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DEVELOPMENT OF DIGITAL PUZZLE MEDIA ASSISTED BY THE PROBLEM-BASED LEARNING (PBL) MODEL TO IMPROVE ELEMENTARY SCHOOL STUDENTS' DECISION-MAKING SKILLS

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Abstract

This study aimed to develop digital puzzle media assisted by the Problem-Based Learning (PBL) model, determine its feasibility and effectiveness, and examine student responses to its use in improving elementary school students' decision-making skills. The study employed a Research and Development (R&D) approach based on the Borg and Gall model, which was adapted into eight operational stages. Participants were Grade IV elementary school students in Cimahi and Bandung. Data were collected through interviews, observations, expert validation sheets, decision-making tests, and student response questionnaires, and were analyzed using qualitative and quantitative descriptive techniques. The results showed that the developed media was highly feasible, with validation scores of 98% from the media expert and 100% from the subject-matter expert. Effectiveness testing consistently showed significant differences between pretest and posttest scores ($p < .001$). The N-Gain scores were 0.41 in the limited trial, 0.43 in the broader trial, and 0.41 in the effectiveness trial, all within the moderate improvement category. Student responses across the three stages were generally very positive. These findings indicate that integrating digital puzzle activities with PBL can provide an interactive problem-solving environment that supports students in analyzing information, considering alternatives, and making decisions during elementary school learning.

Keywords: Digital Puzzle, Problem-Based Learning, Decision-Making Skills, Elementary School.

Abstrak

Penelitian ini bertujuan untuk mengembangkan media puzzle digital berbantuan model Problem Based Learning (PBL), mengetahui kelayakan dan efektivitasnya, serta menganalisis respons siswa terhadap penggunaan media dalam meningkatkan kemampuan pengambilan keputusan siswa sekolah dasar. Penelitian menggunakan metode Research and Development (R&D) dengan model Borg & Gall yang diadaptasi menjadi delapan tahapan operasional. Subjek penelitian terdiri atas siswa kelas IV sekolah dasar di Kota Cimahi dan Kota Bandung. Data dikumpulkan melalui wawancara, observasi, lembar validasi ahli, tes kemampuan pengambilan keputusan, dan angket respons siswa, kemudian dianalisis secara deskriptif kualitatif dan kuantitatif. Hasil penelitian menunjukkan bahwa media memiliki tingkat kelayakan sangat tinggi dengan validasi ahli media sebesar 98% dan ahli materi sebesar 100%. Uji efektivitas menunjukkan perbedaan yang signifikan antara skor pretest dan posttest ($p < 0,001$). Nilai N-

Gain pada uji terbatas sebesar 0,41, uji luas sebesar 0,43, dan uji efektivitas sebesar 0,41, yang seluruhnya berada pada kategori peningkatan sedang. Respons siswa pada ketiga tahap berada pada kategori sangat positif. Dengan demikian, integrasi media puzzle digital dan model PBL berpotensi menciptakan pembelajaran interaktif berbasis pemecahan masalah yang mendukung kemampuan siswa dalam menganalisis informasi, mempertimbangkan alternatif, dan mengambil keputusan.

Kata Kunci: Puzzle Digital, Problem Based Learning, Kemampuan Pengambilan Keputusan, Sekolah Dasar.

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INTRODUCTION

Decision-making is an important cognitive skill that needs to be developed in elementary school because it underlies students' ability to select appropriate actions based on available information. Hidayat (2020) defines decision-making as the process of selecting the best option from several relevant alternatives through logical consideration. Widodo (2021) further explains that decision-making skills contribute to students' independence, responsibility, and direction in learning and everyday activities. Similarly, Lestari (2022b) emphasizes that decision-making should be developed from an early age because it is closely related to students' ability to solve problems and complete tasks effectively. Therefore, decision-making is an essential competence within twenty-first-century learning.

