incorporating cooperative gameplay that requires players to control an animal and navigate environmental challenges, such games can enhance understanding of the impact of human behaviors on wildlife and encourage proactive measures to mitigate threats to biodiversity (Van Greevenbroek *et. al.*, 2020). The other game called "Virtual Energy Hero," can significantly enhance knowledge retention and awareness among players. Research indicates that serious games can be more effective than conventional training methods in improving understanding of sustainability topics. By utilizing immersive storytelling and gamification techniques, these games engage players emotionally, motivating them to recognize and act on environmental challenges. Furthermore, they encourage participation in community initiatives, fostering a sense of agency and responsibility towards sustainable practices within urban settings, ultimately contributing to the development of Smart Cities (West *et. al.,* 2019). On the other hand, Gamers4Nature+ project demonstrated that involving students in the creation of digital games fosters a deeper understanding of ecological themes. This engagement not only promotes environmental awareness but

also encourages the internalization of the importance of preserving nature and maintaining ecosystem balance. The project's outcomes suggest that such game-creation activities can effectively support educational stakeholders in developing impactful educational tools focused on sustainability (Beça and Aresta, 2022). Another similar project called RAISE – gamified learning environment, significantly enhance students' understanding and engagement with sustainability topics. By immersing students in realistic scenarios that reflect real-world environmental challenges, these games facilitate experiential learning and encourage proactive attitudes towards combating climate change. Preliminary feedback from students aged 10 to 15 indicates a positive reception, highlighting the educational impact and the potential for further enhancement in fostering environmental awareness and responsibility among the younger generation ((Minas *et. al.,* 2024). Games addressing environmental issues, such as the mobile game Save The Purple Frog, can significantly enhance learning outcomes, as evidenced by a strong effect size of 0.62 in a study involving UK and Indian participants. However, while these games can effectively improve knowledge about environmental topics, they do not necessarily lead to changes in behaviors or attitudes towards the environment. This highlights the potential of serious games as educational tools, while also indicating the need for further research into gameplay duration and styles to foster behavioral change (Thomas-Walters and Veríssimo, 2022). Games addressing environmental issues, such as the Virtual River Game, facilitate stakeholder participation and enhance social learning by providing a safe experimentation environment. They enable participants to collaboratively explore the complexities of environmental systems, leading to improved cognitive understanding of system functioning, intervention effects, and stakeholder dynamics. Additionally, these games promote relational learning by fostering insights into the perspectives of other participants. Overall, serious games serve as effective tools for engaging diverse stakeholders in environmental management and decision-making processes (Haan *et. al.,* 2020). Most studies reported significant improvements in knowledge and behavior after using these technologies, with some effects retained in follow-up measures. However, not all studies found a positive impact on attitudes, indicating variability in effectiveness. The most commonly targeted issues included energy efficiency and sustainable mobility, while interventions often focused on specific behaviors rather than

comprehensive approaches. Overall, these tools present a promising method for fostering environmental awareness and action (Boncu *et. al.,* 2022).

Methodology

This research employs a comparative qualitative methodology to evaluate the effectiveness of environmental education within three mobile games: *Defender of Nature* (2020) by Y-Group Games based in Bulgaria, *Trash Monsters* (2015) by Bunny & Gnome based in Germany, and *Garbage Gobblers* (2018) by Bored Monkey based in Slovakia. These games were chosen based on several criteria: they are all mobile based, freely available on Google Play, focus on key environmental issues (such as waste separation, recycling, and pollution management), and were released between 2015 and 2020, a period reflecting growing interest in sustainability and ecological awareness in mobile gaming.

The analysis was conducted through structured gameplay observation, in which gameplay features were categorized and recorded systematically to ensure consistency across all three games. The specific categories of analysis include:

1. *Thematic Depth and Environmental Engagement:* This category examines the environmental themes and narrative complexity of each game, particularly focusing on the breadth and nature of tasks related to waste management and pollution prevention.
2. *Gameplay Mechanics and Control Complexity:* This category assesses the control mechanisms within each game, such as tap-and-drag functions, speed adjustments, and strategic sorting mechanics, evaluating how these elements engage players with environmental issues.
3. *In-Game Aids and Environmental Prompts:* This category investigates the visual prompts, guidance tools, and feedback embedded in each game, considering how they assist players in understanding and engaging with environmental tasks.
4. *Environmental Complexity and Sustainability Themes:* This category focuses on the overall environmental scope of each game, assessing how it integrates a range of sustainability themes and provides players with a holistic view of ecological issues.

