



Development of Interactive Puzzle Media Based on Critical Reasoning Games for Fine Arts Material for Grade 5 Elementary School

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ABSTRACT

Purpose of the study: This study aims to develop and evaluate the feasibility of a game-based interactive puzzle learning media designed to foster critical thinking skills in fifth-grade elementary students. The media are used in the instructional topic “Creating Artworks from Household Waste Materials” to enhance students’ critical reasoning abilities.

Methodology: This research employed a Research and Development (R&D) approach based on the ADDIE framework, comprising analysis, design, development, implementation, and evaluation stages. The participants were 20 fifth-grade students. Data were gathered through expert validation forms, teacher and student questionnaires, and pretest–posttest instruments, and then analyzed using Likert-scale scoring and N-Gain testing.

Main Findings: The validation results indicated an average score of 4.56 from the material expert, 4.57 from the media expert, and 4.46 from the practitioner, all categorized as highly feasible. Teacher responses reached 97%, while student responses in the limited trial and field trial were 100% and 99%, respectively, indicating a very high level of practicality. The effectiveness of the media was demonstrated by N-Gain scores of 81.90% in the limited trial and 79.28% in the field trial, both of which were classified as high.

Novelty/Originality of this study: This study introduces a game-based interactive puzzle media integrated with critical thinking indicators in elementary school visual arts instruction. The media emphasizes not only creativity but also the development of students’ critical thinking skills through contextual problem-solving activities that use household waste materials.

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1. INTRODUCTION

Twenty-first-century education requires students not only to master conceptual knowledge but also to develop higher-order thinking skills, particularly critical thinking. This skill constitutes a core component of the 4C competencies critical thinking, creativity, collaboration, and communication which are essential for addressing global challenges and rapid technological advancement. Among these, critical reasoning, creativity, teamwork, and effective communication represent fundamental competencies for success in the twenty-first century [1]. Critical thinking ability is one of the essential competencies of the twenty-first century, enabling

students to analyze information comprehensively, evaluate evidence objectively, and make logical and responsible decisions in addressing complex problems [2]. In the context of the Merdeka Curriculum, learning is expected to be student-centered, contextual, and capable of strengthening the Pancasila Student Profile through meaningful and project-based activities. A curriculum constitutes a structured series of learning experiences that can only be attained by students through active engagement in the educational process [3]-[4].

Visual arts education at the elementary school level holds significant potential for fostering both creativity and critical thinking skills. Through the process of creating artworks, students learn to analyze materials, consider aesthetic values, and make informed decisions during artistic production. However, preliminary observations conducted in a private elementary school in Purworejo revealed that visual arts instruction remains largely dominated by conventional methods, with limited student engagement. Teachers tend to rely on lectures and assignment-based approaches without adequate support from interactive learning media. Consequently, students demonstrate low participation, reduced learning motivation, and underdeveloped critical thinking skills. Teachers play a crucial role in facilitating meaningful learning experiences by guiding students to reflect on what they already know and what they have yet to understand. In this capacity, teachers act as navigators who support students in independently identifying and utilizing appropriate learning resources [5]. The low academic achievement of students is attributed to the limited availability of supportive learning media that can create an engaging learning environment and enhance students' motivation to improve their abilities [6].

Several previous studies have reported that puzzle-based learning media are effective in enhancing students' motivation, collaboration skills, and learning outcomes [7]-[8]. Game-based learning media have also been shown to foster more engaging and participatory learning environments. Learning media function as instructional tools that support the learning process by stimulating students' cognitive and affective domains, as well as sustaining their attention, thereby facilitating meaningful learning experiences [9]-[10]. Nevertheless, a clear research gap remains. First, most puzzle-based studies have focused on mathematics or thematic subjects rather than visual arts. Second, puzzle media are generally developed as standalone game tools without systematic integration with educational posters to reinforce visual and conceptual understanding. Third, limited research has specifically examined the effectiveness of puzzle media in enhancing critical thinking skills within visual arts instruction, particularly on the topic of recycling household waste materials.

