

Interactive PowerPoint Based on Game-Based Learning on Environmental Pollution for Junior High School Students

Suhartatik Suhartatik¹, Shinta Permata Sari¹, Maysara Maysara², Eka Nurul Qomaliyah^{*1}

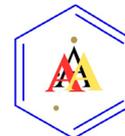
¹Department of Sciences Education, Faculty of Mathematics and Natural Sciences, Universitas Negeri Malang, East Java, Indonesia

²Department of Chemistry Education, Faculty of Teacher Training and Education, Universitas Haluoleo, Southeast Sulawesi, Indonesia

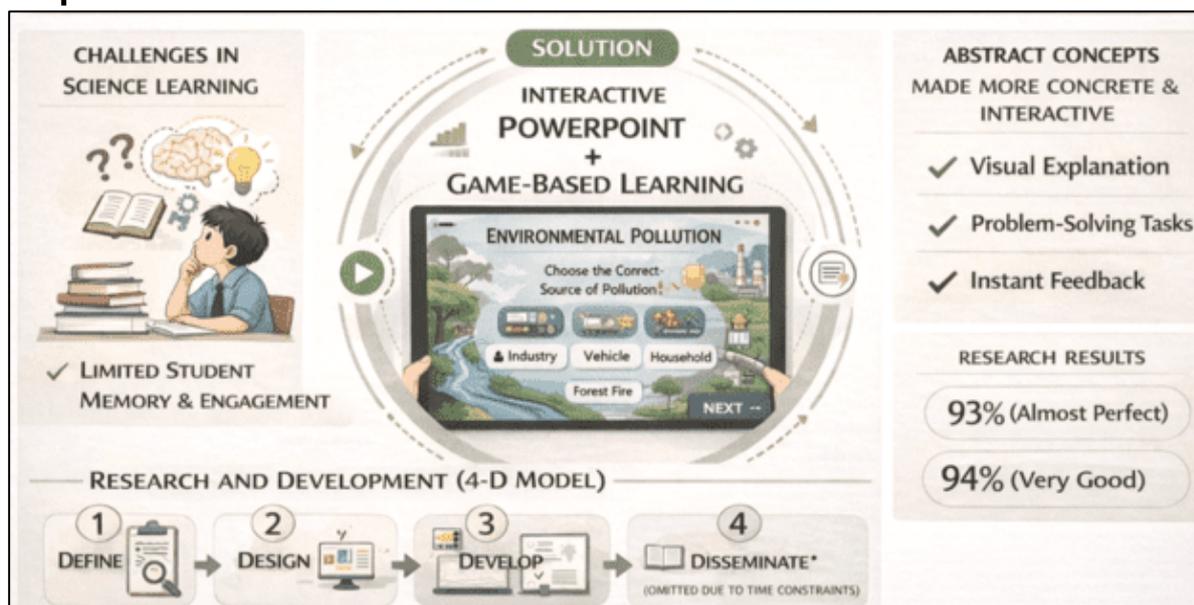
**Corresponding author: eka.nurul.fmipa@um.ac.id*

Abstract: This research aims to develop an interactive PowerPoint-based learning media using Game-Based Learning (GBL) for junior high school students on environmental pollution. The method used is Research and Development (R&D) with a 4-D development model, which includes the stages of Define, Design, Develop, and Disseminate. However, the Disseminate stage was not implemented due to time constraints in the research. The media validation was conducted by three experts, comprising two science education professors and one junior high school science teacher, while the readability test was conducted with 18 seventh-grade students. The validation results showed the media's qualification level at 93%, placing it in the "almost perfect" category. Meanwhile, the readability test results averaged 94%, placing it in the "very good" category. The developed media are equipped with interactive features, including visual materials, animated videos, educational games, question-and-answer exercises, and GBL-based evaluation quizzes. Based on the validation results and readability tests, this media is deemed suitable for use in science instruction at the junior high school level.

Keywords: Learning Media; technology-enhanced learning; innovative media; deep understanding



Graphical Abstract



INTRODUCTION

Technological advancement, globalisation trends, and educational science are the main signs of the 21st century that significantly influence various aspects of life (Suciati et al., 2023). With the fast pace of technological change, humans must adapt to current innovations. This not only affects social structures but also significantly impacts the education sector (Novriandami et al., 2023). Education is a vital effort to develop students' potential to the fullest. Alongside technological progress and rapid change, teachers need to innovate in designing suitable and effective learning environments (Shinta et al., 2025). One key component in education that can be improved with technological support is learning media. The use of media in the learning process has now expanded beyond traditional media, such as textbooks, to include technology-based media, making learning more relevant to contemporary times (Kurniawan & Sumari, 2024).