The study's focus on gameplay-based data collection allows for an in-depth comparison of each game's unique mechanics, themes, and player aids, revealing their impact on learning outcomes related to environmental sustainability. By selecting games from Bulgaria, Germany, and Slovakia, the analysis provides a cross-cultural perspective on mobile games addressing environmental issues, enabling insights into their global applicability as tools for corporate environmental education. The findings highlight each game's strengths in promoting waste management practices, ecological awareness, and corporate sustainability initiatives.

Findings

This part presents the findings from the analysis of three selected video games focused on environmental sustainability: *Defender of Nature*, *Trash Monsters*, and *Garbage Gobblers*. Each game is evaluated on its thematic depth, gameplay mechanics, control complexity, in- game aids, and its capacity to convey environmental messages effectively. These factors are analyzed to determine how each game might serve as a corporate tool for environmental education and training. By examining the varied approaches of each game, we uncover a spectrum of methods through which companies could engage employees in sustainability initiatives, ranging from basic awareness of waste sorting to comprehensive ecological conservation strategies.

Picture 1: Screenshots of Layout Left to Right – Defender of Nature, Trash Monsters, Garbage Gobblers
Source: Own Processing, 2024.

Thematic Depth and Environmental Engagement

The thematic complexity of the selected games varies significantly, reflecting different approaches to conveying sustainability concepts and addressing environmental issues. *Defender of Nature* stands out for its comprehensive portrayal of environmental themes. The game is set in a dual-world environment where players encounter different ecological challenges in both urban and natural settings. The upper world introduces urban spaces that require waste management, plant maintenance, and litter removal. Here, players are encouraged to engage with a broad array of sustainability tasks, such as using a garbage truck to empty waste bins, cleaning a littered playground, and restoring overgrown plants in a city park. In the lower world, players encounter a polluted river, a waste-sorting facility, and a wastewater treatment plant. These settings introduce players to water pollution control, waste sorting, and infrastructure maintenance, broadening their understanding of ecosystem interconnectedness and providing immersive experiences in ecological preservation.

For corporations looking to cultivate environmental awareness, *Defender of Nature* offers substantial depth, allowing employees to explore a variety of environmental practices within a single game environment. By involving players in multi-faceted activities across diverse settings, this game supports experiential learning, making it especially valuable for companies with a strong commitment to corporate social responsibility. Employees can benefit from understanding the interconnectedness of sustainability initiatives, as each task reinforces the impact of individual actions on broader environmental health.

In comparison, *Trash Monsters* presents a more focused but still engaging narrative centered on waste sorting and recycling. While it does not extend into broader ecosystem themes as *Defender of Nature* does, *Trash Monsters* compensates by offering two gameplay modes, Endless and Adventure, that allow different levels of player engagement. Endless mode is designed to introduce players to waste sorting directly, encouraging them to sort waste items quickly and accurately into color-coded bins. Adventure mode, however, enriches the experience by adding characters known as "monsters" who inhabit specific locations representing various aspects of waste management, such as a recycling factory, a composting swamp, and a paper recycling center. Each monster represents a different type of

waste management, guiding the player through tasks associated with recycling, composting, and incineration. This approach allows *Trash Monsters* to balance simplicity with depth, giving players insights into specialized waste management techniques without overwhelming them with multiple sustainability narratives.

Trash Monsters could be particularly beneficial for companies aiming to introduce targeted waste management training for employees. The creature-based sorting system offers an intuitive yet educational experience that emphasizes task-specific knowledge. By interacting with each monster's designated task, players are gradually familiarized with the different types of waste materials, enabling companies to use *Trash Monsters* as a structured tool for training employees in specialized waste sorting and recycling processes.

In contrast, *Garbage Gobblers* is the least complex of the three games, focusing solely on waste sorting without additional environmental themes. Unlike *Defender of Nature* or *Trash Monsters*, *Garbage Gobblers* employs a progressive level structure where players are required to sort waste for points across a series of increasingly challenging levels. While this simplicity might seem limiting, it serves a distinct purpose: introducing players to fundamental waste sorting concepts in a highly accessible manner. *Garbage Gobblers* employs a creature-based sorting system similar to *Trash Monsters* but lacks the narrative and thematic complexity of a multi-level environmental strategy. Each level in *Garbage Gobblers* focuses on accuracy and speed, reinforcing the player's waste sorting habits. This straightforward approach can be advantageous for corporations seeking to engage employees at a foundational level, such as those new to environmental education or those in need of basic training in waste sorting.

