

DEVELOPMENT OF A LUDO-BASED SMART BOX LEARNING MEDIA TO IMPROVE THE NUMERACY SKILLS OF FOURTH-GRADE ELEMENTARY SCHOOL STUDENTS

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Abstract: Numeracy skills are one of the fundamental competencies that students need to understand and solve mathematical problems encountered in daily life. The results of observations and interviews conducted at SD Negeri 5 Bendorejo, SD Negeri 1 Kedunglurah, and SD Negeri 2 Kedunglurah indicated that the numeracy skills of fourth-grade students were still relatively low, particularly in the topic of plane geometry. In addition, the limited use of learning media caused students to be less actively involved in learning and experience difficulties in understanding the concepts of sides, angles, and vertices of plane figures. Therefore, an engaging and interactive learning medium is needed to improve students' numeracy skills. This study aimed to develop a Smart Box learning media that is valid, practical, and effective in improving the numeracy skills of fourth-grade elementary school students. This research employed the Research and Development (R&D) method using the ADDIE model, which consists of the Analysis, Design, Development, Implementation, and Evaluation stages. The research participants were 50 fourth-grade students from SD Negeri 5 Bendorejo, SD Negeri 1 Kedunglurah, and SD Negeri 2 Kedunglurah. Data were collected through observations, interviews, questionnaires, and tests, and analyzed using descriptive quantitative and qualitative techniques. The results indicated that the Smart Box learning media was valid based on expert validation of both the learning material and the media. The media was also considered practical based on the positive responses from teachers and students. Its effectiveness was demonstrated by the improvement in students' learning outcomes, with the average pre-test score increasing from 59 to an average post-test score of 79. Furthermore, the average N-Gain score was 0.5027, which falls into the moderate category, with an N-Gain percentage of 50.27%. It can be concluded that the Smart Box learning media is suitable for teaching plane geometry and is effective in improving the numeracy skills of fourth-grade elementary school students at a moderate level.

Keywords: Smart Box; Learning Media; Numeracy Skills; Elementary School; Plane Geometry.

1. INTRODUCTION

Numeracy skills are one of the essential competencies that elementary school students need to master in order to understand, analyze, and solve mathematical problems encountered in everyday life. Numeracy is not limited to performing arithmetic operations but also includes the

ability to interpret data, apply mathematical concepts in various contexts, and make appropriate decisions based on quantitative information (Widayati, 2026). Therefore, strengthening numeracy skills has become one of the priorities in improving the quality of education in the 21st century (Witono et al., 2025).

However, the numeracy skills of Indonesian students remain relatively low. The results of the Programme for International Student Assessment (PISA) 2022 showed that Indonesia obtained an average mathematics score of 366, which is considerably lower than the OECD average of 472. In addition, only about 18% of Indonesian students achieved at least Level 2 proficiency, indicating that many students still experience difficulties in applying mathematical concepts to real-life situations. These findings indicate the need for more innovative learning strategies and instructional media to improve students' numeracy skills (Ramadhani et al., 2025).

The preliminary observations and interviews conducted at SD Negeri 5 Bendorejo, SD Negeri 1 Kedunglurah, and SD Negeri 2 Kedunglurah revealed similar problems. The numeracy skills of fourth-grade students were still relatively low, particularly in the topic of plane geometry. Students experienced difficulties in identifying the characteristics of geometric shapes, including sides, angles, and vertices. Most students tended to memorize concepts without fully understanding them and encountered difficulties when solving problems presented in visual forms. Furthermore, teachers reported that the learning media used in mathematics lessons were still limited, causing students to become less engaged and less motivated during the learning process.

One alternative to overcome these problems is the use of innovative learning media. Learning media play an important role in facilitating concept understanding, increasing students' motivation, and creating more meaningful learning experiences. Smart Box is an interactive learning medium designed to present learning materials through concrete objects and learning activities that actively involve students (Astuti et al., 2024). The visual and interactive characteristics of Smart Box enable students to learn mathematical concepts in a more enjoyable and meaningful way (Yusnaldi et al., 2025).