Learning media that utilise the current technological advancements bring innovation in teaching methods. This innovation encourages the creation of high-quality teaching and learning processes. Learning has also expanded its scope, so it is no longer limited by space and time. Thus, effectiveness, practicality, efficiency, standardisation, and more flexible learning models can be realised through educational media technology. Learning media play a strategic role in facilitating students' active and independent learning, making them an important consideration (Agustini et al., 2020). Several studies that utilise interactive learning media have been developed for better science teaching (Lailia, 2025; Putri & Habiddin, 2026; Ramadhani & Arista, 2026; Rofik et al., 2025).

The use of innovative, engaging, interactive, and creative learning media is very important for motivating and focusing students in the teaching and learning process,



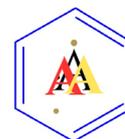
thereby serving as the foundation for achieving learning objectives (Dzikrika et al., 2024). However, at present, many teachers still use less innovative, less interactive technology-based learning media, such as PowerPoint, which is limited to presentations and images.

PowerPoint is used to present materials (Abdillah et al., 2024). One type of learning media that has been commonly used in the learning process is due to its simple and easy-to-understand appearance. However, this medium has limitations, such as only allowing students to read materials and switch slides passively. With technological development, the originally static PowerPoint has begun to take on a more interactive form. In other words, this learning medium has the potential to become more creative and attractive, and to provide a more significant learning experience for students, because it can now facilitate two-way interaction between students and materials (Wirawan & Gading, 2022). Moreover, the presence of images, graphic animations, colours, and interactive features that can be played encourages students to be more enthusiastic and actively involved in learning activities (Nazaretha et al., 2022). Integrating game elements into learning media can also encourage students to be more interested in following the learning process and reduce the tendency to give up when faced with challenging materials (Mantilla et al., 2023).

Research results show that gamifying learning can increase student participation, foster learning motivation, and create a more interactive and enjoyable classroom environment (Ariestiara, 2025). The use of learning media that utilises the concept of play is considered capable of supporting the mastery of 21st-century skills. This strategy can enhance student interest and activity during the learning process, thereby achieving learning goals. Moreover, a game-based approach has been shown to promote learning motivation, develop communication skills, and strengthen collaborative abilities (Rahmawati & Cintamulya, 2025).

Environmental pollution is a real topic in science with a direct connection to situations students often encounter in their daily lives. Problems such as water, soil, and air pollution caused by plastic waste, including microplastics, can be found in the surrounding environment (Wang et al., 2024). International-scale research by Wang et al. (2024) shows that microplastics have spread widely across various environmental media and have become a crucial issue for ecosystem sustainability. Environmental pollution in Indonesia remains a serious problem, especially in the water, air, and land components. This has a direct impact on the quality of human life and the balance of the ecosystem (Ministry of Environment and Forestry, 2023).

Several previous studies, such as that by Afrida et al. (2021), have developed interactive science learning media in the form of an interactive PowerPoint equipped with a quiz feature. However, this media is not yet combined with the GBL approach and does not include practice questions and assessment quiz features. Apart from that, the PowerPoint development is for material on the human digestive system. Apart from that, research conducted by Putriana et al. (2022) has developed interactive science



learning media, which has been proven effective at the elementary school level. However, this research has not integrated the GBL approach and has not specifically discussed environmental pollution. Thus, this research was carried out to develop interactive learning media using the PowerPoint platform as the main tool to integrate GBL on the topic of environmental pollution, with the aim of increasing student involvement and deepening understanding.

Based on the problems described, the researchers determined the title "Development of GBL-based Interactive PowerPoint on Environmental Pollution Material for Middle School Students". The aim of this research is to develop innovative, interactive, interesting, and creative learning media for the Natural Sciences learning process that are relevant to current developments and support learning processes that help achieve learning goals. This media was developed specifically for Phase D Middle School students in accordance with the Independent Curriculum, and will be tested for readability on class VII SMP/MTS students. The media features include material on environmental pollution caused by microplastics, with images, animated videos, interactive buttons, audio, educational games, practice questions, and assessment quizzes. Thus, this media allows two-way interaction between students and the learning material.

METHOD

This research applies the Research and Development (R&D) method to develop learning media in the form of an interactive PowerPoint based on Game-Based Learning (GBL) on environmental pollution materials. The development procedure used is based on the 3-D model, a simplified form of the 4-D model developed by Thiagarajan et al. (1974). This model includes four stages: definition, design, development, and deployment. However, the dissemination stage was not carried out in this research due to time constraints. The stages in the research and development process are explained in Figure 1.