Gameplay Mechanics and Control Complexity

Gameplay mechanics and control systems play a pivotal role in shaping each game's educational potential. *Defender of Nature* employs a variety of control gestures, including tapping, swiping, and rotating, that correspond to specific environmental actions. For example, players tap on waste bins to empty them, swipe to navigate the town environment, and rotate valves in the wastewater treatment plant to stop leaks. By associating different

gestures with environmental tasks, *Defender of Nature* enhances player immersion, transforming each action into a meaningful ecological intervention. This hands-on approach makes the game particularly effective for corporations aiming to simulate real-world environmental practices in an interactive and engaging way.

In contrast, *Trash Monsters* employs a simpler control scheme focused primarily on drag-and- drop mechanics, but it introduces strategic elements that differentiate it from *Defender of Nature*. Players adjust conveyor belt speeds, use a trashdex, a sorting guide that provides information on different waste types, and summon a robotic dog to handle oversized waste. This added layer of control complexity not only heightens player engagement but also simulates the logistics of waste sorting in a more nuanced way. For corporations, *Trash Monsters* offers a middle ground between accessibility and complexity, making it a valuable tool for training employees in sorting practices that require a certain level of precision and strategic thinking.

Garbage Gobblers offers the simplest control scheme, relying solely on tap-and-drag mechanics to direct waste items to the correct monster. Its design minimizes control complexity, making it accessible for players with limited gaming experience. The simplicity of *Garbage Gobblers* aligns well with entry-level sustainability training objectives, allowing companies to introduce waste sorting concepts without requiring extensive player knowledge or skill.

By analyzing these control mechanisms, we observe that each game presents distinct levels of interaction complexity that cater to different training needs. *Defender of Nature* provides an immersive experience suitable for advanced training, while *Trash Monsters* offers a balance of simplicity and strategy that could suit intermediate-level training programs. *Garbage Gobblers*, with its straightforward controls, is ideally suited for basic environmental training, particularly for employees who may be less familiar with gaming.

In-Game Aids and Environmental Prompts

Each game incorporates unique in-game aids and visual prompts that guide players through tasks, creating learning experiences tailored to

different levels of environmental understanding. *Defender of Nature* uses visual cues such as hand icons and arrows to assist players, while also embedding environmental feedback, such as flowers blooming after watering, to indicate task completion. This reinforcement through visual indicators strengthens the player's connection to the ecological impact of their actions, fostering a sense of accomplishment and environmental responsibility. In a corporate context, such cues can facilitate exploratory learning, allowing employees to engage with environmental tasks in a structured but non-penalizing environment, which can encourage continuous learning and improvement.

In contrast, *Trash Monsters* utilizes a structured aid system through its trashdex, a comprehensive tool that categorizes waste items and helps players understand the destination of each item. Additionally, the game's scoreboard penalizes incorrect sorting by deducting points, adding a layer of accountability that encourages players to carefully consider their actions. This penalty system enhances the educational value of *Trash Monsters* by simulating the consequences of improper waste management, a concept highly applicable to corporate training. By encouraging players to make accurate decisions, *Trash Monsters* can help reinforce the importance of proper waste handling, aligning with corporate goals of reducing waste and promoting efficient resource management.

Garbage Gobblers, by contrast, simplifies guidance by displaying icons above each monster to indicate the type of waste it consumes. Without penalties for mistakes, *Garbage Gobblers* creates a low-stakes environment suitable for introductory training. While this approach reduces the educational impact compared to the other two games, it can be useful in easing employees into the basics of waste sorting without the pressure of penalties. For corporations introducing waste sorting for the first time, *Garbage Gobblers* provides a non-intimidating entry point that can build confidence in new environmental concepts.

These differing levels of in-game assistance reveal how each game tailors its guidance to match its educational objectives. *Defender of Nature* encourages independent exploration, suitable for advanced training; *Trash Monsters* fosters responsibility through structured guidance, ideal for reinforcing specific waste management skills; and *Garbage Gobblers* offers gentle support, ideal for beginners who require foundational training.

