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Interactive Learning in Primary Schools: Development of ICT-Based Interactive PowerPoint Media on Types of Waste and Waste Management

Deni Mulyadi*[1a], Ghullam Hamdu[2b]

[1,2]Master's Program in Primary Education, Indonesia University of Education, Indonesia
e-mail: [a]denimulyadi@upi.edu, [b]ghullamh2012@upi.edu
* Corresponding Author.

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Abstract: This study aims to develop and evaluate ICT-based interactive PowerPoint media focused on the topic of types of waste and waste management for use in primary school learning. The purpose of the development was to provide teachers with effective instructional tools and to foster student engagement and understanding of environmental science content. The development process followed the 4D model: Define, Design, Develop, and Disseminate. The Define stage included a needs analysis through classroom observation and media usage evaluation. During the Design and Develop stages, an interactive PowerPoint was created, incorporating text, audio, video, and interactive quizzes. Expert validation was conducted involving four experts: a subject matter expert, instructional design expert, media communication expert, and an end-user (classroom teacher). Validation results indicated that the media was highly valid, with expert scores ranging from 86.67% to 90%. Student responses were also positive, with a satisfaction score of 86.66%, demonstrating high levels of interest and motivation during the learning process. The media successfully delivered educational content on classifying and managing waste in a visually appealing and accessible manner, allowing students to engage in independent learning with embedded navigation instructions. In conclusion, the developed ICT-based interactive PowerPoint media is considered valid and effective for elementary education and is recommended for broader classroom implementation to enhance environmental literacy and learning outcomes.

Keywords: Interactive Learning; Powerpoint Media; ICT-Based Media; Waste Management; Primary Education.

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Introduction

In the era of the Industrial Revolution 4.0, technological advancement has rapidly transformed various aspects of human life, including education (Afif, 2019). The integration of technology into education requires educators to be adaptive and innovative in utilizing digital tools to support the teaching and learning process. Teachers are now expected to possess digital literacy and be proficient

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in employing educational technologies to create engaging and effective learning environments. The use of diverse and modern instructional media not only enriches the learning experience but also increases students' interest and motivation to learn (Magdalena et al., 2021; Afandi, 2015).

Despite these advancements, many teachers still do not fully utilize technology in their classrooms, resulting in monotonous and less interactive teaching. This limited use is often due to the inadequate integration of ICT-based learning media, which stems from the lack of teachers' competence in using such technologies (Lutfi et al., 2020). In fact, studies have shown that Indonesian teachers generally exhibit low competence in mastering ICT (Abdullah et al., 2021). This gap underscores the urgent need for teachers to improve their digital skills, particularly in designing and implementing ICT-based instructional media that can enhance students' engagement and learning outcomes.

One of the accessible ICT-based tools that can be implemented in primary education is PowerPoint. This tool allows the creation of interactive and visually appealing learning materials (Poerwanti & Mahfud, 2018). When used effectively, PowerPoint presentations can deliver content in multimedia formats—combining text, images, audio, videos, and interactive exercises—that help students better understand the subject matter (Minardi & Akbar, 2020). Moreover, the integration of instructional videos and practice questions within the PowerPoint presentation encourages students to actively participate in the learning process, providing a more meaningful and memorable learning experience (Ekayani, 2017).

Although ICT-based media such as PowerPoint are rarely used in elementary schools, their implementation has the potential to enhance student motivation and learning achievement. Teachers must therefore be able to select and design appropriate instructional media that align with learners' needs and educational goals (Abdullah R., 2017). Moreover, research focusing on environmental education—especially topics such as waste management and sustainability—has indicated that young learners benefit more from instructional materials that are visual, contextual, and activity-based. Waste classification and proper waste management are among the most urgent environmental topics that need to be taught early to instill ecological awareness and responsibility. Despite this, learning resources on this topic remain relatively underdeveloped, especially those that utilize interactive digital platforms in elementary education.