Several previous studies have demonstrated the effectiveness of Smart Box learning media. Aminah and Yusnaldi (2024) reported that Smart Box effectively improved students' learning outcomes in social studies. Maulidiana et al. (2024) found that Smart Box received highly positive responses from elementary school students in science learning. Sudarto et al. (2024) showed a significant improvement in students' learning outcomes through the use of Smart Box, while Damayanti et al. (2024) reported that Smart Box effectively improved

mathematics learning outcomes. These findings indicate that Smart Box is a valid, practical, and effective learning medium in various learning contexts.

Nevertheless, previous studies have generally focused on improving learning outcomes and have not specifically developed Smart Box to enhance students' numeracy skills through educational game integration. In addition, studies integrating Smart Box with game-based learning for plane geometry in elementary schools remain limited. Therefore, further research is needed to develop a more innovative learning medium that not only presents instructional content but also actively engages students in meaningful learning activities.

The novelty of this study lies in the development of a Ludo-based Smart Box learning media designed to improve the numeracy skills of fourth-grade elementary school students in learning plane geometry. Unlike previous studies, this Smart Box integrates learning materials with an educational Ludo game, allowing students to learn while playing through interactive activities involving the identification of geometric shapes, sides, angles, and vertices. This integration is expected to increase students' motivation, participation, conceptual understanding, and numeracy skills while providing an effective alternative learning medium for schools with limited access to digital technology.

Based on these considerations, this study aims to develop a Ludo-based Smart Box learning media that is valid, practical, and effective in improving the numeracy skills of fourth-grade elementary school students. The results of this study are expected to contribute to the development of innovative mathematics learning media and provide practical recommendations for teachers in implementing engaging numeracy learning in elementary schools.

2. RESEARCH METHODS

This study employed the Research and Development (R&D) method using the ADDIE development model, which consists of five stages: Analysis, Design, Development, Implementation, and Evaluation. The ADDIE model was selected because it provides a systematic and flexible framework for developing instructional media that are valid, practical, and effective in supporting the learning process (Rachma et al., 2023).

The research was conducted during the 2025/2026 academic year at SD Negeri 5 Bendorejo, SD Negeri 1 Kedunglurah, and SD Negeri 2 Kedunglurah. The research participants consisted of fourth-grade elementary school students, fourth-grade teachers, and validators comprising a material expert, a media expert, a language expert, and a practitioner. Fourth-grade students were selected because they were the target users of the Smart Box learning media developed for plane geometry learning. The product trial was carried out in two stages. The

small-scale trial involved 13 fourth-grade students and one classroom teacher at SD Negeri 5 Bendorejo. After revisions based on the initial trial, a large-scale trial was conducted involving 50 fourth-grade students and two classroom teachers at SD Negeri 1 Kedunglurah and SD Negeri 2 Kedunglurah.

The development procedure followed the five stages of the ADDIE model. The Analysis stage identified students' learning needs, numeracy abilities, learning characteristics, and problems encountered during mathematics instruction through classroom observations and interviews with teachers (Siregar et al., 2025). The Design stage involved designing the Smart Box learning media, preparing learning materials on plane geometry, developing educational game components, and designing the research instruments (Ramadhani et al., 2025). During the Development stage, the Smart Box learning media was produced and validated by material, media, language, and practitioner experts (Umami et al., 2025). Suggestions from the validators were used to revise and improve the product before implementation (Qayyimah, 2025). The Implementation stage consisted of small-scale and large-scale classroom trials. Students completed a pre-test before using the Smart Box learning media and a post-test after the learning activities to measure improvements in numeracy skills (Rahmawati et al., 2026). Finally, the Evaluation stage was conducted continuously throughout the development process to assess the validity, practicality, and effectiveness of the developed learning media (Putri et al., 2025).