Define

This stage is the first step in the learning media design process. At this stage, several activities are carried out, such as problem identification, learning needs analysis, material study, task analysis, and formulation of learning objectives. The problem identification process involves examining learning needs through literature reviews of relevant journals and prior research. Based on the results of this study, many learning media still do not fully support 21st-century skills.

Apart from that, analysis was also carried out on actual conditions in schools, both in terms of student characteristics and the limitations of the media used by teachers in science learning, especially regarding environmental pollution material. Thus, it is necessary to design interactive, relevant learning media that meet students' current needs. After analysing the learning and materials, the researcher formulated the learning objectives to be achieved through the media developed. The formulation of this goal is aligned with the Basic Competency (KD) achievements in the curriculum, as



well as the abilities students want to develop, namely critical thinking skills for solving environmental problems and creativity when facing challenges in games through the GBL approach.

Design

This stage involves the initial design of learning media based on analysis results from earlier stages. Activities in this phase include preparing tasks, selecting media types, and choosing a presentation format suited to the learners' characteristics. The media design is designed to engage students and boost their interest in learning activities. Additionally, the design aims to be as informative as possible to facilitate use by both students and teachers. The materials included in the media are systematically organised, comprehensive, and aligned with expected learning outcomes, thus enhancing students' understanding of the content. Furthermore, the media features interactive elements such as games, exercise questions, and quizzes that serve as self-evaluation tools for students to assess their mastery of the material after learning.

Develop

This stage is the process of developing learning media that has gone through the design phase in the previous stage. After obtaining the interactive PowerPoint design that includes the material and interactive elements, this stage is followed by expert validation to assess the feasibility and suitability of the media. The validation is carried out by two lecturers from the Department of Science Education and one science teacher from SMP Putri Al Irsyad Al Islamiyyah.

The validation process is conducted to ensure that the developed learning media meets the criteria for media quality, including content and materials, visual presentation, language, and functionality. Feedback and evaluations from the validators are used as references for revisions, ensuring the final media is more optimal and better meets learners' needs. After completing the revision process, the learning media are tested for practicality through a limited trial at SMP Putri Al Irsyad Al Islamiyyah involving 18 seventh-grade students. This readability test aims to determine whether the media are easily understood by students and to identify potential problems during their use. Based on the readability test results, the interactive PowerPoint media is deemed feasible and can be used for the next stage of development.

Disseminate

This stage is the final phase in the 4D development model, focused on wider dissemination and implementation of the product. However, in this research, the dissemination phase was not carried out due to time constraints and the scope set by the researchers. Furthermore, the researchers chose to limit the development process to the Develop stage so that the resulting learning media could be tested and revised as thoroughly as possible based on feedback from validators and practical testing by students. Therefore, the researchers hope that the developed media achieves optimal quality before moving on to the wider dissemination stage in future research.

