



Development of a Flipbook-Based E-LKPD Using Bruner's Cognitive Theory to Enhance Learning Independence of Third-Grade Elementary School Students

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Abstract: This study addresses the limited integration of cognitive learning theory with interactive digital media in elementary mathematics instruction, which contributes to low student learning independence. The study aims to develop and evaluate a flipbook-based electronic student worksheet (E-LKPD) grounded in Bruner's cognitive theory. A Research and Development (R&D) approach was employed using the ADDIE model, involving third-grade students at SDN 25 Sungai Sirah Hilir (N = 50; experimental and control groups). Data were collected through expert validation sheets, practicality questionnaires, learning independence instruments, and pretest-posttest measures, and analyzed using descriptive statistics, N-Gain, and an independent sample t-test. The results indicate that the developed E-LKPD achieved very high validity (92.55%) and practicality (teacher: 98.40%; students: 97.00%). The effectiveness test showed that the experimental group outperformed the control group in learning independence (80.20% vs. 67.47%) with a significant difference ($p < 0.05$) and a higher N-Gain score (0.80 vs. 0.43). These findings demonstrate that integrating Bruner's cognitive theory through enactive, iconic, and symbolic stages in flipbook-based E-LKPD enhances students' learning independence. Therefore, the developed E-LKPD is feasible and effective as an innovative instructional medium to support independent learning in elementary mathematics.

Keywords: Bruner's cognitive theory; E-LKPD; Elementary mathematics; Flipbook; Learning independence

Introduction

Mathematics learning in elementary school plays a fundamental role in developing students' cognitive abilities, particularly in logical reasoning and problem-solving (Ahmad, 2022). However, instructional practices in many classrooms remain predominantly teacher-centered, emphasizing procedural knowledge rather than conceptual understanding. This condition is especially evident in lower grades, where students often encounter difficulties in mastering basic operations such as addition and subtraction of whole numbers (Safitri et al., 2024). Consequently, students tend to rely heavily on

teacher explanations and exhibit low levels of learning independence.

Learning independence, often conceptualized as self-regulated learning, is a critical competency that enables students to take initiative, manage their own learning processes, and evaluate their progress (Darmansyah, 2021). In the context of elementary education, fostering this competence is essential, as it supports not only immediate academic achievement but also long-term learning capacity (Nurahlina & Aprilia, 2025). Despite its importance, many existing instructional materials and classroom practices have not been systematically designed to promote students' independence in learning (Rahman et al., 2024).

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The integration of digital learning media offers a potential pathway to address these challenges by creating more interactive and student-centered learning environments (Darmansyah, 2023). Well-designed digital materials can support self-paced learning, increase engagement, and encourage active participation (Zainil et al., 2024). However, current digital learning resources, including electronic worksheets, are often developed with a primary focus on visual appeal and usability, while lacking a strong theoretical foundation that supports students' cognitive development (Syamil et al., 2026). As a result, their impact on deeper learning processes and learning independence remains limited (Utia et al., 2024).

Bruner's cognitive theory provides a robust theoretical framework for designing meaningful learning experiences through its three modes of representation: enactive, iconic, and symbolic (Fadila & Syutaridho, 2025). These stages are particularly relevant for elementary mathematics, as they guide students from concrete experiences toward abstract understanding (S. Nisa et al., 2023). Previous studies have shown that applying Bruner's framework can enhance conceptual understanding and cognitive engagement (Safira et al., 2025). Nevertheless, its integration into digital instructional media, especially in the form of electronic worksheets, remains underexplored (Yudhi & Wahyuni, 2025).

In this context, flipbook-based electronic student worksheets (E-LKPD) emerge as a promising instructional medium that combines interactivity, structured content, and accessibility (C. Nisa, 2025). Flipbook media allows the integration of text, images, and interactive elements in a format that supports independent exploration of learning materials. Although prior studies have demonstrated the effectiveness of flipbook-based media in improving engagement and learning outcomes (Putri et al., 2021; Rahmawati et al., 2022), they have not explicitly integrated cognitive learning theory as a design foundation to foster learning independence.

Therefore, the novelty of this study lies in the integration of Bruner's cognitive theory into the design of flipbook-based E-LKPD, specifically structured through the enactive, iconic, and symbolic stages to systematically promote students' learning independence in elementary mathematics (Annisa, 2025). In addition, this study not only focuses on the development of digital instructional media but also evaluates its effectiveness in enhancing learning independence through empirical testing using a comparative experimental design (Pardomuan Simanullang, 2024).