Ideally, elementary school students should be able to express opinions, select solutions based on logical reasons, cooperate effectively, and resolve conflicts appropriately. However, previous studies indicate that these skills are not always well developed. Pratiwi (2020) reported that many students experienced difficulty selecting solutions when facing simple classroom problems, while Suryani (2021) associated weak decision-making with limited learning activities that train students to analyze information and consider alternatives. Kartika (2022) also reported that students may choose answers impulsively without sufficient logical consideration. Preliminary interviews with an elementary school teacher in Cimahi revealed a similar pattern: when students were required to choose a solution or determine the most appropriate answer, some appeared uncertain, took considerable time, and waited for teacher direction rather than independently comparing available options. These findings suggest that students need more opportunities to analyze information before making decisions.

One instructional approach that can address this need is Problem-Based Learning (PBL). Sani (2020) describes PBL as a learning model that uses authentic problems as a basis for students to analyze information and construct solutions. Yuliastuti (2022) explains that PBL can support higher-order thinking by engaging students in inquiry, while Rahmawati (2023) emphasizes that problem-based activities can train decision-making through problem formulation, evaluation of alternatives, and selection of the most appropriate solution. PBL offers several advantages, including increased student participation (Sani, 2020), development of critical thinking and problem-solving skills (Yuliastuti, 2022), and stronger learner independence and responsibility (Rahmawati, 2023). Nevertheless, PBL may require more instructional time, careful teacher facilitation, and sufficient student readiness for independent and collaborative learning.

In addition to an appropriate learning model, learning media can shape how actively students participate in problem solving. Digital puzzles are relevant because they present pieces of information that must be arranged or selected to form an appropriate solution. Ramadhani (2023) describes digital puzzle media as technology-based learning media that require students to arrange information into a correct configuration, thereby stimulating analysis. Fitria (2022) notes that digital puzzles can make learning more engaging through visual and interactive challenges, while Nurbaiti (2021) argues that puzzle activities can support decision-making because students must select and place information accurately. Such media may improve attention, accuracy, and conceptual understanding, although their implementation depends on access to appropriate devices and teachers' ability to integrate technology effectively.

Previous studies have demonstrated positive contributions of digital learning media and PBL in elementary education. Adventyana et al. (2023) reported that digital media can create more innovative and interactive learning environments, while Putri and Lestari (2023) found that game-based digital media can increase active student participation. Hayati and Yamin (2023) reported improved learning outcomes through puzzle media, and Ramadhani et al. (2024) highlighted the potential of puzzle-based activities to support engagement and critical thinking. From the instructional-model perspective, Lestari and Winanto (2022) reported that PBL supports elementary students' problem-solving skills. Mustasphia et al. (2025) similarly associated interactive and collaborative puzzle activities with critical thinking development.

Although these findings are promising, previous research has generally focused on learning outcomes, motivation, participation, problem solving, or critical thinking. Research specifically integrating digital puzzle media with PBL to improve elementary school students' decision-making skills remains limited. The novelty of the present study therefore lies in combining a digital puzzle developed with Canva AI and the PBL model in learning activities explicitly designed to train students to identify problems, examine alternatives, and make reasoned decisions. This integration is also relevant to technology-supported learning and the implementation of the Merdeka Curriculum.

Based on this background, the study addressed four questions: how digital puzzle media assisted by PBL can be developed; whether the developed media is feasible; whether it is effective in improving elementary school students' decision-making skills; and how students respond to its use. Accordingly, the study aimed to develop the media, determine its feasibility, evaluate its effectiveness, and analyze student responses to the implementation of the digital puzzle media assisted by the PBL model.

METHOD

This study employed a Research and Development (R&D) approach adapted from Borg and Gall. Gall et al. (2007) describe educational R&D as a systematic process for developing and validating educational products. The approach was selected because it allows a product to be designed, tested, revised, and evaluated according to field needs. Kustiawan et al. (2020) also note that development procedures may be adapted to the requirements and context of a study.