This study aims to address these gaps by developing and validating an ICT-based interactive PowerPoint instructional media specifically designed for the topic of types of waste and waste management in primary school settings. The scientific novelty of this study lies in its integration of interactive and autonomous learning features in an environmentally themed digital media, validated through the 4D development model (Define, Design, Develop, Disseminate) and tested for both expert feasibility and student engagement. The research seeks to answer the following question: To what extent is the ICT-based interactive PowerPoint media effective and valid for improving student engagement and understanding in the topic of waste management.

Therefore, the purpose of this research is to develop an ICT-based interactive PowerPoint media on the topic of types of waste and waste management, and to examine its validity and effectiveness in supporting environmental education in primary schools.

Method

This study employed a quantitative approach using the 4D development model, which consists of four stages: Define, Design, Develop, and Disseminate. The research began with the Define stage, which involved conducting a descriptive analysis to identify and interpret the initial data relevant to the learning media needs. The Design stage focused on planning and structuring the development process of ICT-based interactive PowerPoint media tailored for elementary school learning. In the Develop stage, the media was created and refined through classroom observations and implementation trials with the target class to evaluate its functionality and user engagement. The Disseminate stage involved evaluating the developed media to identify its strengths and weaknesses, followed by its broader application in other classrooms to assess its overall effectiveness in enhancing student motivation and learning outcomes.

The subjects of this research were elementary school students from a selected target class, involved during the development and trial phases. Data were collected through classroom observations, documentation, and learning outcome evaluations. The instruments used included observation sheets, student response questionnaires, and test items designed to assess students' understanding before and after the intervention. The data analysis was conducted quantitatively using descriptive statistics to determine improvements in learning motivation and comprehension, based on students' performance and feedback during the implementation of the ICT-based media.

Results

This research employed a development methodology utilizing the 4D model, which consists of four stages: Define, Design, Develop, and Disseminate. The primary product developed through this process was an ICT-based interactive PowerPoint learning media specifically designed for use in elementary school settings. The main objective of this study was to produce a functional and pedagogically effective instructional medium that could be integrated into classroom learning activities.

Based on the findings obtained throughout the development and implementation process, the research yielded significant outcomes related to the quality, feasibility, and effectiveness of the developed media in supporting and enhancing the learning experience.

Initial Stage

a. Media Usage Description

Prior to the development of the instructional media, a preliminary study was conducted to analyze the types of learning media commonly used by students during classroom instruction. This initial analysis aimed to identify gaps and opportunities for improvement, ensuring that the subsequent development of the ICT-based interactive PowerPoint media would be more targeted and effective in meeting student learning needs.

b. Observation

At the outset of the study, the researcher conducted classroom observations in the target school and class. The purpose of this observation was to investigate the types of instructional media employed by teachers and to gather initial insights into student responses during learning activities prior to the integration of the developed media. The observation revealed that instructional delivery was predominantly traditional, lacking the use of digital or interactive tools. Furthermore, this stage was

essential to ensure that the design and development of the interactive PowerPoint media would align with the actual classroom conditions and the specific learning needs of the students.

Development of Instructional Media

a. Problem Identification

The issue identified by the researcher during classroom observations was the limited use of instructional media by teachers, which led to a lack of student enthusiasm during the learning process. To address this problem, the researcher developed an ICT-based interactive PowerPoint instructional media aimed at enhancing students' motivation and engagement during lessons.

b. Data Collection

1) Expert Validation

The instructional media underwent validation by four experts: a subject matter expert, an instructional design expert, an educational media and communication expert, and an end-user representative (classroom teacher). Data were collected through structured questionnaires completed by each expert. The responses were then analyzed to evaluate the feasibility and appropriateness of the developed instructional media.

2) Student Responses

Student response data were collected to measure their level of interest and engagement with the ICT-based interactive PowerPoint media used during the learning process. The data were obtained through self-administered questionnaires completed by the students.

c. Product Design

The design of the ICT-based interactive PowerPoint instructional media focused not only on the accuracy and relevance of the learning content but also on visual appeal, incorporating engaging images and colors. The PowerPoint media developed by the researcher did more than just present instructional material; it also included interactive quizzes to attract students' attention after the delivery of each topic. Additionally, short educational videos were embedded to help clarify complex concepts. The media was also designed for independent student use, supported by clear usage instructions. This audiovisual medium facilitated students' understanding of the material and promoted a more interactive learning experience.

