Designing and Developing Digital Computer Game of Plastic Waste Awareness for Young Children

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Abstract— providing education about how to behave or make decisions using game media will enable children to develop positive attitudes in dealing with waste problems which increasingly require our thoughts together. The design method through the stages of observation in the form of visual data search, analysis elaboration mapping problem, then visually determining the essential character as the main idea. The result is a character design with the function that allows player to know the existence of the threads. The game is made to arouse the interest of the players about anticipating plastic waste. This game is made in a 2-dimensional form which conveys information regarding the condition of the plastic waste which is described as attacking and filling the sea. Thus, actions will appear that will foster a sense of care for environmental cleanliness. The prototype of digital computer game was developed using scratch. The result of this prototype will be used for next development.

Keywords—game design, plastic waste

I. INTRODUCTION

Playful interactive systems, gamification and digital or hybrid games are emerging approaches that have been used to inform, educate and change people's behavior about environmental problems related to ecological sustainability Emerging strategies like playful interactive systems, gamification, and digital/hybrid games are increasingly utilized to educate, engage, and drive behavioral shifts concerning environmental issues tied to ecological sustainability. These innovative methods leverage entertainment and interactivity to convey crucial information, fostering a deeper understanding of ecological challenges and encouraging proactive actions for a greener future[1] . Persuasive technologies and ecologically-focused gamification approaches enrich game and interaction design techniques through involving and motivating users to act while at the same time disseminate critical information about the effects of human intervention to nature. Incorporating persuasive technologies and ecologically-focused gamification strategies enhances the landscape of game and interaction design techniques. These innovative approaches not only captivate users but also drive meaningful engagement by motivating them to take proactive steps. Simultaneously, these techniques serve as powerful conduits for imparting essential insights into the consequences of human intervention on the natural world. By weaving persuasive elements into the fabric of digital experiences, users are enticed to participate, learn, and act in environmentally responsible ways. This synergy between technology, gamification, and ecological awareness generates a harmonious blend where information dissemination seamlessly coexists with user motivation. The result is an empowered user base that not only comprehends the intricacies of ecological sustainability but also embraces a shared responsibility to protect and restore the environment. In this dynamic paradigm, technology becomes an enabler of positive change, propelling society towards a more balanced and symbiotic relationship with nature.

Numerous recent scientific studies have resulted in strong indications about the value and effectiveness of interactive technologies and games in education and sensitization about environmental issues [2]

With a population of 250 million, Indonesia finds itself among the four most heavily polluted nations globally, trailing only China in plastic waste production. Each year, the country grapples with an overwhelming 3.2 million tons of untreated plastic waste, a staggering 1.29 million tons of which finds its way into the oceans, tarnishing marine ecosystems. Amplifying this crisis, approximately 10 billion plastic bags, totaling 85,000 tons, inundate the environment annually.[3] This dire situation underscores the urgent need for comprehensive waste management strategies and heightened environmental awareness. Mitigating this ecological crisis demands collective action on multiple fronts: advocating for reduced plastic consumption, promoting recycling infrastructure, and fostering sustainable behaviors. By addressing this pervasive issue head-on, Indonesia can strive towards a cleaner, healthier future while serving as a model for global environmental stewardship.[1]

Ongoing and persistent efforts are directed towards addressing waste issues, with a special emphasis on plastic waste. Demonstrating unwavering commitment, the government acknowledges the paramount importance of this cause, engaging in proactive measures to discover impactful solutions that enhance both the environment and society. The approach involves a multi-faceted strategy spanning short, medium, and long-term actions. While governmental initiatives play a pivotal role, it is equally crucial to bolster public awareness campaigns. Empowering individuals to make conscious choices about plastic usage in their daily lives

becomes pivotal. By fostering a collective sense of responsibility, citizens can actively contribute to the reduction of plastic waste. Thus, a synergistic interplay of official endeavors and citizen involvement is essential in crafting a sustainable future marked by decreased plastic consumption and heightened environmental consciousness.[3]