Data were collected using observations, interviews, questionnaires, tests, and documentation. Observations and interviews were conducted during the needs analysis stage to identify learning problems and students' numeracy abilities. Validation questionnaires were administered to material experts, media experts, language experts, and practitioners to evaluate the feasibility of the developed learning media. Teacher and student response questionnaires were used to determine the practicality of the media, while pre-test and post-test instruments were administered to measure students' numeracy improvement. Documentation was used to support and complement the research findings.

The research instruments consisted of observation sheets, interview guidelines, expert validation questionnaires, teacher and student response questionnaires, and numeracy test instruments. Before implementation, the developed instruments and learning media were validated by experts to ensure their validity and suitability for classroom use.

The collected data were analyzed using descriptive qualitative and quantitative techniques. Qualitative data obtained from observations, interviews, and expert suggestions were analyzed descriptively to improve the developed product. Quantitative data obtained from expert

validation, teacher and student responses, and learning outcome tests were analyzed using descriptive percentage analysis to determine the validity and practicality of the Smart Box learning media. The effectiveness of the developed media in improving students' numeracy skills was analyzed using the N-Gain test by comparing the pre-test and post-test scores.

3. RESULTS AND DISCUSSIONS

This study developed a Ludo-Based Smart Box Learning Media for fourth-grade elementary school students on the topic of plane geometry using the ADDIE development model. The development process consisted of five stages, namely Analysis, Design, Development, Implementation, and Evaluation.

The analysis stage was conducted through classroom observations, interviews, and questionnaires administered to teachers and students at SDN 5 Bendorejo, SDN 1 Kedunglurah, and SDN 2 Kedunglurah. The findings indicated that students' numeracy skills in plane geometry were still relatively low. The average mathematics scores were 68, 71, and 73 at the three schools, respectively. In addition, mathematics learning was still dominated by the use of textbooks and whiteboards, while concrete learning media were rarely utilized. As a result, students experienced difficulties in understanding the concepts of sides, angles, and vertices of plane geometric figures. These findings indicate the need for an innovative learning medium capable of providing meaningful learning experiences and improving students' numeracy skills.

Based on the needs analysis, a Ludo-Based Smart Box Learning Media was developed. The media consists of a Smart Box containing plane geometry materials, an educational Ludo game board, question cards, answer cards, student worksheets, learning materials, and a teacher's guide. The media was designed using colorful visual elements and interactive learning activities to encourage students to learn mathematics through play. Unlike conventional learning media, the developed Smart Box integrates learning materials with an educational Ludo game, allowing students to solve numeracy problems collaboratively while participating in enjoyable learning activities. This integration represents the main innovation of the developed product because it combines concrete learning media with game-based learning to support numeracy development.

Figure 1 presents the overall appearance of the developed Smart Box learning media, including the outer design, learning materials, educational Ludo board, supporting learning tools, and teacher guide.



Figure 1. Smart Box Learning Media



Figure 2. Ludo Game Components

Before implementation, the developed media was validated by a material expert, a media expert, a language expert, and a learning practitioner. The validation results are presented in Table 1.

Table 1. Expert Validation Results

Validator	Percentage	Category
Media Expert	95%	Very Valid
Material Expert	95%	Very Valid
Language Expert	78%	Valid
Practitioner	90%	Very Valid

The validation results demonstrate that the Smart Box learning media satisfies the criteria for instructional feasibility. The media expert and material expert awarded the highest validation score (95%), indicating that the developed media fulfilled the requirements regarding visual design, instructional content, and ease of use. The language expert assigned a score of 78%, suggesting that minor revisions were necessary to improve language clarity and readability. Meanwhile, the practitioner provided a score of 90%, indicating that the media was practical and suitable for classroom implementation. Overall, the validation results confirm that the developed Smart Box learning media is appropriate for use in elementary mathematics instruction.

Following expert validation, the product was implemented through small-scale and large-scale classroom trials. The small-scale trial involved 13 fourth-grade students at SDN 5

Bendorejo, while the large-scale trial involved 50 fourth-grade students from SDN 1 Kedunglurah and SDN 2 Kedunglurah. Students completed a pre-test before using the Smart Box learning media and a post-test after the learning activities. The average learning outcomes are presented in Table 2.