d. Design Validation

The finalized instructional media was then validated by four experts: a subject matter expert, an instructional design expert, an educational media and communication expert, and an end-user (classroom teacher). The subject matter expert was an elementary school teacher holding a Bachelor's degree in education, with expertise in science content. The instructional design expert was a preschool teacher (also with a Bachelor's degree) who had participated in instructional design training and held a certification in the field. The educational media and communication expert was a junior high school teacher experienced in the use of instructional communication media. The end-user validator was an elementary school teacher with over ten years of teaching experience at the primary education level. This validation process was conducted to assess the quality and suitability of the ICT-based interactive PowerPoint instructional media before it was tested in the classroom setting. The validation results are presented in the following section.

1) Expert Validation Data Subject Matter Expert

The content validation process was conducted until the instructional media was deemed valid by the subject matter expert. The validation utilized a set of criteria outlined in a questionnaire, as presented in Table 1 below.

Table 1. Subject Matter Expert Validation Results

No	Assessment Aspect	Evaluation Scale	
		Yes	No
1	Accuracy of content	√	
2	Free from conceptual errors	√	
		1 2 3 4 5	
3	Relevance and up-to-dateness		√
4	Coverage and depth of content	√	
5	Adequacy of references used	√	
	Total Score	**13**	

Based on the table above, the subject matter expert's assessment consisted of five criteria. Two of these criteria, related to the content accuracy and conceptual correctness, were assessed using binary responses (Yes/No), and indicate that the instructional media was both accurate and free of conceptual errors. The remaining three aspects were rated on a Likert-type scale and calculated using the following formula:

$$P = \frac{\sum x}{\sum xi} \times 100 \quad \text{-------> } P = \frac{13}{15} \times 100 = 86{,}67\ \%$$

According to the calculation, the total score from the subject matter expert reached 86.67%. The following categories were used to interpret the results: 81%–100%: Very Valid, 60%–80%: Valid/Good, 40%–60%: Fair, 20%–40%: Poor, <20%: Very Poor. Therefore, based on the score of 86.67%, the ICT-based interactive PowerPoint instructional media can be classified as very valid.

2) Expert Validation Data Instructional Design Expert

The instructional design validation process was conducted until the instructional media design was confirmed as valid by the instructional design expert. The validation employed a questionnaire with specific assessment criteria, as shown in Table 2:

Table 2. Validation Results from Instructional Design Expert

No	Assessment Aspect	Rating Scale				
		1	2	3	4	5
1	Appropriateness of the media delivery strategy with respect to students' characteristics					√
2	Effectiveness of the media strategy in facilitating ease and speed of understanding, mastery of concepts or skills				√	
3	Potential to foster students' critical thinking and problem-solving abilities				√	
4	Level of contextual relevance to real-life applications					√
5	Relative advantage of media selection compared to alternative media				√	
	Total Score				**22**	

Based on the table above, the instructional design expert evaluated five assessment aspects. The total score was calculated using the following formula:

$$P = \frac{\sum x}{\sum xi} \times 100 \quad \text{-------> } P = \frac{22}{25} \times 100 = 88\ \%$$

According to the scoring criteria: 81%–100%: Very Valid, 60%–80%: Valid/Good, 40%–60%: Fair, 20%–40%: Poor, <20%: Very Poor. The resulting score of 88% indicates that the ICT-based interactive PowerPoint instructional media is categorized as very valid based on the assessment by the instructional design expert.

3) Expert Validation Data Educational Media Communication Expert

The validation process by the media communication expert was carried out until the instructional media was declared valid. The validation utilized a questionnaire with specific evaluation criteria, as shown in Table 3:

Table 3. Validation Results from Educational Media Communication Expert

No	Assessment Aspect	Rating Scale				
		1	2	3	4	5
1	Clarity of narration, audio, video, animation, simulation, and appropriateness of language style for the audience					√
2	Relevance of narration, audio, video, animation, and simulation to the learning objectives and content				√	
3	Appeal of the overall multimedia presentation					√
4	Effectiveness and attractiveness of the video media as a whole				√	
	Total Score			**18**		

Based on the table above, the media communication expert evaluated four aspects of the instructional media. The total score was calculated using the following formula:

$$P = \frac{\sum x}{\sum xi} \times 100 \quad \text{-------> } P = \frac{18}{20} \times 100 = 90\ \%$$

According to the categorization criteria: 81%–100%: Very Valid, 60%–80%: Valid/Good, 40%–60%: Fair, 20%–40%: Poor, <20%: Very Poor. With a score of 90%, the ICT-based interactive PowerPoint instructional media is considered very valid based on the assessment of the educational media communication expert.