Programs that are carried out in the long term are education, communication and outreach programs. Educating about this matter specifically for the younger generation and encouraging them to be supportive of environmental sustainability will be a solid foundation in achieving this goal.[2]

Initiating education for young individuals from an early stage holds the key to nurturing not only their knowledge but also their conscious awareness, fostering a proactive stance towards environmental concerns. By instilling environmental values and understanding in the formative years, we pave the way for a future society marked by a pervasive commitment to sustainable practices. Equipping young minds with the tools to comprehend the intricate interplay between human actions and their impact on the planet empowers them to make informed decisions.

Such foundational education ignites a positive attitude towards environmental sustainability, spurring a collective consciousness that transcends generations. As these youngsters grow into responsible citizens, they carry forward this ethos, catalyzing a ripple effect that shapes eco-friendly policies, innovations, and lifestyle choices. Thus, investing in early environmental education becomes an investment in the very fabric of a society that not only possesses the knowledge but also the innate inclination to safeguard our planet for years to come. Providing education for young people from an early age so that they not only have knowledge but awareness to act proactively on environmental issues will shape a future society that has a positive attitude towards environmental sustainability. [4]

Computer games are increasingly popular, and, in some situations, are important in our society and keep growing in our industry. The rising popularity of computer games is an undeniable phenomenon that holds significant relevance in contemporary society. As a form of entertainment and interactive engagement, computer games have transcended mere pastime status to become influential cultural artifacts. Their impact is particularly pronounced in sectors like education, healthcare, and business, where gamification strategies enhance learning, therapy, and consumer engagement.

In the gaming industry, this trend is underscored by continuous growth and innovation. Evolving technology and creative advancements propel game development, resulting in immersive experiences that captivate diverse audiences. Moreover, the economic weight of the gaming industry is undeniable, generating substantial revenue and contributing to technological progress.

This intersection of popularity, utility, and economic clout positions computer games as more than mere diversions. They are transformative tools with the potential to shape perceptions, influence behaviors, and inspire novel approaches across various domains. As computer games continue to evolve, their role in society becomes increasingly integral, inviting both entertainment enthusiasts and various stakeholders to explore the multifaceted dimensions of this dynamic medium. [5]

This research aims to develop a digital computer game centered on environmental awareness, serving as a catalyst for users to adopt the practice of environmental cleanliness through engaging gameplay. The envisioned game not only imparts knowledge but also hones cognitive processes, fostering a habitual inclination towards responsible waste disposal and recycling. By navigating the virtual world of waste sorting and reduction, players are immersed in scenarios that simulate real-life challenges, enhancing their decision-making skills in waste categorization and encouraging judicious plastic usage. This initiative offers environmental educators a tangible approach beyond conventional methods reliant on attitudes and theoretical understanding. By merging education with interactive entertainment, the game strives to instill genuine behavioral change, empowering users to become proactive agents of environmental preservation, leading to a cleaner, more sustainable future.

This digital game is to invite young children to appreciate nature. This media is designed to write stories about waste cases in Indonesia which are packaged with digital computer games aimed at children aged 6-9 years. The expected end result is a media that has a message to reduce waste.

The benefits that will be obtained after the target is exposed to the information conveyed are:

- Children are more aware of the threat of waste.
- Children are careful to treat environmental conditions related to waste
- Gradually reducing waste.

II. THE COMPUTER GAME'S DESIGN AND DEVELOPMENT

A. Methodology

The initial phase involves delineating the design problem and identifying the specific needs of the target audience. By comprehensively defining the challenges and constraints at hand, a clearer perspective emerges, enabling the formulation of more precise and effective solutions[6,7]. This step is pivotal, as it establishes the foundation upon which the entire project will be built. Gaining a profound understanding of the intricacies of the problem enhances the ability to tailor solutions that align seamlessly with the project's objectives.