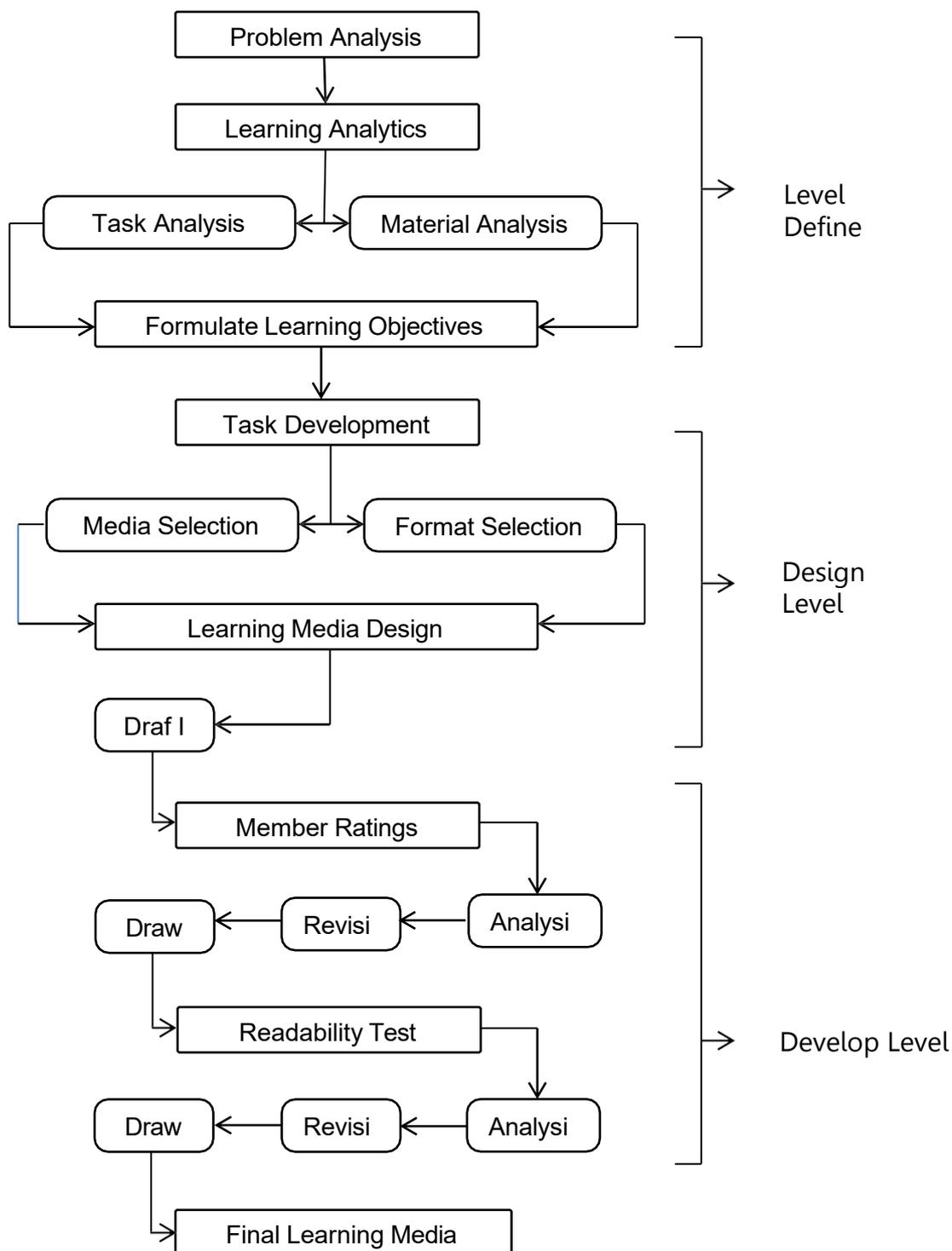
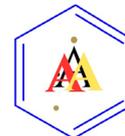
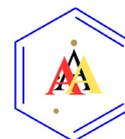


Figure 1. Research procedures



Measurement tools used in this research include various instruments, such as: (1) Expert validation instruments to assess the feasibility of the media in terms of content, design, language, and interactivity. (2) Readability test instruments distributed to learners to determine how easy and engaging the media is. Data from the questionnaire are analysed using descriptive statistics. The evaluation scale uses a 4-point Likert scale, with each item assigned a value from 1 to 4.

Table 1. Likert scale

Evaluation	Information	Score
SS	Strongly agree	4
S	Agree	3
KS	Disagree	2
TS	Strongly disagree	1

Media validation was carried out by three expert validators using a percentage agreement method based on the relative score difference between raters. This approach is a simplification of the per cent agreement principle, as explained by McHugh (2012), which states that agreement between raters can be determined by the closeness of their scores. The following is the formula used in equation 1.

$$\text{Percentage of Agreement} = 1 - \left(\frac{|V_1 - V_2|}{V_{max}} \right) \times 100\% \dots\dots\dots(1)$$

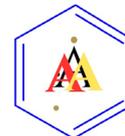
Where:

- V_1 and V_2 = Scores given by the two validators
- V_{maks} = The highest possible score from the validators
- $|V_1 - V_2|$ = Absolute value of the difference between the validators' scores

If both validators assign the same score, the agreement percentage is 100%. If there is a 1-point difference on a Likert Scale of 4, the agreement value will be in the 75% range. Comparisons were made for each pair of validators: between Validator 1 and Validator 2, between Validator 1 and Validator 3, and between Validator 2 and Validator 3. The percentage agreement results were then interpreted using the agreement-level categories. The media is considered valid if the agreement level exceeds 64%. Meanwhile, the readability test is conducted by asking students for responses after they have tried using the media. The formula used is presented in Equation 2 (Arikunto, 2010).

$$\text{Readability} = \frac{\text{Total score of data collection result}}{\text{Score max}} \times 100\% \dots\dots\dots(2)$$

This readability percentage is then interpreted using practicality-level categories. Students' responses to the media are categorised as good when they reach 56%. Thus, the developed media is declared eligible when it meets both criteria.