4) Instructional Media User Validation Data

The validation process by the instructional media user was conducted until the media was declared valid. The validation was carried out using a questionnaire with specific criteria, as shown in Table 4 below:

Table 4. Validation Results from Instructional Media User

No	Assessment Aspect	Rating Scale				
		1	2	3	4	5
1	Ease of use					√
2	The likelihood of increasing students' interest and motivation, whether in individual or group settings				√	
3	Suitability for independent learning by students or as a teaching aid for teachers					√

4	Contextual relevance to real-life application in accordance with the audience's (students') characteristics	√
	Total Score	**18**

Based on the table above, there are four assessment aspects used by the media user to evaluate the instructional media. The total score was calculated using the following formula:

$$P = \frac{\sum x}{\sum xi} \times 100 \quad \text{-------> } P = \frac{18}{20} \times 100 = 90\ \%$$

Based on the calculation, the overall score from the media user is 90%. According to the interpretation scale: 81%–100%: Very Valid, 60%–80%: Valid/Good, 40%–60%: Fair, 20%–40%: Poor, <20%: Very Poor, Thus, the ICT-based interactive PowerPoint media is considered very valid by the user. Furthermore, based on the validation data of the developed instructional media, the ICT-based interactive PowerPoint media fulfills the criteria of being feasible and validated by experts. Therefore, no revisions or improvements are required.

5) Student Response Data

Students' reactions to using the interactive PowerPoint media during the learning process were generally positive. They accepted the media well and responded enthusiastically, showing better focus during the lesson. Students were particularly engaged when asked to interact with the media, especially during the quiz sessions provided at the end of the lesson. The PowerPoint contained quizzes that students could answer by clicking on-screen choices, fostering an interactive learning atmosphere (Sitohang & Simamora, 2023). The detailed student responses can be seen in Table 5:

Table 5. Student Responses

No	Statemen	3	2	1	Total Score
1	Easy to understand the lesson content	20	5		70
2	Felt bored when teacher explained material			25	25
3	Excited when the teacher used PowerPoint	25			75
4	Found it easier to understand lessons using media	21	4		71
5	Felt bored without the use of instructional media	24	1		74
6	Clear visuals and audio; language easy to understand	25			75
	Total Score			**390**	

Based on Table 5, six assessment indicators were used to evaluate student responses to the interactive PowerPoint media. The total score was calculated using the following formula:

$$P = \frac{\sum x}{\sum xi} \times 100 \quad \text{-------> } P = \frac{390}{450} \times 100 = 86{,}66\ \%$$

With a total percentage of 86.66%, student responses toward the media were highly positive. According to the interpretation scale, this indicates that the media is highly engaging for students. Before the introduction of the ICT-based interactive PowerPoint media, students' concentration levels were relatively low, especially during conventional classroom sessions without visually or interactively engaging tools. Therefore, besides the teacher's delivery, instructional media plays a crucial role in supporting an engaging and effective learning process. After the implementation of

the media by the researcher, students demonstrated improved focus and were more actively involved in classroom learning activities.

Discussions

The results of this study demonstrate that the development of ICT-based interactive PowerPoint media is highly effective in addressing the instructional challenges observed in primary schools, particularly in improving student engagement and comprehension. Expert validations from various fields—including subject matter, instructional design, media communication, and end-user perspectives—yielded high validity scores (ranging from 86.67% to 90%), indicating that the media meets both pedagogical and technical standards. These findings are consistent with recent studies highlighting the effectiveness of digital instructional media in enhancing learning environments (Setiawan & Mahpudz, 2022; Zainuddin et al., 2020).