Table 2. Students' Pre-Test and Post-Test Results

Trial	Pre-Test	Post-Test	Improvement
Small-scale	53	76	23
Large-scale	59	79	20

The results show a significant improvement in students' numeracy skills after using the Smart Box learning media. During the small-scale trial, the average score increased from 53 to 76, while the large-scale trial demonstrated an increase from 59 to 79. These findings indicate that the developed learning media successfully facilitated students' understanding of plane geometry concepts through interactive and enjoyable learning experiences.

The effectiveness of the developed media was further evaluated using the N-Gain test. The analysis produced an average N-Gain score of 0.5027, which falls into the moderate category, with an N-Gain percentage of 50.27%. Although the improvement is categorized as moderate, the results indicate that the developed Smart Box learning media contributed positively to enhancing students' numeracy skills. The moderate N-Gain category may be influenced by differences in students' prior mathematical abilities, the relatively limited duration of implementation, and students' adaptation to a new learning approach.

The positive findings of this study are consistent with previous research conducted by Aminah and Yusnaldi (2024), who reported that Smart Box effectively improved learning outcomes and increased students' learning motivation. Similar findings were also reported by Maulidiana et al. (2024), who found that Smart Box created more interactive learning experiences and received highly positive responses from students. Likewise, Sudarto et al. (2024) and Damayanti et al. (2024) demonstrated that Smart Box significantly improved students' mathematics learning outcomes. These studies confirm that Smart Box is an effective instructional medium for elementary education.

However, the present study provides a distinctive contribution compared with previous studies. Earlier research primarily focused on evaluating the effectiveness of Smart Box as a learning medium, whereas this study integrates the Smart Box with an educational Ludo game specifically designed to improve students' numeracy skills in learning plane geometry. Through

this integration, students not only receive learning materials but also participate actively in collaborative game-based activities requiring them to identify geometric figures, solve numeracy problems, discuss answers with peers, and construct plane shapes using concrete materials. Consequently, the developed learning media offers a more meaningful and engaging learning experience while simultaneously strengthening students' conceptual understanding and numeracy skills.

Overall, the findings demonstrate that the developed Ludo-Based Smart Box learning media is valid, practical, and effective for improving the numeracy skills of fourth-grade elementary school students. The integration of concrete learning media with educational games provides an innovative alternative for mathematics instruction, particularly in schools with limited access to digital learning technologies.

4. CONCLUSIONS AND SUGGESTIONS

CONCLUSIONS

This study successfully developed a Ludo-Based Smart Box Learning Media for fourth-grade elementary school students on the topic of plane geometry using the ADDIE development model. The developed learning media was proven to be valid, practical, and effective based on expert validation, teacher and student responses, and improvements in students' numeracy skills. The expert validation results showed that the Smart Box met the required standards for instructional content, media design, language, and classroom implementation. Furthermore, the implementation results demonstrated an increase in students' average learning outcomes from the pre-test to the post-test, with an average N-Gain score of 0.5027, indicating a moderate improvement in numeracy skills.

The integration of the Smart Box with an educational Ludo game represents the main contribution of this study. The developed media provides a more interactive and enjoyable learning experience, encourages active student participation, and supports students in understanding plane geometry concepts through concrete and collaborative learning activities. Therefore, the Ludo-Based Smart Box learning media can serve as an innovative alternative for improving numeracy learning in elementary schools.

SUGGESTIONS

Teachers are encouraged to utilize the Ludo-Based Smart Box learning media as an alternative instructional medium to create more engaging and meaningful mathematics learning

experiences. Schools may also adopt and further develop similar game-based learning media to strengthen students' numeracy skills across different mathematical topics.

Future researchers are recommended to implement the developed media in a larger number of schools and investigate its effectiveness in other mathematics topics or grade levels. Further studies may also integrate digital technologies or augmented learning features to enhance the interactivity and educational value of the Smart Box learning media.

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