RESULTS AND DISCUSSION

This section describes the stages of developing GBL-based interactive PowerPoint learning media, from planning through the final stage, and includes the results of validation and readability tests on the developed media. Needs analysis is the basis for media development, highlighting the challenges of the 21st century that demand technology-based learning innovations (Suciati et al., 2023; Novriandami et al., 2023). Learning media is seen as an important component that can be strengthened through technology integration (Kurniawan & Sumari, 2024). PowerPoint was chosen because it is simple yet effective and can be made interactive and innovative to increase student motivation and involvement (Wirawan & Gading, 2022; Dzikrika et al., 2024).

Environmental pollution caused by microplastics was chosen because it is relevant to everyday life (Lee, 2024; Wang et al., 2024). The design stage was carried out in Canva to produce an attractive media display that is in harmony with the material and supports creative and interactive learning. The Develop stage is carried out with product validation tests to assess the level of validity. After being declared valid, it is continued with a readability test on students to see the suitability and ease of use of the media. From these stages, the final product is produced as follows:



Figure 2. Initial media display

This media is equipped with navigation buttons that are quite complex, consisting of logo elements, titles, and a continue button that, when pressed, automatically directs the user to the main menu slide. Apart from that, moving animations were added to create a more dynamic, less monotonous impression.

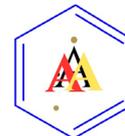


(a) Main menu



(b) Directions for use

Figure 3. Menu display and contents of the main menu



The main menu on interactive PowerPoint media contains (b) instructions for use. Once the entire section has been studied by the students, they can proceed to the material menu. The usage instructions section provides information on learning objectives, steps for use, navigation, special features, and usage suggestions students need to know. The validator suggested aligning the developer and guide profile photos by adding a background and removing the navigation button if it is not needed to simplify the display and avoid confusion.



Figure 4. Menu display and contents of the main menu

The material menu includes (b) subject matter, (c) games, (d) practice questions, and (e) assessment quizzes. In the main discussion section, there is a submenu which includes a concept map, a discussion of plastic waste, and material about microplastics. After all the material has been studied, students can access the Eco Detective game, the Mission to Save the Earth game, and the MicroDetect game. After playing the game, students can do practice questions and assessment quizzes as the final part of the learning media.