Environmental Complexity and Sustainability Themes

The environmental scope and complexity of each game offer distinct educational advantages for corporate sustainability training. *Defender of Nature* integrates a wide array of sustainability activities, such as waste management, water conservation, and ecosystem restoration, within an immersive game world. This variety provides a holistic view of environmental issues, making it ideal for companies committed to comprehensive sustainability programs. By exposing employees to multiple ecological themes, *Defender of Nature* fosters an awareness of how different sustainability practices contribute to broader environmental health, aligning with corporate efforts to promote ecological literacy among employees.

Trash Monsters focuses more narrowly on waste management but achieves educational depth by organizing tasks around waste-specific locations, each associated with a unique creature. This creature-based structure provides a memorable and engaging way for players to understand specialized waste management practices. For corporations that wish to implement waste reduction and sorting initiatives, *Trash Monsters* offers a structured approach that reinforces task-specific knowledge. The game's modular design allows for a more targeted training approach, making it an ideal choice for companies looking to train employees on specific waste streams, such as recycling or composting.

In contrast, *Garbage Gobblers* simplifies the environmental narrative, remaining focused solely on waste sorting. This closed-loop level structure reinforces sorting habits by encouraging players to assign waste to the correct creatures. Although *Garbage Gobblers* lacks the thematic complexity of the other two games, its simplified focus makes it suitable for companies aiming to raise basic awareness around waste sorting. By emphasizing accuracy and repetition, *Garbage Gobblers* builds foundational sorting skills without the need for complex narrative structures.

The varied thematic depth, control complexity, in-game guidance, and environmental narratives of these games reveal a range of opportunities for corporate training. *Defender of Nature* provides an expansive, exploratory experience suited to advanced sustainability programs, while *Trash Monsters* offers a focused, creature-driven approach that is ideal for task-specific waste management training. *Garbage Gobblers*, with its straightforward

gameplay, provides an accessible entry point for foundational environmental education. By aligning the selection of each game with specific corporate objectives, companies can engage employees in meaningful sustainability education, fostering environmental awareness and responsible behavior within the workplace.

Table 1: Findings Based on Game Categories

Category	Defender of Nature	Trash Monsters	Garbage Gobblers
Thematic Depth and Environmental Engagement	Dual-world, diverse tasks, pollution control, restoration.	Waste sorting, character-driven, recycling focus.	Simplistic, basic sorting, no narrative depth.
Gameplay Mechanics and Control Complexity	Tapping, swiping, rotating, immersive mechanics.	Drag-and-drop, conveyor belts, trashdex, penalties.	Tap-and-drag, beginner-friendly, minimal complexity.
In-Game Aids and Environmental Prompts	Visual cues, blooming flowers, reinforced actions.	Trashdex guidance, feedback, error penalties.	Icon above characters, no penalties, low-stress.
Environmental Complexity and Sustainability Themes	Interconnected systems, wide range, sustainability focus.	Task-specific, waste management, specialized themes.	Limited scope, foundation knowledge, narrow focus.

Source: Own Processing, 2024.

The table organizes the findings from the games *Defender of Nature*, *Trash Monsters*, and *Garbage Gobblers* into four key areas: thematic depth, gameplay mechanics, in-game aids, and environmental complexity, using concise keywords to capture their unique features. *Defender of Nature* stands out with its dual-world setting and diverse ecological tasks, while *Trash Monsters* offers a focused, character-driven narrative around recycling, and *Garbage Gobblers* takes a simpler approach with limited narrative depth. In terms of gameplay, *Defender of Nature* uses immersive gestures like tapping and swiping, *Trash Monsters* introduces drag-and-drop mechanics paired with strategic elements, and *Garbage Gobblers* opts for basic, beginner- friendly controls. Regarding in-game aids, *Defender of Nature* provides detailed visual feedback to reinforce actions, *Trash Monsters* offers structured guidance with error penalties, and *Garbage Gobblers* uses icons for prompts without penalties, creating a low-pressure learning environment. Lastly, in terms of environmental complexity, *Defender of Nature*

covers interconnected sustainability systems with a broad scope, *Trash Monsters* focuses on task- specific waste management, and *Garbage Gobblers* limits itself to foundational knowledge.