In fact, the theme "Creating Artworks from Household Waste Materials" holds significant urgency within the context of twenty-first-century education. This theme not only develops artistic skills but also fosters environmental awareness, creativity, and social responsibility. Without the support of innovative and interactive learning media, the integrative potential of this theme cannot be optimally achieved. Therefore, it is necessary to develop instructional media that are not only visually engaging but also systematically designed to stimulate students' processes of analysis, evaluation, and reflection.

As a solution to these issues, this study develops a game-based interactive puzzle media integrated with critical thinking components and supported by educational posters. The use of puzzle media in the learning process is expected to enhance students' motivation and participation through engaging, hands-on activities. Such interactive experiences encourage students to demonstrate higher levels of active involvement during instructional activities [11]. The media were developed using the ADDIE model to ensure their validity, practicality, and effectiveness. The puzzle functions as a manipulative and collaborative learning tool, while the educational poster reinforces conceptual understanding through visual representation. The integration of both components is expected to create a multisensory learning experience that encourages students to observe, connect information, analyze materials, and logically conclude the process of creating recycled art products.

Thus, this study offers novelty through the development of a physical puzzle media integrated with educational posters in visual arts learning, the design of a game-based learning media that explicitly targets the enhancement of critical thinking skills, and the evaluation of the feasibility and effectiveness of the media within the context of recycled art material for Grade V elementary school. In line with this, the study aims to develop a game-based interactive puzzle media that promotes critical thinking in Grade V visual arts lessons, to determine the level of feasibility (validity) of the developed media, to examine its practicality based on teachers' and students' responses, and to test its effectiveness in improving students' critical thinking skills. Based on these objectives, the research questions of this study are: (1) How is the process of developing a game-based interactive puzzle media that promotes critical thinking in Grade V elementary school visual arts lessons carried out? (2) Does the developed media meet the criteria of validity and practicality? (3) Is the use of interactive puzzle media effective in improving students' critical thinking skills?

2. RESEARCH METHOD

This study employed a Research and Development (R&D) approach using the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation) as proposed by [12]. The ADDIE model was selected because it provides a systematic framework for developing, testing, and evaluating instructional products in sequential stages to ensure that the resulting media are valid, practical, and effective. The study was conducted at

a private elementary school in Purworejo, Central Java, during the 2025/2026 academic year. The research participants consisted of 20 fifth-grade students.

The sampling technique employed was total sampling (saturated sampling), in which all students within the class were selected as research participants. This technique was chosen due to the relatively small population size and the study's objective to examine the feasibility and effectiveness of the product within a specific classroom context rather than to generalize the findings to a broader population.



Figure 1. ADDIE Development Stages

The product trial in this study was conducted in two stages: a limited trial and a field trial. Research data were collected through observations, interviews, documentation, and questionnaire distribution. The media validation process involved a material expert, a media expert, and a practitioner to assess the feasibility of the developed product. The instruments used included observation sheets, interview guidelines, teacher and student response questionnaires, comprehension tests, and validation assessment sheets. The collected data were analyzed both qualitatively and quantitatively, encompassing validity assessment, practicality analysis based on teacher and student responses, and measurement of media effectiveness by comparing pre-test and post-test results using the N-Gain analysis. The criteria for determining product quality were adapted from established evaluation standards [13] as presented in the following Table 1.

Table 1. Product Feasibility Criteria

No	Score Range	Category
1	1.00 – 2.49	Not Feasible
2	2.50 – 3.32	Less Feasible
3	3.33 – 4.16	Feasible
4	4.17 – 5.00	Highly Feasible

To calculate the mean score, the following formula can be used:

$$X = \frac{\sum x}{n} \dots (1)$$

Description:

X = Mean score

$\sum x$ = Total score obtained

n = Number of items

Practicality was analyzed based on teacher and student responses in the form of a checklist completed during the use of the instructional media. The teacher and student response questionnaires were assessed using the following formula 2.

$$\text{Presentase} = \sum \left(\frac{\text{score obtained for each aspect}}{\text{maximum possible score}} \right) \times 100\% \dots (2)$$

Table 2. Practicality Criteria

Score Range	Category
75% < skor ≤ 100%	Highly Practical
50% < skor ≤ 75 %	Practical
25% < skor ≤ 40 %	Less Practical
≤ 25%	Not Practical

Based on the analysis presented in Table 2, the quality of the learning media was determined according to the scores obtained from teacher and student responses. The media were categorized as good when the score exceeded 50, and as very good when the assessment score was above 75. These criteria indicate that higher scores reflect a more positive level of acceptance and feasibility in supporting the learning process. Therefore, this evaluation serves as an important indicator for determining the effectiveness of the developed media based on direct user perceptions.