In this stage, the criteria for success are outlined. By setting specific benchmarks and goals, the path towards achievement becomes more tangible. This meticulous planning ensures that all subsequent efforts are purposeful and directed, minimizing the risk of veering off course. Ultimately, this phase lays the groundwork for the project's success by harmonizing the design problem, audience needs, and project goals into a cohesive blueprint that guides the subsequent stages of development. The research stage reviews information such as the history of the design

problem, end-user research and opinion-led interviews, and identifies potential obstacles. Ideate is the stage where end-user motivations and needs are identified and ideas are generated to meet these, perhaps through brainstorming. Prototyping sees the resolve or working-up of these ideas, which are presented for user-group and stakeholder review, prior to being presented to the client. Selection sees the proposed solutions reviewed against the design brief objective[3]. Some solutions might be practical but may not be the best ones. Implementation sees design development and its final delivery to the client. Learning helps designers improve their performance and, for this reason, designers should seek target audience feedback and determine if the solution met the goals of the brief. This may identify improvements that can be made in the future.[4]

1. Identify problem– the proponents included this phase which the processes related to initiation of the proposed project like create the project vision, identify the users, developmental of a game, sprint backlog and conduct release planning.
2. pre production - the proponents included this phase which consists of processes related to planning and estimating the tasks of the proposed project which include on how to create user stories, how to approve, estimate, commit user stories, create tasks, estimate tasks, and create sprint backlog.
3. Production and post production–the proponents included this phase which is related to the execution of the tasks and activities to create a project's product.
4. Learning - the proponents included this phase which is concerned with reviewing the deliverables and the work that has been done and determining ways to improve the practices and methods used to do to the proposed project.
5. release - the proponents included this phase which is emphasizes on delivering the output to the client and identifying, documenting, and internalizing the lessons learned while doing and finishing the proposed project.

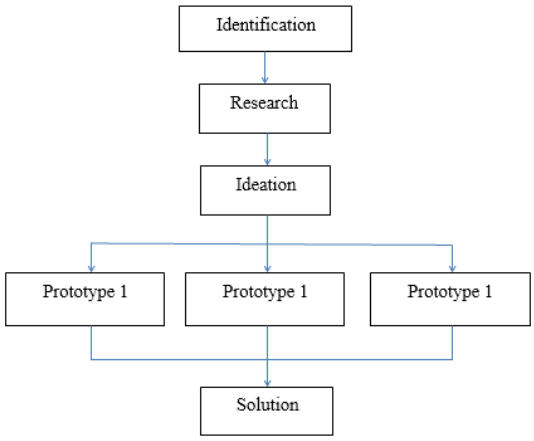

Fig. 1. Design process

B. Graphical user interface design

Fig. 2. Main menu

. In Figure 2, the proponents present their conceptualization for the main menu of the proposed game. The layout features key elements, including a "Play" button, an "Options" button, and an "Exit" button. The "Play" button serves as the gateway to initiate gameplay, seamlessly guiding users into the immersive world of the game. Conversely, the "Exit" button provides a quick means to close the game, ensuring user convenience. The inclusion of an "Options" button hints at potential customization or settings, where players might fine-tune their gaming experience according to preferences.

This main menu design showcases an intuitive interface, prioritizing ease of navigation and accessibility. Its simplicity aligns with user expectations, allowing for swift interactions without unnecessary complexity. By offering clear choices for gameplay, customization, and exit, the proponents have strategically designed a menu that provides a seamless and user-friendly entry point into their envisioned gaming experience.

