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# Plastopoll: A Serious Game to Raise Awareness About Plastic Pollution

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**Abstract**— Plastics are widely used due to their durability, versatility, and affordability. However, their excessive and improper use has resulted in a significant build-up of plastic waste, especially in Malaysia. This plastic pollution poses a significant threat to wildlife, with millions of animals suffering harm or death from ingesting or becoming entangled in plastic debris. To address this, this project introduces a serious game application that may assess students' understanding, raise awareness about plastic pollution, and promote environmental protection through an enjoyable learning experience. Furthermore, the Rapid Application Development (RAD) methodology, which consists of four phases, was chosen for the project due to its efficient and rapid development process, allowing for quick production and deployment of the game. The Knowledge, Attitude, Practice (KAP) scoring with an 80% cut point is used to determine participants' levels of knowledge, attitude and practice regarding plastic pollution. Additionally, the findings from 40 respondents, especially among male participants aged 7 to 12 years old, indicated raised knowledge, attitude and practice. This suggests that the Plastopoll game effectively assesses students' understanding of plastic pollution. However, further research with a larger and more diverse group of participants may be necessary to validate and expand on these findings.

**Keywords**— *Game-Based Learning, Plastic Pollution, Educational Technology*

## I. INTRODUCTION

Plastics are made of synthetic organic polymers and are durable, lightweight, versatile, and relatively inexpensive to produce, making them one of the most widely used materials [1]. Our daily lives rely heavily on plastic, which can be found in everything from cutlery, and supermarket bags to water bottles and sandwich wraps. However, our desire for convenience has gone too far, and we are wasting resources and endangering the environment by improperly using plastics [2].

There are too many plastics that have accumulated in the environment. According to a study published in the academic journal Science, Malaysia is the eighth worst country in the world for plastic waste. Malaysia is estimated to have created between 0.14 and 0.37 million tonnes of plastic waste that drifted into the oceans in 2010 [3]. In addition, [4] stated that the accumulation of plastic in the oceans and its breakdown into micro- and nano-plastics can make contamination more likely. According to a report by [5], plastic had become a persistent pollutant in many parts of the environment by the end of the 20th century. This includes the summit of Mount Everest as well as the depths of the ocean. Plastics are becoming increasingly known as large-scale pollutants for many reasons, including that some animals mistake them for food, block drainage systems, low-lying flood areas, and more.

Since plastics have become a large-scale pollutant, it kills millions of wildlife, from birds to fish to other aquatic organisms. Research shows that 693 species have been exposed to plastic debris, with nearly 400 of them getting caught in it or eating it. An animal that does not pick and choose what it eats, like a sea turtle, might mistake a plastic bag for food. Sea turtles are unable to differentiate between their usual prey, such as jellyfish, and man-made objects, such as plastic bags. As a result, their bodies are unable to endure the damage and danger caused by these man-made products when they are ingested [6]. Thus, this situation has proven how harmful plastic pollution can be.

In Malaysia, many businesses and restaurants have taken steps to reduce plastic usage as part of an awareness campaign to reduce plastic pollution. For example, some restaurants have switched to reusable containers and utensils for takeaway orders. Even though people are aware of plastic pollution, they still need to learn and do more. This can be a good start if awareness is being promoted towards education. Environmental education is essential for promoting environmental awareness because it teaches students how to protect the environment and can raise students' awareness of plastic pollution [7][8]. Since the current generation of students has been called "digital natives" due to their apparent familiarity and comfortability with digital technologies [9], it has been shown that the fun and excitement of gaming can keep students interested [10]. Therefore, this project presents the application of a serious game that can be used to make students more aware of plastic pollution's damage to the environment. As a result, students can be aware of the harmful effects of plastic pollution and learn new things while having fun.

## II. LITERATURE REVIEW

Every year, roughly 513 million tons of plastic end up in the oceans, with the following 20 countries accounting for 83.1% of the total: China is the most mismanaged plastic waste polluter, accounting for 27.7% of the global total, followed by Indonesia with 10.1%, the Philippines with 5.9%, Vietnam with 5.8%, Sri Lanka with 5.0%, Thailand with 3.2%, Egypt with 3.0%, Malaysia with 2.9%, Nigeria with 2.7%, Bangladesh with 2.5%, South Africa with 2.0%, India with 1.9%, Algeria with 1.6%, Turkey with 1.5%, and Pakistan with 1.5% [11][12]. According to [13], the rest of the world's countries account for 16.9% of the mismanaged plastic garbage in the oceans. At the global level, the Asian continent is the most responsible for plastic trash generation and pollution. For example, the top five regions generating plastic waste in 2015 were Asia (82 million tons), Europe (31 million tons), Northern America (29 million tons), Latin America and Africa (19 million tons). Plastics can have serious environmental consequences if they are not used properly. In addition, plastic pollution also poses threats to the marine environment, the land, and human health.