The effectiveness of the learning multimedia was determined based on the results of the pre-test and post-test scores. The pre-test and post-test results were analyzed using the N-Gain test. The N-Gain score criteria according to Sukarelawan et al., [14] are presented in the following table 3.

N-Gain Value	Interpretation
$0.70 \leq g \leq 1.00$	High
$0.30 \leq g < 0.70$	Moderate
$0.00 < g < 0.30$	Low
$g = 0.00$	No Improvement
$1.00 \leq g < 0.00$	Decrease Occurred

The effectiveness value was calculated from the obtained data using the following formula 3.

$$N \text{ Gain} = \frac{\text{posttest score} - \text{pretest score}}{\text{ideal score} - \text{pretest score}} \dots (3)$$

Table 4. Criteria for Determining the Level of Effectiveness

Percentae (%)	Interpretation
< 40	Not Effective
40 – 55	Less Effective
56 – 75	Moderately Effective
>76	Effective

Based on the results presented in Table 4, the learning media are considered effective if the N-Gain score exceeds 76. This value indicates that there is a high-category improvement in students' learning outcomes after the implementation of the media in the instructional process. These criteria emphasize that the higher the N-Gain score obtained, the more significant the improvement in students' understanding of the material. Therefore, an N-Gain value above 76 serves as an indicator that the developed media have a positive impact and contribute optimally to the enhancement of students' learning achievement.

3. RESULTS AND DISCUSSION

The entire series of research activities based on the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation) was conducted over a six-month period. Each stage was carried out systematically and sequentially, ensuring that the outcomes of one phase served as the foundation for the subsequent phase. This process was designed to ensure that product development proceeded in a structured, measurable manner and aligned with actual instructional needs in the classroom context.

The following section provides a detailed explanation of the activities carried out at each stage of the research in accordance with the ADDIE model procedures, beginning with the needs analysis phase and concluding with the evaluation phase to assess the effectiveness and feasibility of the developed product. Learning media play a crucial role in enhancing student engagement, as not all learning experiences can be obtained directly; therefore, media are required as intermediaries to facilitate the delivery of instructional messages [15]. This study demonstrates that the development of a game-based interactive puzzle media integrated with critical thinking components is effective in enhancing students' critical reasoning skills and conceptual understanding. Learning activities supported by instructional media encourage active student participation through the use of concrete objects, such as images or boards, which facilitate deeper comprehension and improve retention of the material being studied [16].

3.1. Development of a Game-Based Interactive Puzzle Media to Enhance Critical Thinking Skills in Fifth-Grade Elementary Visual Arts Instruction

During the analysis phase, it was found that visual arts instruction in a private elementary school in Purworejo predominantly employed conventional teaching methods. As a result, students demonstrated limited active participation and low motivation in creating artworks. The minimal use of instructional media by teachers

contributed to suboptimal understanding of the material, which subsequently affected students' learning outcomes. In response to these findings, an interactive and contextual learning media in the form of an interactive puzzle was developed, incorporating types of waste materials, recycling processes, and examples of artistic products. This media was designed to foster students' critical thinking skills, creativity, and collaboration. The initial step involved conducting a needs analysis to identify the necessity for more interactive visual arts learning media, as classroom practices were still teacher-centered and insufficiently engaging. Field findings indicated that the low quality of student learning was largely due to teacher-dominated instruction, while students tended to assume passive roles as listeners rather than active participants [17]. The use of puzzle media consisting of multiple pieces enables students to assemble and match components concretely, thereby facilitating a more meaningful understanding of mathematical concepts [18].