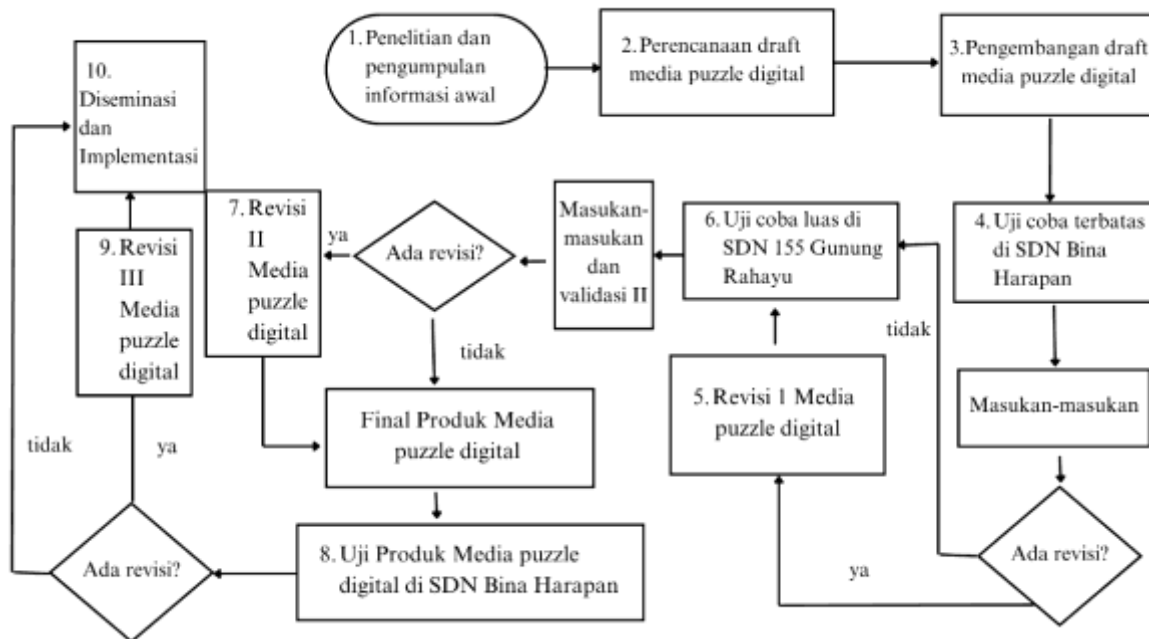
The original Borg and Gall procedure contains ten stages: preliminary research and information gathering; planning; development of the preliminary product; preliminary field testing; revision of the preliminary product; broader field testing; product revision; final product testing; final revision; and dissemination and implementation. In this study, these procedures were operationally adapted into eight development stages to match the research scope and field conditions. The stages included preliminary research and information collection, planning,

preliminary product development and validation, limited testing, product revision, broader field testing and further validation, final product revision, and final effectiveness testing.

The study involved Grade IV students from elementary schools in Cimahi and Bandung. Participants were selected purposively by considering schools that implemented the Merdeka Curriculum and had facilities that supported the use of digital media. The study comprised three testing stages. A limited trial was conducted with 24 Grade IV students in Cimahi to identify initial weaknesses in content, appearance, and usability. A broader field trial was then conducted with 52 students from Grades IVB and IVC in Bandung. Finally, an effectiveness trial was conducted with 24 Grade IV students in Cimahi to strengthen the evidence concerning the effectiveness of the developed media.

Data were collected through interviews, observations, expert validation sheets, decision-making tests, and student response questionnaires. Semi-structured interviews with Grade IV teachers were used during the needs-analysis stage to obtain information about classroom learning, media use, and students' decision-making skills. Observation was used to document classroom activities and supporting infrastructure. Media and subject-matter expert validation sheets assessed the appearance, content, language, and alignment of the media with learning objectives. Decision-making skills were measured using five essay items for the pretest and five essay items for the posttest, developed around the indicators of identifying problems, generating alternatives, evaluating alternatives, selecting an option, and evaluating the effectiveness of the selected option. Student responses were collected using a 15-item four-point Likert questionnaire covering media attractiveness, learning motivation, decision-making, collaborative participation, and understanding of the material. According to the source manuscript, the instruments had been tested and showed very high validity, high reliability, easy-to-moderate difficulty levels, and discrimination indices ranging from fair to very good.

Qualitative data from interviews, observations, and validator comments were analyzed descriptively and used to revise the product. Quantitative data were analyzed using Microsoft Excel and IBM SPSS Statistics 26 for Windows. The Shapiro-Wilk test was used to examine data normality before parametric hypothesis testing. When the data met the normality assumption, a paired-samples t-test was used to compare pretest and posttest scores from the same group. Statistical significance was interpreted at $p < .05$. N-Gain analysis was subsequently used to determine the magnitude of improvement in students' decision-making skills after using the developed media.