Plastic pollution is caused due to the increasing accumulation of plastic waste material in the environment (Drowning in Plastics - Marine Litter and Plastic Waste Vital Graphics, 21 C.E.) There are many factors that contribute to plastic pollution. Among them is the overuse of plastic, fishing tools and littering.

The amount of plastic produced and the variety of this material have increased alongside the plastics industry's expansion. In this situation, the things that cause pollution have spread to many countries, industries, and product groups [14]. People use this variety of plastics without considering the fact that it creates a lot of waste that is impossible to manage [15]. Because of this, besides being the most used in the world, plastic is seen as one of the most dangerous things for the environment [16].

To summarize, plastic pollution harms all living things in this world, from the ocean to land living things. Nonetheless, many responsible organizations in all countries have taken steps such as passing legislation, running awareness campaigns, and other initiatives to help reduce the amount of plastic pollution. Game-based technology is believed as an effective medium to attract more young people, especially students and educate them at the same time to be more aware of plastic pollution. Therefore, this is in line with the proposed pedagogical theory. This project proposes a serious game with the objective of spreading awareness regarding the impact of plastic pollution. A suitable methodology, which is the RAD model, also has been chosen for this project due to its rapid iterations and simple flows.

## III. METHODS

The RAD methodology was chosen for this project because it requires four phases, which are Requirement Planning, User Design, Construction, and Cutover. Each phase has its own job in developing this project, which is excellent for making a game that needs to be made quickly and put out quickly. Flowcharts and low-fidelity storyboards are examples of visual prototypes that can be used with the RAD model to make projects quickly and easily. Also, this RAD technique is helpful because it requires less planning and lets the project quickly build, test, and iterate on new features and functions. A survey is conducted towards participants who are students between the ages of 7 to 12 years old at Sekolah Rendah Arab (JAIM) Pernu, Melaka. They participated in testing by playing the game that had been shared with them using the game link. A sample size of 40 volunteers within the target user age range participated in the game evaluation.

To provide an overview of the project's progression, this section will outline the overall process based on the phases of Rapid Application Development (RAD) followed in the development of the game project flow. The first process involves creating a game using a flow chart, which serves as a guide for the entire game process, from start to finish. The upgraded flowchart is very important as it provides detailed instructions for the game development process.

Next, create a storyboard. Initially, low – fidelity storyboard was used as a rough idea. However, high – fidelity storyboard incorporates more detailed interfaces required for the game, where it has a more detailed design. The purpose of the high–fidelity storyboard is to present a more detailed game interface flow.

Furthermore, the next process is the game-designing process. The software and hardware requirements specified in this report are used to design the characters, all in-game items, buttons, the background environment, sound effects and music.

After the game has been designed, the implementation of code functions ensures smooth gameplay. Every scene of the game and its gameplay script are fully coded and developed, and then thoroughly reviewed. Then, the game will undergo several rounds of testing before being deployed through a website link where it can be played.

#### IV. RESULTS AND FINDINGS

The KAP survey is used to assess the understanding based on knowledge, attitude and practice, resulting in increased knowledge and awareness of the impact of plastic pollution. The KAP survey used in this project is based on [17] and is used to evaluate the understanding among students through this Plastopoll game. A total of 40 respondents aged between 7 to 12 years old participated in filling out this survey. The structured questionnaire has been adapted and finalized, consisting of 18 multiple-choice questions divided into four sections, (1) demographic information (2 questions), (2) knowledge (5 questions), (3) attitude (6 questions), and (4) practice (5 questions). This adapted questionnaire is used for the evaluation of the project.

To analyze the data, this project used a variety of statistical analyses including descriptive statistics (frequency and percentage), KAP scoring and cross-tabulation. To summarize the questionnaire responses, descriptive statistics such as frequency and percentage are used. A scoring system is implemented for KAP scoring, with respondents receiving 1 mark for the “Yes/Ya” responses, 0.5 mark for “Maybe/Mungkin” and “Sometimes/Kadang-kadang”, and 0 mark for “No/Tidak” responses. To determine KAP status, the data were calculated for each respondent's total score, using an 80% cut point to distinguish between respondents and determine their “good” and “poor” status. All the data were analysed using the Microsoft Excel Software.

A total of 40 respondents participated in filling up the survey. According to the results, the highest frequency of respondents is from males, representing (62.5%) of all respondents, while the remaining respondents are female, accounting for (37.5%). Additionally, the majority of the respondents (45%) were from the age of 12 years old, followed by (25%) who were 10 years old, (15%) who were 11 years old, and identical results (5%) for respondents aged 7 to 9 years old.

#### V. CONCLUSIONS

To conclude, “Plastopoll: A Serious Game to Raise Awareness about Plastic Pollution” successfully raised awareness about the impact of plastic waste issues among students aged 7 to 12 years old. However, the project encountered limitations such as software issues during design, difficulties in gathering enough respondents for evaluation, and reliance on strong internet connectivity for web access. Exploring alternative software, expanding data collection, providing offline access, and refining the evaluation questionnaire will improve the game's impact in raising awareness and promoting sustainable behaviour to combat plastic pollution effectively in the future.

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