This research is important because it addresses the gap between technology integration and pedagogical theory in elementary education (Asyari et al., 2025). By combining a strong theoretical foundation with interactive digital media, this study contributes to the development of more meaningful, student-centered learning environments that support independent learning skills. Furthermore, it provides practical implications for teachers in designing and implementing innovative instructional materials that align with the demands of 21st-century education (Azizah et al., 2024).

Method

This study employed a Research and Development (R&D) design aimed at developing and evaluating a flipbook-based electronic student worksheet (E-LKPD) grounded in Bruner's cognitive theory. The development process followed the ADDIE model, consisting of analysis, design, development, implementation, and evaluation stages (Maisy & Ahmad, 2024). This model was selected to ensure a systematic and iterative process in producing an instructional product that is valid, practical, and effective.

The study was conducted at SDN 25 Sungai Sirah Hilir and involved third-grade elementary school students learning addition and subtraction of whole numbers. A total of 50 students participated in the study, consisting of 25 students in the experimental class and 25 students in the control class. The experimental class used the developed flipbook-based E-LKPD, while the control class used conventional learning materials. The grouping followed existing classroom conditions to maintain ecological validity. In addition, expert validators consisting of specialists in mathematics content, instructional media, and language were involved to assess the feasibility of the developed product.

The product developed in this study is a flipbook-based E-LKPD designed to facilitate students' understanding of mathematical concepts while promoting learning independence. The instructional design explicitly integrates Bruner's cognitive theory through three stages of representation: enactive (students engage in concrete and activity-based tasks), iconic (students interpret visual representations such as images and diagrams), and symbolic (students solve problems using mathematical symbols and abstract reasoning). The flipbook format enables interactive navigation, visual presentation, and structured exercises that support self-paced and independent learning.

Data were collected using validation sheets, practicality questionnaires, a learning independence

questionnaire, and pretest-posttest instruments. Validation sheets were used by experts to assess content, construct, language, and visual aspects of the E-LKPD. Practicality questionnaires were administered to teachers and students to evaluate usability, clarity, and attractiveness. The learning independence questionnaire measured students' self-regulated learning, including initiative, responsibility, discipline, and self-evaluation. Pretest and posttest instruments were used to measure students' cognitive learning outcomes to complement the analysis of learning independence.

The research procedure followed the ADDIE framework in a continuous and interconnected manner. The analysis stage involved identifying learning problems, including students' difficulties in understanding mathematical concepts and their low level of learning independence. The design stage focused on formulating learning objectives and structuring the E-LKPD content based on the enactive-*iconic-symbolic* sequence. During the development stage, the product was created, validated by experts, and revised accordingly. In the implementation stage, students in the experimental class were guided to engage with the E-LKPD following the structured flow of Bruner's representation stages, ensuring that learning activities progressed from concrete experiences to abstract understanding. The evaluation stage assessed the overall quality of the product in terms of validity, practicality, and effectiveness.

Data analysis was conducted using both descriptive and inferential techniques. Validity and practicality data were analyzed using a Likert scale converted into percentages and interpreted based on predetermined criteria. The effectiveness of the E-LKPD was analyzed by comparing the experimental and control groups using the N-Gain score to measure improvement and an independent sample t-test to determine statistical significance ($p < 0.05$). This combination of analyses was used to ensure a comprehensive evaluation of both learning independence and cognitive learning outcomes.

Result and Discussion

Results

Validity of the Developed E-LKPD

Table 1. Summary of Validation Results

Aspect	Score (%)
Content	89.6
Language	87.0
Visual Design	96.8
Construct	96.8
Average	92.55

The validation results demonstrate that the developed flipbook-based E-LKPD achieved a very high level of feasibility, with an overall average score of 92.55%. The visual design and construct aspects obtained the highest scores (96.80%), indicating strong alignment between instructional design and Bruner's cognitive theory. The language aspect, although slightly lower (87.00%), remains within the very valid category, indicating that the material is clear and appropriate for third-grade students.

Practicality of the E-LKPD

The practicality findings reveal that the developed E-LKPD is highly feasible for classroom implementation. Teacher responses during the trial phase reached 98.4%, while student responses reached 97%, both categorized as very practical. Furthermore, during the main implementation stage, teacher responses reached 95.2%, confirming the high level of practicality of the product. These results indicate that the media is intuitive, efficient, and supportive of instructional delivery. In addition, student responses reflect a high level of engagement and ease of interaction with the learning material.

Table 2. Practicality Results

Respondent	Score (%)
Teacher (Trial)	98.4
Students (Trial)	97.0
Teacher (Implementation)	95.2

These findings highlight that the flipbook format successfully bridges the gap between instructional design and actual classroom usability, making it a practical and effective tool to support independent learning in elementary mathematics.