Figure 1. Research and Development Procedure

RESULTS AND DISCUSSION

Results

Development Process of the Digital Puzzle Media

The development process followed the adapted Borg and Gall sequence. In the first stage, preliminary research and information collection were conducted through teacher interviews and a literature review. The findings showed that students had limited opportunities to practice decision-making in classroom learning and that digital learning media had not been used optimally. In the planning stage, the researchers designed the structure of the digital puzzle media and selected Canva AI as the development platform. Research instruments were also prepared at this stage.

During preliminary product development, the digital puzzle media was constructed and reviewed through supervision before being submitted to media and subject-matter experts for validation. The product was then revised according to validator comments. The fourth stage was a limited trial involving 24 Grade IV students, followed by the first product revision. The revised product was subsequently tested in a broader field trial with 52 Grade IV students. Findings from this stage were used to refine the product again. The final stage involved an effectiveness trial to examine whether the digital puzzle media assisted by PBL consistently supported improvements in students' decision-making skills.

Table 1. Digital Puzzle Media Developed Using Canva AI

Media Display	Description
	The cover uses illustrations and colors aligned with the Bhinneka Tunggal Ika topic and the characteristics of elementary school students. The Teacher Mode provides a teacher dashboard for viewing instructions, PBL flow, and students' learning progress.

Figure 2. Cover and Teacher Mode

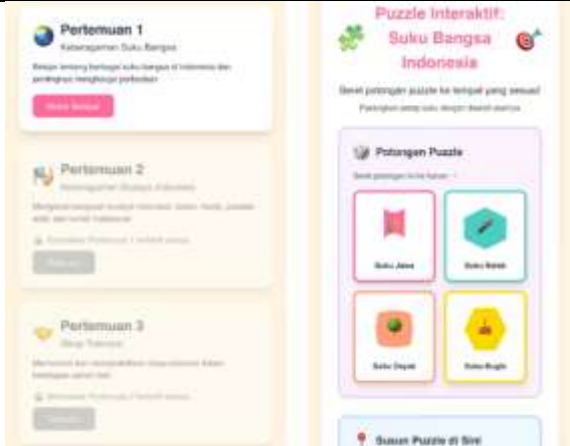
	The activity-design section presents the sequence of learning activities across meetings. The Digital Puzzle section requires students to arrange or select puzzle elements and determine appropriate answers, thereby providing structured opportunities to practice decision-making.
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Figure 3. Learning Activities and Digital Puzzle

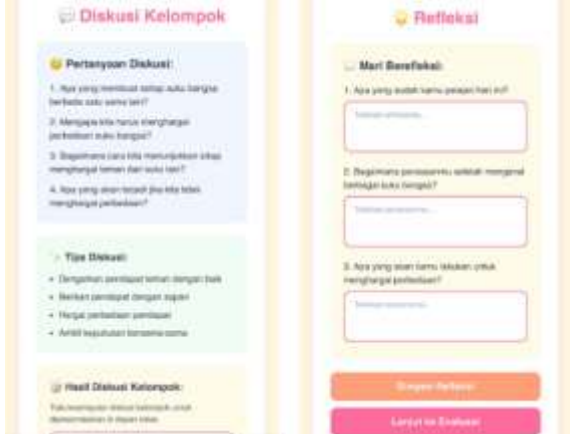
	The group discussion section contains worksheet-based tasks completed collaboratively in accordance with PBL stages. Reflection and evaluation activities are provided at the end of learning to help students review the material and the reasoning used in reaching decisions.
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Figure 4. Group Discussion and Reflection

Feasibility of the Digital Puzzle Media

Product feasibility was evaluated through expert validation using a four-point Likert scale. The media expert assessed technical presentation, visual quality, usability, and interactivity, while the subject-matter expert assessed the appropriateness of the content, learning objectives, student characteristics, and alignment with PBL activities.