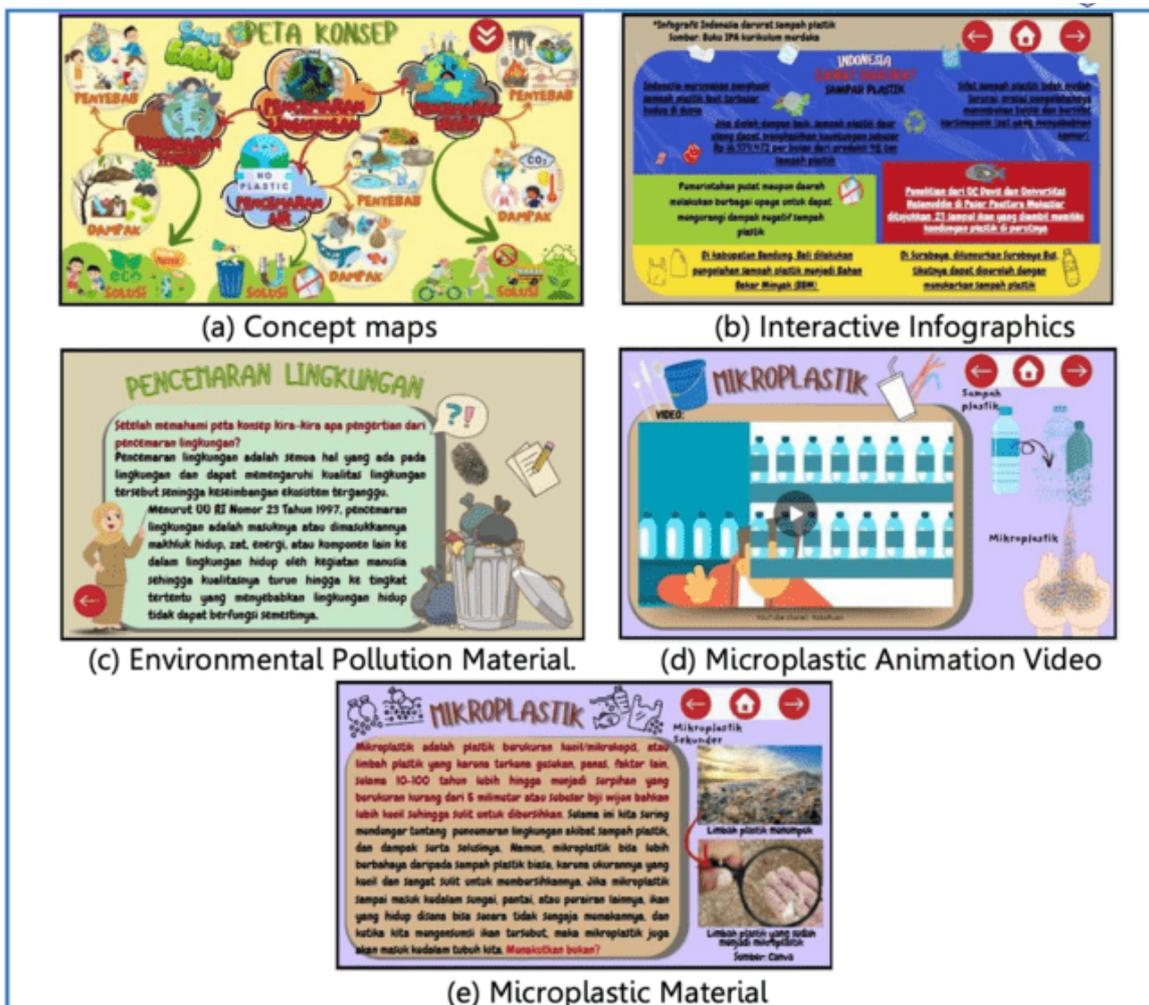


Figure 5. Display of environmental pollution and microplastic material

The following are several views of the material presented in the media, including (a) an interactive concept map that allows students to access the underlined words to refer to explanations of related material. Apart from that, (d) animated learning videos are also provided to help improve the initial understanding of the material. Then proceed with a more in-depth discussion regarding (e) the topic of microplastics. Previously, the concept map was not interactive and there was no explanation section regarding land, water, air pollution causes and solutions, then the researcher was given advice by the Validator so that the concept map could be directly accessed into the material and added to the material, in order to get a more active and material-rich display. Apart from that, the validator also suggested adding image sources to the available images, so that researchers could add them. And researchers also added (b) interactive infographics to make the material rich.