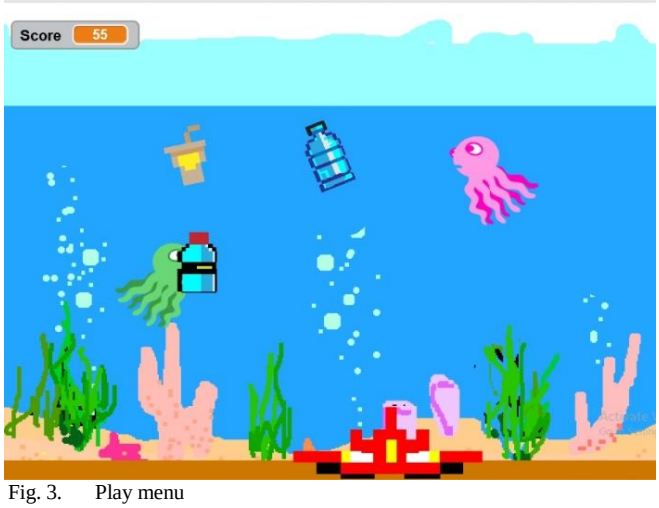

Fig. 3. Play menu

Figure 3 shows the idea of the proponents to start the game and how the game process. If you click the help button, it shows the guide and instructions of the game. The play button will direct you to the game which you will shoot the trash.

C. Scratch

Scratch is the world's largest coding community for children and a coding language with a simple visual interface that allows young people to create digital stories, games, and animations. Scratch is designed, developed, and moderated by the Scratch Foundation, a nonprofit organization.

Scratch promotes computational thinking and problem solving skills; creative teaching and learning; self-expression and collaboration; and equity in computing.

Scratch is always free and is available in more than 70 languages.

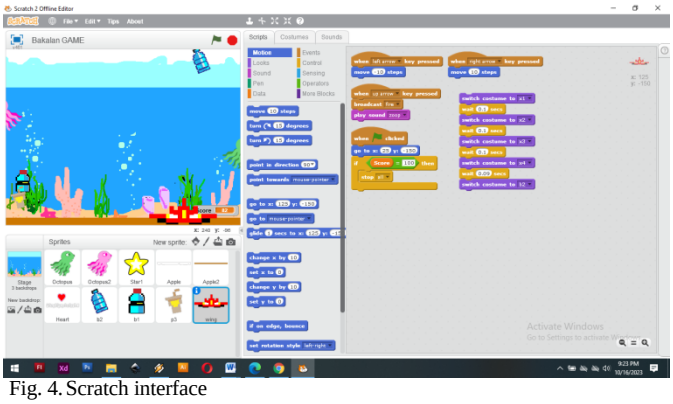

Fig. 4. Scratch interface

D. Game assets

Fig. 5. Assets and sprites

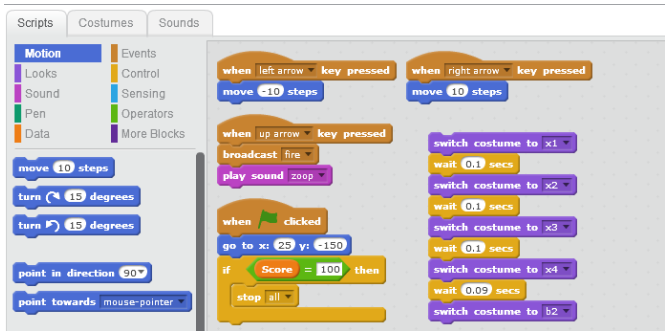

Fig. 6. Script.

III HOW TO PLAY THE GAME

In the initial stage of the game, players will engage in shooting targets resembling falling trash, aiming to prevent them from reaching and sinking to the seabed. A successful hit on a target awards the player an additional 10 points, reinforcing the concept of waste interception and encouraging proactive participation in environmental cleanup.

Advancing to the next stage, players are tasked with shooting at targets to earn points. However, an added layer of complexity is introduced: if any of the descending garbage touches the seabed without being intercepted, 5 points are deducted. This dynamic encourages players to not only hit the targets accurately but also to prevent waste from reaching the aquatic environment.

The subsequent stage adds another dimension of challenge. If any of the falling trash makes contact with the seabed, the player's score is penalized by 10 points. Moreover, shooting at swimming animals incurs the same 10-point deduction, emphasizing the importance of not harming marine life while combating pollution.