Table 2. Expert Validation Results

Expert Validator	Percentage	Category
Media Expert	98%	Highly Feasible
Subject-Matter Expert	100%	Highly Feasible

The media expert awarded 51 points out of a maximum of 52, corresponding to approximately 98%, and categorized the product as highly feasible for use without further revision. This result indicates that the media met the expected criteria for presentation, ease of use, visual quality, and interactivity. The subject-matter expert awarded the maximum score of 60 out of 60, equivalent to 100%, also in the highly feasible category. The material was therefore considered appropriate for the learning objectives, elementary students' characteristics, and the stages of the PBL model. Together, these results indicate that the digital puzzle media was suitable for classroom implementation.

Effectiveness of the Digital Puzzle Media

Effectiveness was examined across a limited trial, a broader field trial, and a final effectiveness trial. In each stage, students completed pretest and posttest measures of decision-making skills. Normality was examined using the Shapiro-Wilk test, differences were tested using a paired-samples t-test, and improvement was interpreted using N-Gain scores.

Table 3. Limited Trial Results

Measure	Result
Number of Students	24
Pretest Mean	65.4
Posttest Mean	75.5
Shapiro-Wilk Normality	Pretest $p = 0.381$; Posttest $p = 0.551$ (normal)
Paired-Samples t-test	$p < .001$ (significant)
N-Gain	0.41 (Moderate)

In the limited trial, the mean score increased from 65.4 on the pretest to 75.5 on the posttest. Both datasets were normally distributed ($p > .05$). The paired-samples t-test showed a statistically significant difference between the two measurements ($p < .001$), and the N-Gain of 0.41 indicated a moderate level of improvement. These results suggest that the media supported students in identifying information, considering alternatives, and selecting appropriate solutions during problem-solving activities.

Table 4. Broader Field Trial Results

Measure	Result
Number of Students	52
Pretest Mean	61.2
Posttest Mean	73.8
Shapiro-Wilk Normality	Pretest $p = 0.332$; Posttest $p = 0.119$ (normal)
Paired-Samples t-test	$p < .001$ (significant)
N-Gain	0.43 (Moderate)

In the broader field trial with 52 students, the mean score increased from 61.2 to 73.8. The normality assumption was met for both pretest and posttest data, and the paired-samples t-test again indicated a significant difference ($p < .001$). The N-Gain score of 0.43 was in the moderate category. The consistency of improvement in a larger group suggests that the media can be implemented beyond a small pilot group while maintaining a similar pattern of learning gains.

Table 5. Effectiveness Trial Results

Measure	Result
Number of Students	24
Pretest Mean	72.8
Posttest Mean	82.6
Shapiro-Wilk Normality	Pretest $p = 0.124$; Posttest $p = 0.333$ (normal)
Paired-Samples t-test	$p < .001$ (significant)
N-Gain	0.41 (Moderate)

The final effectiveness trial also showed an increase in mean score, from 72.8 to 82.6. Both distributions met the normality criterion, and the paired-samples t-test indicated a significant pretest-posttest difference ($p < .001$). The N-Gain score of 0.41 again fell within the moderate category. Across the three stages, the repeated pattern of significant improvement and moderate N-Gain values provides consistent evidence that the digital puzzle media assisted by PBL was effective in supporting students' decision-making skills within the conditions of the study.

Student Responses to the Digital Puzzle Media

Student responses were collected after implementation using a 15-item four-point Likert questionnaire. The questionnaire covered media attractiveness, learning motivation, decision-making, collaborative participation, and understanding of the material. The results from the three testing stages are presented below.

Table 6. Student Response Questionnaire Results

Testing Stage	Aspect	Percentage	Category
Limited Trial	Media Attractiveness	82%	Very Good
Limited Trial	Learning Motivation	78%	Very Good
Limited Trial	Decision-Making	82%	Very Good
Limited Trial	Collaborative Participation	79%	Very Good
Limited Trial	Material Understanding	81%	Very Good
Broader Trial	Media Attractiveness	84%	Very Good
Broader Trial	Learning Motivation	82%	Very Good
Broader Trial	Decision-Making	83%	Very Good
Broader Trial	Collaborative Participation	81%	Very Good
Broader Trial	Material Understanding	82%	Very Good
Effectiveness Trial	Media Attractiveness	85%	Very Good
Effectiveness Trial	Learning Motivation	82%	Very Good
Effectiveness Trial	Decision-Making	84%	Very Good
Effectiveness Trial	Collaborative Participation	82%	Very Good
Effectiveness Trial	Material Understanding	82%	Very Good