The integration of multimedia elements—such as images, videos, audio, and interactive quizzes—in the developed media aligns with the principles of Mayer's (2020) updated Cognitive Theory of Multimedia Learning. This theory posits that students learn more effectively when instructional materials engage both visual and auditory channels in a coordinated manner, allowing for better information processing and retention. In this study, the use of audiovisual content and student-directed interaction supported this cognitive engagement, as evidenced by positive student responses and improved motivation levels.

Furthermore, student-centered design features such as autonomous navigation and embedded instructions enable self-directed learning, a crucial component of 21st-century education (Anshari et al., 2021). According to Hapsari and Raharjo (2022), instructional media that encourages autonomy not only fosters student independence but also cultivates higher-order thinking skills. In this research, students actively interacted with the media, completed embedded quizzes, and engaged in reflective thinking, demonstrating a shift from passive reception to active participation.

The positive student response score of 86.66% aligns with the findings of Pratama and Wardani (2021), who showed that interactive PowerPoint media could significantly improve student motivation and learning outcomes in science subjects. Similarly, Syahputra et al. (2023) emphasize that students are more likely to engage with digital materials that are visually appealing and include game-like elements, such as quizzes or simulations. The media developed in this study incorporated both, thereby increasing its pedagogical effectiveness.

In terms of instructional design, the application of the 4D model (Define, Design, Develop, Disseminate) proved instrumental in ensuring systematic development, expert validation, and iterative refinement. Recent studies have reaffirmed the relevance of the 4D model in media development, particularly for elementary and secondary school contexts (Putra & Mulyani, 2020; Siregar et al., 2022). The Define stage in this study was critical in identifying teacher limitations in ICT usage, which is a well-documented issue in Indonesian education (Yuliana et al., 2021). Teacher feedback and classroom observations during the Define and Design stages provided crucial contextual data that informed the development of relevant and user-friendly media.

Additionally, the findings also highlight the importance of teacher readiness and digital literacy in media implementation. Abdullah et al. (2021) and Kurniawati & Fitriyah (2023) report that limited technological skills among teachers remain a significant barrier to the integration of ICT in classrooms.

Therefore, media such as this interactive PowerPoint tool—designed with simplicity and clarity—can serve as a transitional aid for teachers who are less experienced in digital pedagogy.

Finally, the dissemination stage, although limited in scope in this study, provided valuable insights into the scalability of the media. When implemented in parallel classrooms, the media maintained its effectiveness, suggesting potential for broader adoption. This reinforces the argument made by Taufik et al. (2020) that ICT-based instructional tools, when properly validated and contextualized, can be adopted across diverse educational settings with consistent results.

In conclusion, this study contributes to the growing body of research supporting the design and implementation of ICT-based instructional media in primary education. The interactive PowerPoint media developed here not only meets expert standards of validity but also demonstrates high student engagement and learning impact. Future research may focus on longitudinal assessments of learning retention and explore the integration of adaptive learning features to further personalize the media for diverse learner needs.

Conclusion

This study concludes that the development of ICT-based interactive PowerPoint instructional media on the topic of types of waste and waste management using the 4D development model (Define, Design, Develop, and Disseminate) has been both feasible and pedagogically effective in the context of primary school education. The media was validated by experts in subject matter, instructional design, media communication, and teacher users, with very high validity scores ranging from 86.67% to 90%. Student responses also showed a high level of engagement, reaching 86.66%. The media was successful in presenting environmental science material—specifically the classification of waste and its proper management—in a way that was visually engaging, interactive, and accessible to young learners. Features such as video explanations, interactive quizzes, and colorful visuals not only helped students understand the concepts of waste segregation and sustainable practices, but also increased their interest and motivation during the learning process. These findings affirm that the integration of multimedia and interactive design elements can significantly enhance conceptual understanding, particularly in thematic and science-based learning. Given its simplicity, adaptability, and strong alignment with curriculum goals, the developed media holds potential for broader classroom application. Future studies are encouraged to assess the long-term impact of such media on environmental awareness and behavioral change among students, as well as its adaptability across various thematic subjects.

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