Moreover, visual arts instruction, which should ideally be exploratory and contextual in nature, has not yet fully provided opportunities for students to develop higher-order thinking skills, particularly critical thinking. Visual arts education contributes significantly to character formation by optimizing right-brain functions, including the development of intrapersonal, naturalistic, and emotional intelligence, as well as creativity, spirituality, and morality in a holistic manner [19]. Students tend to follow instructions without engaging in processes of analysis, reflection, or independent decision-making. As a consequence, learning motivation becomes low, and the resulting artworks often lack originality and deep conceptual understanding. Based on these issues, an innovative learning media is required to actively engage students both cognitively and socially.

Therefore, an interactive game-based puzzle learning media was developed, containing content on types of household waste, recycling processes, and examples of artworks made from recycled materials. This media was designed as a solution to the challenges of inclusive learning by offering a more innovative approach. Its design integrates adaptive technology with game-based learning strategies, enabling it to accommodate the diverse needs and learning characteristics of students [20]. Thus, the analysis phase not only identified the weaknesses of the still conventional teaching methods but also formulated the need for interactive, contextual, and game-based learning media. The results of this analysis served as the foundation for developing a game-based interactive puzzle media integrated with critical thinking for fifth-grade visual arts instruction, with the aim of enhancing students' motivation, creativity, collaboration, and overall learning outcomes.

The Design phase involves the initial planning of an educational, game-based instructional media integrated with critical thinking, aligned with the Merdeka Curriculum. In this stage, the researcher gathered supporting references such as teacher guides, student textbooks, and other relevant learning resources to serve as the foundation for material development. The content was focused on transforming waste into artworks and was developed into a puzzle media format that is contextualized to students' daily lives to make learning more meaningful. The appeal of learning media plays a crucial role in student engagement the more engaging the media, the higher the students' motivation to participate in the learning process [21]. The activities began with the development of the concept and storyboard, followed by the design of the instructional media components, which consisted of the puzzle, educational poster board, and user guide. The storyboard serves to visually map the layout of each instructional element within the learning media with precision [22]. The puzzle was designed in four sets made of thick cardboard, featuring artworks created from household waste materials such as wood, plastic bottles, cardboard, and used cans. The poster board displays the steps for creating the artworks, examples of finished products, and the benefits of waste management with visually appealing illustrations. Meanwhile, the cover of the user guide was designed to be informative, including the publisher's identity, Universitas Muhammadiyah Purworejo, and artwork illustrations to reinforce the educational impression.

Next, a development workflow was established that integrated recycling content, visual illustrations, puzzle assembly instructions, and critical thinking questions into a unified interactive media. The subsequent step involved preparing research instruments, including validation sheets, response questionnaires, and pre-test and post-test items, which were then reviewed by the supervising lecturer. The consultation results indicated that all instruments met the criteria for content validity, language, presentation, and graphic design, making them suitable for evaluating the developed product. Therefore, the Design phase aimed to ensure that the instructional media were systematically organized, feasible, and ready to be trialed in the learning process. Additionally, this phase ensured the reliability of the outcomes and the appropriateness of the evaluation methods employed [23].

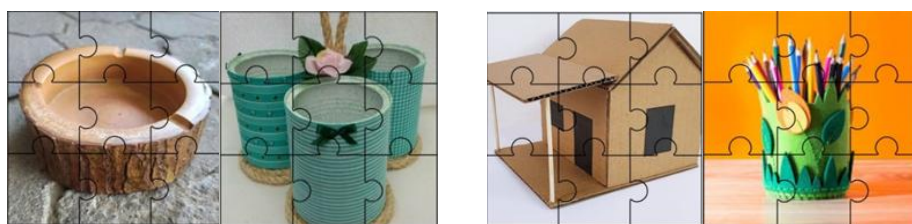


Figure 2. Puzzle design

3.2. Validation Results of the Development of Game-Based Interactive Puzzle Media Integrated with Critical Thinking

The Development phase involved creating the instructional media, followed by consultations with the supervising lecturer and validation by a media expert, a material expert, and a practitioner to assess the feasibility of the product. Once the media was validated and deemed highly feasible, the next step was to conduct trials of the game-based interactive puzzle integrated with critical thinking.