Across the three stages, student responses were consistently positive. In the limited trial, scores ranged from 78% to 82%; in the broader trial, from 81% to 84%; and in the effectiveness trial, from 82% to 85%. The highest percentage was recorded for media attractiveness in the effectiveness trial (85%). According to the categories reported in the source manuscript, all aspects were interpreted as very good. Classroom observations also indicated that students were more active in discussion, more willing to express opinions, and more focused when working collaboratively to solve the digital puzzle tasks.

Discussion

Development of the Digital Puzzle Media

The digital puzzle media was developed using an adapted Borg and Gall R&D process that began with needs analysis and continued through iterative planning, validation, testing, revision, and effectiveness testing. This sequence enabled the product to be refined based on both expert feedback and classroom implementation. Kustiawan et al. (2020) support the

adaptation of development procedures to field conditions, while Widodo (2023) highlights the continuing need to strengthen the use of interactive digital media in elementary education.

The preliminary findings showed that students tended to be passive and had limited experience with activities requiring independent decision-making. This condition also reflects the importance of interactive media in increasing motivation and classroom participation (Utami, 2021). Hidayat (2021) similarly argues that learning that does not involve problem-based processes provides fewer opportunities for students to develop critical thinking and decision-making. The integration of digital puzzle media with PBL was therefore designed to respond to both the media-use gap and the need for cognitive engagement.

At the planning stage, puzzle activities were structured as pieces of information that students needed to analyze, compare, and arrange into an appropriate solution. Such game-based tasks can encourage active selection and reasoning (Putra, 2021), while interactive digital media can increase cognitive engagement (Lestari, 2022a). The PBL structure further required students to analyze problems before deciding on solutions, a process that is closely aligned with decision-making practice (Saputra, 2020).

The limited and broader trials showed that students became increasingly engaged in arranging puzzle elements and discussing possible answers. This shift from passive reception toward active participation is consistent with previous findings concerning interactive media (Utami, 2021), PBL-based discussion and problem solving (Saputra, 2020), and digital participation in learning (Lestari, 2022a). The broader trial also demonstrated that the pattern of improvement persisted in a larger group, suggesting that the design was not only workable in a small pilot setting.

The final effectiveness trial strengthened the evidence that the developed media supported decision-making skills. The combination of digital tasks and PBL required students to identify a problem, communicate ideas, compare options, and reach a solution. Firdaus et al. (2023) associate problem-based learning supported by interactive digital media with critical thinking development, while Farhin et al. (2023) emphasize the role of technology-supported interactive learning in increasing engagement and collaboration. Overall, the development process produced a learning environment in which students did not merely receive information but actively used information to make decisions.

Feasibility of the Digital Puzzle Media

The expert validation results indicate a very high level of feasibility: 98% from the media expert and 100% from the subject-matter expert. These findings suggest that the developed media met the expected standards in terms of visual presentation, usability, interactivity, content alignment, and compatibility with learning objectives. Media feasibility is important because technically usable and conceptually appropriate media can reduce unnecessary barriers during learning and allow students to focus on the reasoning tasks embedded in the activity.

The media was intentionally designed with a simple visual structure and interactive components to support exploration and problem solving. Handayani and Mulyani (2022) report that interactive digital media can improve students' cognitive engagement because it invites direct participation in exploration. This was reflected in the present study through students' discussions, connections between information, and collaborative decisions about puzzle answers. Similar findings concerning analytical engagement have been reported by Ramadhani and Suryani (2024). Rahayu et al. (2024) also emphasize that validated digital learning media

can support learning quality when content and objectives are appropriately aligned, while Wulandari and Prasetyo (2022) and Sari (2023) highlight the importance of feasibility and validity for effective classroom use.