Conclusion

In conclusion, digital games addressing environmental issues, often categorized as serious games, demonstrate significant potential in fostering environmental awareness, education, and behavior change. By combining immersive gameplay with educational content, these games effectively engage users with pressing environmental issues. The incorporation of gamification, integrating game mechanics like rewards, leaderboards, and interactive tasks helps to motivate players while enhancing learning outcomes, especially within corporate settings where environmental responsibility is increasingly prioritized.

This research highlights the impact of three distinct games: *Defender of Nature*, *Trash Monsters*, and *Garbage Gobblers*, which serve as valuable examples of environmental education tools. However, certain limitations must be noted. The study's narrow focus on these three games, while providing detailed insights, limits the generalizability of its findings across the broader genre of environmental games, which vary significantly in mechanics, narratives, and target demographics. Consequently, the conclusions drawn may not fully apply to games with different styles or cultural contexts. Additionally, this research uses a qualitative methodology, focusing on in-depth gameplay analysis but lacking quantitative measures of behavior change or knowledge retention. This limits our understanding of the long-term effectiveness of these games in promoting pro-environmental attitudes and behaviors.

Despite these constraints, the games examined present various approaches to environmental education, each catering to different training levels and objectives. *Defender of Nature* offers comprehensive experience, engaging players in multi-layered tasks that span urban and natural settings, making it suitable for advanced corporate training programs with a focus on ecological literacy. *Trash Monsters* provides a character-based sorting system and structured waste management tasks, serving as an effective tool for companies aiming to develop specialized waste handling skills among

employees. *Garbage Gobblers*, with its straightforward, penalty- free gameplay, offers a basic introduction to waste sorting concepts, making it ideal for corporations beginning their environmental awareness initiatives.

The impact of these games extends beyond mere awareness, as they foster collaborative attitudes and personal responsibility among players. However, limitations such as potential oversimplification of complex ecological issues and accessibility concerns may hinder the full effectiveness of such games. Moreover, without quantitative data on the games' impact on behavior change and knowledge retention, the long-term value of these games in promoting real-world pro-environmental behaviors remains uncertain.

Future research should aim to expand this analysis by including a wider array of games and incorporating longitudinal, quantitative studies to assess knowledge retention and behavior change more accurately. Despite these research limitations, digital environmental games hold promising potential as tools for corporate sustainability initiatives and as an engaging means of cultivating ecological responsibility and awareness. By selecting and aligning games to meet specific corporate training objectives, organizations can effectively foster environmental literacy and proactive attitudes within their workforce. Through simulating real-world sustainability challenges, these games can bridge the gap between theoretical understanding and practical application, demonstrating the broader value of gamified learning experiences in addressing complex global issues.

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UTJECAJ DIGITALNIH IGARA NA EKOLOŠKU ODRŽIVOST

Sažetak

Ovo istraživanje proučava utjecaj popularne kulture, s posebnim naglaskom na digitalne igre, u okviru suvremenog dijaloga o ekologiji i održivosti. Analizira se prikaz ekoloških tema unutar digitalnih igara i njihov potencijalni utjecaj na javnu svijest. Cilj je istražiti u kojoj mjeri ove digitalne platforme oblikuju kolektivne stavove o ekološkoj odgovornosti.

Ova detaljna studija nastoji razjasniti složen odnos između digitalnog igranja, korporativnih poruka i težnje prema ekološkoj održivosti. Također, istraživanje naglašava dinamičnu povezanost između ekoloških politika, ekonomskog razvoja i promjena u kulturnim normama. Pregled literature fokusira se na definiranje osnovnih pojmova i principa ozbiljnih igara (serious games), kao i na njihovu učinkovitost u komunikaciji ekoloških problema. Iz tog razloga korišteni su najnoviji izvori i studije kako bi se osigurala relevantnost analize. Očekivani rezultati istraživanja uključuju dublje razumijevanje povezanosti između digitalnih medija, korporativnih strategija i stavova javnosti. Ova analiza mogla bi doprinijeti razvoju sofisticiranijih pristupa ekološkim pitanjima u korporativnom sektoru i popularnoj kulturi. Istraživanje sustavno analizira strategije triju različitih videoigara i igrificiranih mobilnih aplikacija, koje su usmjerene na različite demografske skupine. Poseban naglasak stavlja se na različite metode komunikacije tema održivosti, kao i na elemente igrifikacije koji se koriste za angažiranje i edukaciju korisnika.

Ključne riječi: digitalne igre, dizajn igara, edukativne igre, ekološka održivost, igrifikacija