Table 5. Validation Results of the Interactive Puzzle Media

Assessment	Media Expert	Material Expert	Practitioner
Total Score	119	121	116
Number of Aspects	26	26	26
Mean	4.57	4.56	4.46
Criteria	Highly Feasible	Highly Feasible	Highly Feasible

The validation results (Table 5) show that the media expert assigned an average score of 4.57, the material expert gave an average of 4.56, and the practitioner scored 4.46, all of which fall into the “Highly Feasible” category. Furthermore, the mean scores from all three experts ranged between 4.17 and 5.00, indicating a “Highly Valid” classification. These results demonstrate that the interactive puzzle media has successfully met the established feasibility and validity criteria.

These findings indicate that the developed media meets the feasibility criteria in terms of content, presentation, and visual design, while also effectively stimulating students’ critical thinking skills. The interactive puzzle media has been shown to shift students’ learning patterns from passive to more active and responsive engagement during the learning process. Learning media constitute an essential component of teaching and learning activities. The instructional materials developed have undergone validation by experts, including instructional design specialists, material experts, and language experts, leading to the conclusion that the materials meet established validity criteria [24]. This media functions as a learning resource selected based on its alignment with the learning objectives and content, thereby facilitating a more effective understanding of the lesson for students [25], [26].

3.3. Teacher Response Results and Pretest and Posttest on Student Learning Improvement

Next, in the Implementation phase, the learning media was gradually trialed with students at a private elementary school in Purworejo. A limited trial was conducted with 5 students to gather initial feedback on the clarity, attractiveness, and ease of use of the media. Following revisions based on the limited trial results, a broader field trial was conducted with 15 students to more comprehensively assess the effectiveness of the media and user responses. Both trial stages were carried out to identify teachers’ and students’ perceptions of the Interactive Puzzle media in the elementary school setting. The response data are presented in the following table 6.

Table 6. Results of Teacher and Student Responses

No	Assessment	Respondent Score	Maximum Score	Percentage	Category
1	Teacher	31	32	97%	Highly Practical
2	Limited Student Trial	160	160	100%	Highly Practical
3	Field Student Trial	476	480	99%	Highly Practical

Based on the questionnaire results (Table 6), teachers assigned a score of 97%, which falls into the “Highly Practical” category. Teachers evaluated the interactive puzzle media integrated with critical thinking as highly relevant to the learning material, easy to implement, and effective in helping students understand the content while creating a more engaging learning environment. The limited trial with students also yielded a “Highly Practical” score of 100%, with students reporting that the media was interesting to use, easy to operate, and encouraged active and enthusiastic participation in learning. In the broader field trial involving 15 students, a score of 99% was obtained, still classified as “Highly Practical.” Although minor adjustments were made to indicators of active engagement and willingness to reuse the media, overall, the instructional tool was considered effective, enjoyable, and capable of enhancing students’ conceptual understanding.

The variety of shapes, sizes, illustrations, and puzzle pieces successfully captured students’ interest, motivating them to assemble, organize, and match each component to its correct position. Consequently, the media proved highly suitable for teaching flat shape concepts. Additionally, teacher preparation before the lesson, including module arrangement, project planning, and media usage, served as a key factor in supporting the development of students’ creativity in visual arts [27], [28]. Seseorang dapat menumbuhkan kreativitas

melalui aktivitas yang melibatkan imajinasi atau perpaduan gagasan, di mana hasilnya tidak sekadar merupakan rangkuman, tetapi melahirkan pola baru serta kombinasi informasi yang orisinal [29].

The limited trial was conducted with five fifth-grade students at a private elementary school in Purworejo. In this phase, pre-test and post-test assessments were administered using the game-based interactive puzzle media integrated with critical thinking.

Table 7. Pre-test and Post-test Results of the Limited Trial

	N	Minimum	Maximum	Mean	Std. Deviation
N-Gain Score	5	0.55	1.00	0.8191	.19070
N-Gain Percentage	5	54.55	100.00	81.9091	19.07034
Vaid N (listwise)	5				

The limited trial (Table 7) was conducted with five fifth-grade students at a private elementary school in Purworejo. The purpose of this phase was to assess students' initial understanding, the appeal of the media, and the feasibility of conducting learning activities using the game-based interactive puzzle integrated with critical thinking. Based on the pre-test and post-test results, the average N-Gain score was 0.819, which falls into the high category ($0.70 \leq g \leq 1.00$). This indicates a significant improvement in students' understanding after using the interactive puzzle media. The minimum score of 0.55 and maximum of 1.00 demonstrate that all students showed increased learning outcomes. The mean N-Gain percentage was 81.90%, categorized as effective. The results of the limited trial indicate that the interactive puzzle media is suitable for use in the broader field trial, as it meets the effectiveness criteria on a small scale.