Effectiveness of the E-LKPD (Learning Outcomes)

Table 3. Effectiveness Based on N-Gain

Group	N-Gain	Percentage (%)
Experimental	0.80	80
Control	0.43	43

The effectiveness analysis based on normalized gain (N-Gain) indicates a clear difference between the experimental and control groups. The experimental group achieved an N-Gain score of 0.80 (80%), categorized as high, while the control group obtained 0.43 (43%), indicating a moderate level of improvement. This result shows that the use of the flipbook-based E-LKPD contributes to improved students' understanding of mathematical concepts, particularly in addition and subtraction of whole numbers.

However, this improvement should be interpreted alongside the findings on learning independence, which represent the primary focus of this study.

Learning Independence

Table 4. Learning Independence Results

Group	Score (%)
Experimental	80.00
Control	67.47

The results of the learning independence questionnaire indicate that the experimental group achieved a score of 80.00%, categorized as very good, while the control group obtained 67.47%, categorized as moderate. This finding suggests that the developed E-LKPD effectively promotes students' independent learning behaviors, including initiative, responsibility, and self-regulation in learning activities.

Discussion

The findings of this study indicate that the flipbook-based E-LKPD grounded in Bruner's Cognitive Theory is effective in improving both students' learning outcomes and learning independence in elementary mathematics. The effectiveness analysis based on normalized gain (N-Gain) shows that the experimental group achieved a higher score (0.80, high category) compared to the control group (0.43, moderate category). This result suggests that the use of the developed E-LKPD provides a more meaningful learning experience, enabling students to better understand mathematical concepts, particularly in addition and subtraction of whole numbers.

This improvement can be explained through the instructional design of the E-LKPD, which integrates Bruner's three modes of representation: enactive, iconic, and symbolic. At the enactive stage, students engage in concrete activities that help them build initial understanding. The iconic stage supports learning through visual representations, while the symbolic stage facilitates the transition to abstract mathematical concepts. This structured progression allows students to construct knowledge gradually, which is essential in elementary mathematics learning. Such findings are consistent with Bruner's theory, which emphasizes that learning becomes more effective when concepts are introduced through sequential cognitive stages.

In addition to improving learning outcomes, the developed E-LKPD also contributes to enhancing students' learning independence. The results show that the experimental group achieved a higher independence score (80.00%) compared to the control group (67.47%). This indicates that students who used the E-LKPD were more capable of managing their own learning processes, including setting learning goals, monitoring progress, and evaluating their understanding. The interactive and

structured nature of the flipbook-based E-LKPD encourages active participation and reduces reliance on teacher-centered instruction.

The high validity (92.55%) and practicality (teacher responses up to 98.40% and student responses 97.00%) further support the effectiveness of the developed product. These results indicate that the E-LKPD is not only theoretically sound but also applicable in real classroom settings. The integration of interactive digital features in the flipbook format enhances student engagement and facilitates self-paced learning, which are important elements in promoting independent learning.

These findings are in line with previous studies that highlight the role of digital learning media in improving student engagement and learning effectiveness (Surur et al., 2023). Furthermore, the results support constructivist learning theory, which emphasizes that students actively construct knowledge through interaction and experience (Arafah et al., 2023). The structured learning design in the E-LKPD provides scaffolding that helps students transition from guided learning to independent learning.

Moreover, the improvement in learning independence aligns with the concept of self-regulated learning, where students are able to plan, monitor, and evaluate their own learning processes (Sakinah et al., 2026). The E-LKPD facilitates this process by providing clear instructions, interactive tasks, and opportunities for reflection, thereby encouraging students to take greater responsibility for their learning.

Overall, the findings of this study demonstrate that the integration of Bruner's Cognitive Theory with flipbook-based digital learning media results in a valid, practical, and effective instructional product. The E-LKPD not only improves students' conceptual understanding in mathematics but also enhances their learning independence, making it a valuable innovation for supporting student-centered learning in elementary education.

Conclusion

This study concludes that the development of a flipbook-based E-LKPD grounded in Bruner's Cognitive Theory through the ADDIE model has resulted in an instructional product that is valid, practical, and effective for elementary mathematics learning. The integration of enactive, iconic, and symbolic representations provides a structured learning pathway that supports students' conceptual understanding and facilitates active engagement. The findings indicate that the use of the developed E-LKPD contributes to higher learning outcomes and promotes better learning independence compared to conventional instructional approaches. In particular, students demonstrate improved ability to

manage their learning processes, including planning, monitoring, and self-evaluation. Therefore, the flipbook-based E-LKPD can be considered a meaningful and innovative instructional medium that supports student-centered learning and enhances learning independence in primary education contexts.

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Author Contribution

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Conflicts of Interest

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