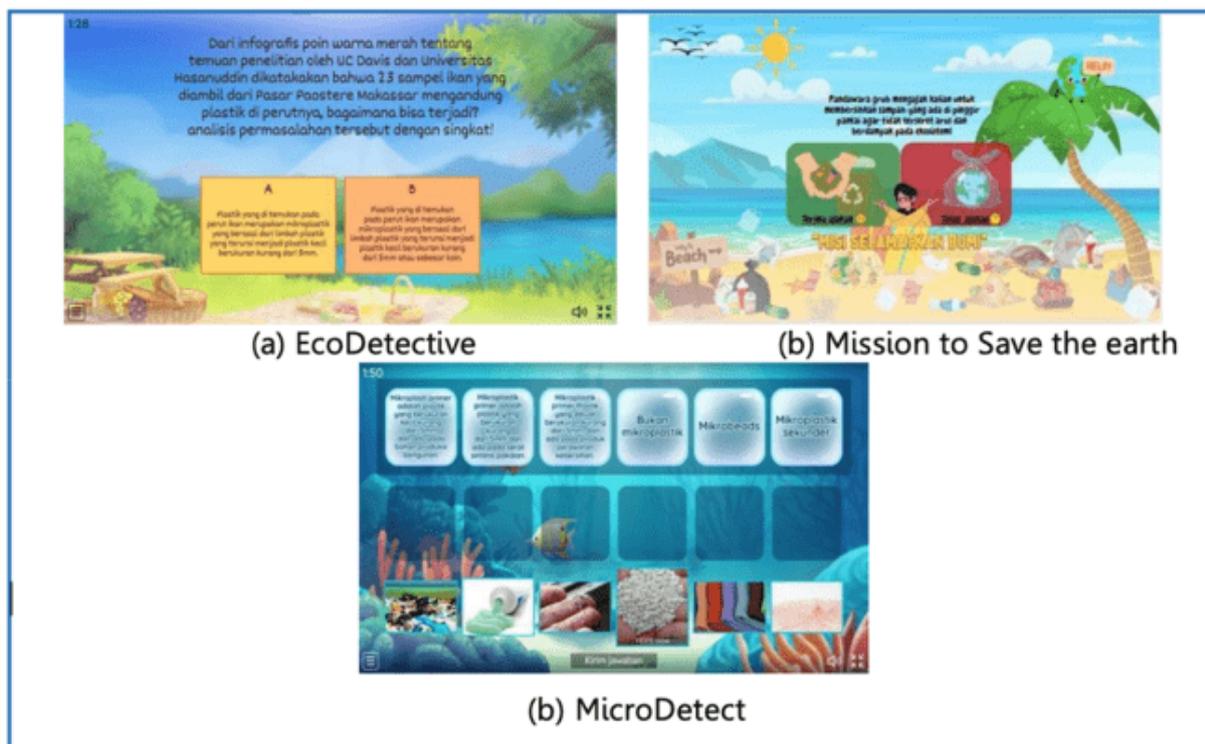


Figure 6. Game display

In the game section, the game appearance is adjusted as shown in the image. Students will be directed to press the "Start Game" button, which will automatically display the game. (a) The EcoDetective game and (c) MicroDetect are developed using the Wordwall platform, while game (b) Mission Save Earth is created using Canva. The games added to the learning media can make the learning process more enjoyable. This is consistent with the statement by Mantilla et al. (2023) that integrating game elements into learning media can encourage students to be more interested in learning and reduce the tendency to give up when facing challenging material.

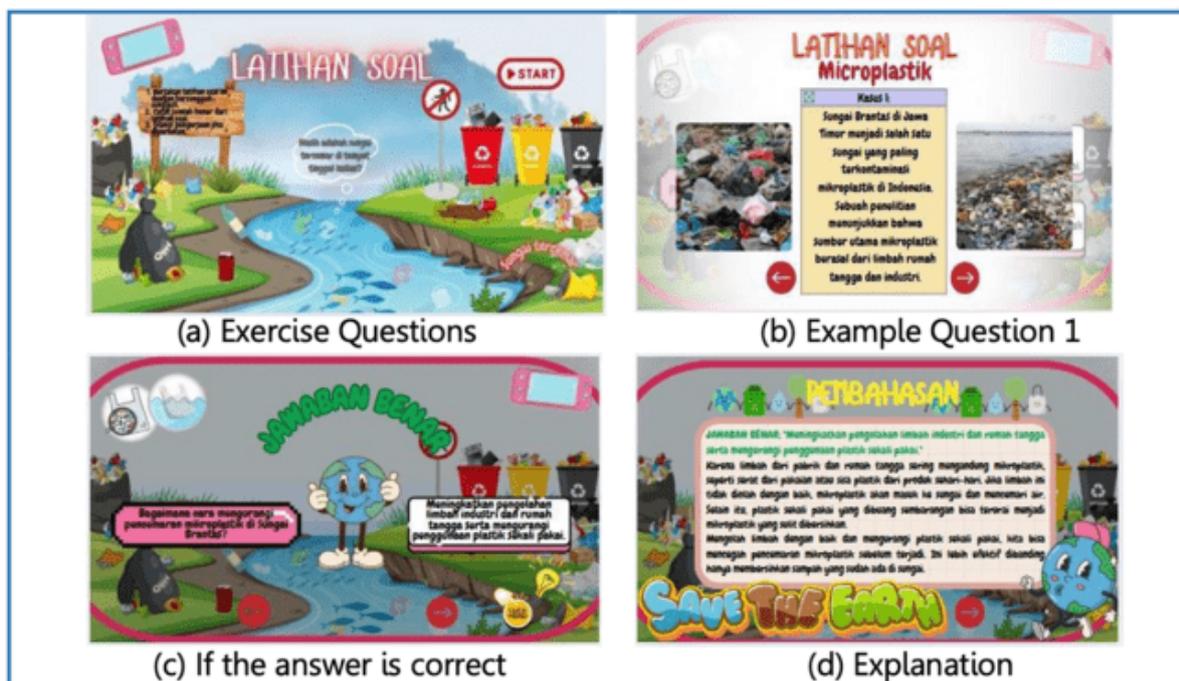


Figure 7. Display of practice question

In part (a) of the practice question, students are asked to complete all parts of the question in order from the beginning to the end. This exercise consists of five multiple-choice questions based on problems such as (b) cases of pollution in daily life, accompanied by (d) explanations. The system will automatically detect the student's answer, whether (c) their answer is correct or incorrect.



Figure 8. Display of quiz assessment

The final feature of this medium is the quiz assessment feature. The quiz is available in two modes: individual and class. In individual mode, students can access the quiz directly. Meanwhile, in class mode, the quiz can only be accessed by the teacher, who then shares the link with all students so the teacher can monitor the assessment results collectively.

Results of the validity and readability test of the interactive PowerPoint-based GBL medium that has been developed. The evaluation was conducted by experts and students to assess the medium's suitability in terms of the material's substance, appearance, and readability. The data is presented as average percentages, which are then analysed against the established evaluation categories.