The field trial was conducted with 15 fifth-grade students at a private elementary school in Purworejo. In this phase, pre-test and post-test assessments were administered using the game-based instructional media integrated with critical thinking.

Table 8. Pre-test and Post-test Results of the Field Trial

	N	Minimum	Maximum	Mean	Std. Deviation
N- Gain Score	15	0.50	1.00	0.7928	.19004
N-Gain Percentage	15	50.00	100.00	79.2826	19.00430
Vaid N (listwise)	15				

The field trial (Table 8) was conducted with 15 fifth-grade students to evaluate the effectiveness of the media on a larger scale and to test the consistency of findings obtained from the limited trial. The pre-test and post-test results showed an average N-Gain score of 0.7928, which falls into the high category ($0.70 \leq g \leq 1.00$). This indicates that the effectiveness of the interactive puzzle media in improving learning outcomes remained consistent, even when applied to a larger group of students. The average N-Gain percentage was 79.28%, categorized as effective.

The results of both the limited and field trials reinforce the effectiveness of the media. In the limited trial, the average N-Gain score was 0.8191, classified as high ($0.70 \leq g \leq 1.00$), with a percentage score of 81.90%, categorized as effective. In the field trial, the average N-Gain score was 0.7928, also in the high category, with a percentage score of 79.28%, likewise categorized as effective. The field trial demonstrated a significant improvement in students' learning outcomes within the effective range. This indicates that the use of the interactive puzzle media not only deepens students' understanding of visual arts material but also fosters their learning motivation and emotional engagement during the instructional process. The success of delivering learning content depends heavily on the alignment and coherence of systematically designed instructional components [30]. Based on the N-Gain results, it can be concluded that the developed instructional media is effective for use in the learning process, as it demonstrated a significant improvement in students' learning outcomes following its implementation [31]. Effective learning requires active student engagement so that the learning process involves not only receiving information but also independently constructing understanding [32], [33]. The improvement in students' learning outcomes is evident from the pre-test and post-test scores in both the scientific argumentation and cognitive tests, with both showing a moderate level of increase based on the N-Gain values [34].

The effectiveness of this interactive puzzle media can also be explained through the game-based learning approach, which uses various types of games to achieve learning objectives. Interactive learning media facilitate the instructional process by enhancing the clarity of content delivery, enabling learning goals to be achieved both effectively and efficiently [35], [36]. The use of puzzle-based instructional media has demonstrated its effectiveness in enhancing students' collaboration skills, as evidenced by increased active participation in group activities, including helping one another, sharing opinions, and staying engaged until the tasks are completed [37]. In the context of this study, students actively engaged in assembling, observing, and

discussing puzzles containing information about waste and artworks, creating an integration of logical thinking, collaboration, and aesthetic appreciation. The puzzle media stimulates students' critical thinking through trigger questions associated with each key term, thereby developing their critical reasoning skills and effectively improving learning outcomes. The use of concrete media helps students understand concepts more meaningfully, leading to enhanced academic achievement [38], [39].

Moreover, the visual arts material carries strong environmental education value. Through the manipulative activities of the puzzle and visual analysis of the poster, students learn to identify types of waste, understand processing methods, and develop creative ideas to transform waste into artworks. The alignment between the learning material and the planned objectives, along with the established competencies and indicators, supports the enhancement of students' skills and helps achieve learning goals more effectively [40]. This process aligns with the principles of the *Merdeka Curriculum*, which emphasizes project-based learning and the development of creative, collaborative, and environmentally conscious character. Learning media serve as tools that convey instructional messages or information intended to support teaching and learning objectives [41], [42]. Infographic poster media play a crucial role in facilitating students' understanding of learning material in the classroom [43].