As the game draws to a close, players are presented with a choice to either exit or replay the game. This structure enhances engagement and enables players to continuously refine their skills and strategies. By gamifying environmental awareness and incorporating consequences for both missed targets and inadvertent harm to animals, the game serves as an effective tool to educate players about waste management, ecological preservation, and responsible decision-making.

IV. END GAME AND WINNER

The culmination of the game occurs under two distinct circumstances. The first is when a player achieves a score of 100 points, signifying their adeptness at tackling the challenges presented. Conversely, the game also concludes if a player's score dips to -50 due to point deductions. These thresholds add an element of suspense and strategy, compelling players to aim for positive scores while avoiding pitfalls that could lead to negative outcomes.

Upon reaching a score of 100 points, a player gains automatic access to the next stage, presenting an opportunity for heightened difficulty and further skill development. This feature caters to players seeking extended engagement and challenges, ensuring a seamless transition for those who wish to continue their environmental awareness journey. Players are also given the freedom to opt out if they decide to conclude their gaming experience.

Conversely, when a player's score plummets to -50, they are presented with a choice: to either replay the game or to exit the game. This decision reinforces the educational aspect of the game by encouraging players to learn from their mistakes and make more informed decisions in subsequent attempts.

As an added incentive, players who achieve a score of 100 are rewarded with a service mark, symbolizing their success in mastering the game's challenges. This recognition not only acknowledges their accomplishment but also serves as a tangible reminder of their commitment to environmental stewardship. By intertwining these elements, the game fosters engagement, learning, and a sense of achievement, underscoring its efficacy in promoting environmental awareness and responsible decision-making [9]

Fig. 7. Game finished

V. Result and Discussion

This study presents the designing and developing of an educational computer game to improve awareness toward waste in childrens. The "trash invaders," which aims to making choices and performing action is a simple and effective way to achieve this goal. Games have been suggested to be most effective and have long-term positive outcomes in children seven years and older.[9] We present the design and development of digital games for children about plastic waste pollution, one of the biggest environmental problems facing the world, because large amounts of waste and microplastics have a serious impact on animals and plants in the ocean, and on ultimately, on human health. The need to make changes to people's consumption habits makes education a priority for the next generation of consumers to enable a consistent pro-environmental transition. The aim of the game is:

- to raise awareness about the destruction of marine ecosystems,
- to provide knowledge about how and to what extent human activities contribute to the phenomenon, and
- to encourage behavior that can help reduce adverse impacts on the environment.

This goals are set after considering the sophistication of games regarding similar topics, as well principles of environmental education and the main scientifically based factors that contribute to them behavioral changes in humans. These games can be effective as a stand-alone entity, although in practice, the use of this game can also be in the form of competition considering that in this game there are stages that have different levels of difficulty.

Conclusion

Moving forward, an essential trajectory involves evaluating the game's validity and user acceptance. This assessment seeks to ascertain whether the game effectively fulfills its intended educational purpose and if it resonates with the target audience. Additionally, feedback from players spanning various age groups will play a pivotal role in guiding improvements to the game. This iterative process aims to enhance gameplay mechanics, content, and overall user experience, aligning the game more closely with the preferences and needs of its players.

As the landscape of educational gaming evolves, rigorous research and ongoing refinement are imperative to substantiate the efficacy and feasibility of using such approaches to promote healthy behaviors. Ultimately, this effort not only contributes to the advancement of game-based education but also has the potential to shape how we harness technology to facilitate positive behavioral changes across diverse populations

The researchers were able to create an 2D computer educational game that can provide certain information about waste, shows the awareness on how to properly keep the environment clean. Another possible change to be implemented regards the graphics, as for a quick development of the game concept, we used a simple 2D environment. However, children of our target age group would potentially appreciate a different (and immersive) style as compared to the one shown in the prototype. Hence, the aesthetic is certainly one of the aspects to investigate in future steps, when target users will be involved Its existence, which was initiated due to technological limitations, has now become a challenge to creativity.

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