The integration of PBL further strengthened the educational function of the media. Prasetyo and Lestari (2023) explain that PBL encourages learners to analyze problems, evaluate possible solutions, and select logical decisions. In this study, those processes were embedded in the task of arranging and interpreting puzzle elements through group discussion. Thus, the product's feasibility was not limited to appearance or technical usability; it also reflected alignment between media functions and the targeted decision-making processes.

Effectiveness of the Digital Puzzle Media

The effectiveness results showed statistically significant differences between pretest and posttest scores in all three testing stages, with moderate N-Gain values ranging from 0.41 to 0.43. These findings indicate that the use of digital puzzle media assisted by PBL was associated with consistent improvement in students' decision-making skills. The moderate N-Gain values are important because they suggest meaningful improvement while also indicating that there remains room for further instructional strengthening.

The observed improvement can be understood through the learning processes required by the PBL-integrated media. Rather than simply receiving content, students needed to interpret a problem, analyze available information, consider alternatives, and determine a solution. Dayu et al. (2022) link PBL with the development of critical thinking because students are required to analyze and solve problems. In the present study, students demonstrated this process while discussing puzzle arrangements and justifying their decisions. Maria et al. (2022) similarly report that PBL-supported interactive media can promote higher-order thinking, while Fitriyah et al. (2022) found positive effects of PBL on reasoning and problem-solving ability.

The findings are also consistent with Hidayat and Nugroho (2022), who report significant effects of PBL on critical thinking, and with Wahyuni et al. (2024) and Adawiyah et al. (2024), who emphasize the contribution of digital media integrated with problem-based learning to learning outcomes and problem-solving skills. The present study extends these findings by focusing specifically on decision-making rather than only on achievement or general critical thinking.

Student Responses to the Digital Puzzle Media

Student responses were consistently positive across the limited, broader, and effectiveness trials. Students reported strong interest in the media and positive perceptions of motivation, decision-making activities, collaboration, and material understanding. The visual design, straightforward language, Bhinneka Tunggal Ika content, and group problem-solving tasks appeared to make the learning experience more engaging. Classroom observations similarly suggested that students were more enthusiastic, focused, and confident when participating in the digital puzzle activities.

Positive responses are relevant because engagement can support sustained participation in cognitively demanding activities. Hidayati and Nurhasanah (2023) associate interactive digital media with stronger cognitive engagement through exploration and problem solving. Pratama et al. (2024) report that integrating PBL with digital media can support critical thinking and

active participation, while Novianti et al. (2023) link interactive media with motivation and engagement. Putri and Lestari (2023) likewise emphasize that game-based learning can create enjoyable learning experiences that encourage active participation.

The collaborative component of the media also supported communication and shared decision-making. Saputra and Firmansyah (2022) note that PBL can strengthen interaction and cooperation, while Yusuf et al. (2023) associate digital PBL activities with communication, collaboration, and decision-making. Handoko et al. (2022) further explain that problem-based learning can develop higher-order thinking because students learn to analyze conditions before selecting solutions. Therefore, the positive student response in the present study supports the practicality of the product and complements the statistical evidence of improvement.

CONCLUSION

The digital puzzle media assisted by the Problem-Based Learning (PBL) model was successfully developed through an adapted Borg and Gall Research and Development process and was found to be feasible, effective, and positively received for supporting elementary school students' decision-making skills. Expert validation produced scores of 98% from the media expert and 100% from the subject-matter expert, indicating a very high level of feasibility. Across the limited trial, broader field trial, and final effectiveness trial, paired-samples t-tests showed significant differences between pretest and posttest scores ($p < .001$), while N-Gain scores of 0.41, 0.43, and 0.41 respectively indicated moderate improvement. Student responses were consistently positive across media attractiveness, learning motivation, decision-making, collaboration, and material understanding. The findings suggest that integrating digital puzzle activities with PBL can create a more active and interactive learning environment in which students practice identifying problems, analyzing information, comparing alternatives, and making reasoned decisions. The developed media therefore has practical potential as an innovative digital learning resource for elementary education. However, the study was limited to particular learning content, grade levels, and implementation periods. Future research should examine the media across different subjects, longer intervention periods, and a wider range of grade levels to determine the consistency and generalizability of its effects on students' decision-making skills.

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