3.4. Evaluation of the Game-Based Interactive Puzzle Media Integrated with Critical Thinking

The Evaluation phase is the final stage, aimed at assessing the overall quality of the instructional media that has been designed and developed. This evaluation ensures that the learning tool is feasible and suitable for use in the teaching and learning process.

Table 9. Product Revision Results

No	Aspect Revised	Improvement
1	Weak adhesive	Replaced with a stronger, heavy-duty cardboard adhesive to ensure the puzzle pieces are more durable and do not detach easily during use.
2	Untidy box appearance	Improved box cutting precision, reinforced the corners, and added simple graphic designs to make it more attractive, aesthetic, and practical for puzzle storage.
3	Learning Outcomes and Learning Objectives not included	Added Learning Outcomes and Objectives at the beginning of the user guide to provide clearer instructional direction.

Revisions were made in three aspects: using a specialized adhesive to strengthen the puzzle, improving the puzzle box design for greater neatness and visual appeal, and adding Learning Outcomes and Objectives to the user guide and poster to align with the curriculum.

Through this evaluation process, a game-based interactive puzzle media integrated with critical thinking was developed to be more effective in supporting students' thinking skills. Consequently, the Interactive Puzzle media has the potential to assist teachers in delivering visual arts content while also fostering students' interest and active participation during learning. Recommended improvements focus on strengthening the materials, refining the visual design, and aligning the content with the curriculum; these enhancements will be addressed in subsequent research and development. Considering that elementary students are naturally inclined to play, move, work in groups, and perform tasks hands-on, learning should be designed to be more student-centered, promoting active participation through the use of appropriate models and media [44], [45]. The developed instructional media needs to be aligned with the learning program in use and tailored to the needs of students in the class, encompassing the syllabus, lesson plans, student worksheets, learning media, and assessment instruments for evaluating learning outcomes [46]. Learning media are essential to support the teaching and learning process by facilitating the delivery of instructional content [47].

Overall, this study successfully developed instructional media that meet the criteria of validity, practicality, and effectiveness. The learning media, developed through the stages of planning, design, and evaluation, aim to ensure alignment between the content, instructional strategies, and the needs of students within the learning environment [48]. The learning media developed based on the principles of the *Merdeka Curriculum* is able to support the enhancement of 21st-century competencies, including critical thinking, creativity, and students' independent learning skills [49]. The implementation of the game-based interactive puzzle has been proven to enhance students' critical thinking skills, promote active engagement, and assist teachers in creating a more enjoyable and meaningful learning experience. The puzzle media helps children understand and follow instructions effectively to achieve learning objectives [50]. These findings play a

significant role in innovating teaching and learning tools for elementary schools, particularly by applying the game-based learning concept within the context of visual arts education.

4. CONCLUSION

This study developed an interactive puzzle learning media aimed at creating and testing the feasibility of game-based puzzles integrated with critical thinking for fifth-grade visual arts material. Based on the results of both the limited and field trials, the media proved effective in deepening students' understanding of visual arts concepts. In addition, the interactive puzzle media was able to enhance student participation in a more active, enjoyable, and collaborative learning process. Validation by material experts, media experts, and practitioners indicated that the instructional tool is highly feasible, with mean validity scores of 4.56 from material experts, 4.57 from media experts, and 4.46 from practitioners. Both students and teachers responded very positively to the use of this media, demonstrating that it is not only easy to use but also effective in motivating students, making learning more engaging and meaningful. Overall, the game-based interactive puzzle is effective in improving learning quality, particularly in the context of recycled art, while simultaneously fostering students' character development to meet 21st-century challenges.

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AUTHOR CONTRIBUTIONS

KTS, NN, and S designed the study, carried out the analysis, collected the data, and prepared the manuscript.

CONFLICTS OF INTEREST

The author(s) declare no conflict of interest.

USE OF ARTIFICIAL INTELLIGENCE (AI)-ASSISTED TECHNOLOGY

The authors declare that no artificial intelligence (AI) tools were used in the generation, analysis, or writing of this manuscript. All aspects of the research, including data collection, interpretation, and manuscript preparation, were carried out entirely by the authors without the assistance of AI-based technologies.

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