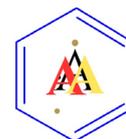


Table 2. Result of Expert Validity

Aspect	Percentage Rate (%)	Category
Software engineering function	83	Almost perfect
Learning media design	91	Almost perfect
Visual communication	93	Almost perfect
Material presented	87	Almost perfect
Average Percentage	93	Almost perfect
Feasibility		Valid

According to Table 2, the average percentage of validator agreement across media aspects is very high. The functional aspect of software engineering reached 83% (near perfect), learning media design 91% (near perfect), visual communication 93% (near perfect), material presented 87% (near perfect), and overall aspects 93% (near perfect). In accordance with the assessment scale from Mchugh (2012), these figures indicate that experts consider the media adequate in terms of content and appearance, with only minor improvements needed in several technical elements.

Table 3. Student Readability

Aspect	Percentage Rate (%)	Category
Media function	88	Very Good
Media presentation	95	Very Good
Language and audio	93	Very Good
Average Percentage	94	Very Good

Table 3 indicates that, of 18 students, the average media readability for the media function aspect was 88% (very good), media presentation was 95% (very good), language and audio were 93% (very good), and all aspects combined were 94% (very good). Consistent with Arikunto's (2010) readability test scale, most participants found this GBL-based interactive media easy to understand, engaging, and communicative.

The development of GBL-based learning media on environmental pollution emphasises the crucial role of technological innovation in 21st-century education. The needs analysis reveals that junior high school students require media that not only deliver information effectively but also offer an engaging, interactive, and motivational learning experience. This aligns with Ariestiera's (2025) view that gamifying learning can enhance student involvement and participation while fostering a positive classroom atmosphere.

The choice of PowerPoint as a media platform is suitable because it offers high flexibility and is easy for teachers and students to use. However, unlike traditional PowerPoint, which tends to be passive, this development introduces interactivity and educational games, allowing students not only to receive the material but also to explore and practice independently. These findings align with those of Wirawan &



Gading (2022) and Nazaretha et al. (2022), which state that interactive features, animations, and visual elements can increase attention and deepen understanding of concepts. The context of the selected material, namely environmental pollution caused by microplastics, is highly relevant because it is directly connected to students' daily lives. Therefore, learning is not solely focused on conceptual knowledge but also aims to develop environmental awareness. This is consistent with the findings of Wang et al. (2024), who emphasised that microplastic pollution is a global problem with serious impacts on ecosystem sustainability. Through the integration of GBL in this topic, students are not only encouraged to understand concepts but also trained to think critically about real issues in their environment.

The results of research conducted by Afrida (2021) show that the interactive PowerPoint learning media developed achieved a practicality percentage of 81.22%, placing it in the very practical category. These findings indicate that the media is easy to operate and meets user needs. Conversely, a study conducted by Putriana (2022) used a Likert scale of 1 to 5 and obtained an average score of 4.7, also categorised as very practical. The findings from these two studies demonstrate that well-developed interactive PowerPoint learning media often garner positive user responses, particularly in terms of practicality. These results emphasise the importance of practicality as a key indicator in creating effective and functional learning media.

Compared with previous research (Afrida et al., 2021; Putriana et al., 2022), this development is notably different. Earlier interactive media mainly focused on presenting material and simple quizzes, whereas this study incorporates elements of educational games, practice questions, evaluation quizzes, and GBL integration. This distinction adds value because students not only learn passively but also actively engage in the learning process through challenging yet enjoyable games.

With these features, this GBL-based interactive PowerPoint can support the development of 21st-century skills, such as critical thinking and creativity. Students can apply critical thinking when solving environmental problems and demonstrate creativity when facing challenges in the game. Therefore, the product being developed not only acts as a teaching tool but also as a strategic means of fostering student skills relevant to the demands of the global era.

CONCLUSION

The GBL-based interactive PowerPoint media developed shows a high level of feasibility, based on validation results from experts and readability tests by students. Validation carried out by experts produced an appropriateness percentage of between 83% and 93% with an overall average of 93%, which is in the "almost perfect" category, while readability testing by students produced a percentage of between 88% and 95%



with an overall average of 94%, which is in the "very good" category. The majority of students stated that the media was easy to understand, interesting and communicative. Overall, the media is declared suitable for use because it meets the criteria for validity and readability according to experts and students. These results strengthen the conclusion that media can be applied effectively in the junior high school learning process.

AI-ASSISTED TECHNOLOGY STATEMENT

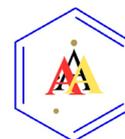
While preparing this work, the authors used Grammarly to check for grammatical errors and ChatGPT to create the Graphical Abstract. After using this tool, the authors reviewed and edited the content as necessary and took full responsibility for the publication's content.

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