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Development of Mathematical Snakes and Ladders Media Game Based Learning Approach to Improve Learning Outcomes Class 2 Primary School Students

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A B S T R A C T

This study aimed to develop a Mathematics Snakes and Ladders learning media that is valid, practical, and effective in improving the learning motivation and mathematics achievement of second-grade elementary school students. The study employed a Research and Development (R&D) approach using the ADDIE model: analysis, design, development, implementation, and evaluation. The analysis stage identified students' difficulties in understanding addition concepts up to 20 and the lack of interactive learning media. The design and development stages produced a Mathematics Snakes and Ladders game board, question cards, answer cards, punishment cards, worksheets, and a teacher guidebook. Validation results showed that the media was categorized as Very Valid, with material validation scores of 92.8% and 90.9%, language validation of 92.8%, and media validation of 87.5%. The implementation stage demonstrated high practicality, with teacher practicality scores of 4.60 and 4.73, student responses of 93.2%, and prototype feasibility percentages ranging from 92.00% to 97.33%. Evaluation results showed significant improvement in students' achievement, with average pretest and posttest scores increasing from 44.00 to 81.33. The N-Gain score reached 0.92 (High category), while classroom observations obtained 98% feasibility. These findings indicate that the media is feasible, practical, and effective for elementary mathematics learning.

1. Introduction

Mathematics is a core subject in primary education that plays an essential role in developing students' logical, systematic, and analytical thinking skills. However, it is often perceived by elementary students as difficult and anxiety-inducing, which negatively affects learning motivation and outcomes. This condition highlights the critical role of teachers in designing mathematics instruction that is meaningful,

engaging, and suited to students' developmental characteristics. Instructional success is closely linked to teachers' ability to select appropriate strategies, methods, and learning media that align with students' cognitive needs, particularly to avoid abstract and monotonous learning experiences that may hinder engagement and understanding.

For second-grade students, who are in the concrete operational stage of cognitive development, effective mathematics learning should emphasize hands-on, contextual, and concrete experiences. Learning media play a vital role in supporting this process by making abstract concepts more accessible, enhancing motivation, and fostering active student involvement. In this context, play-based and game-based learning approaches emerge as effective alternatives, as they align with children's natural learning tendencies and support meaningful knowledge construction. Through learning while playing, students can actively explore and internalize mathematical concepts in ways that are enjoyable, motivating, and cognitively appropriate.

Games in educational contexts function not merely as entertainment but also as powerful pedagogical tools (Dicheva et al., 2015). Game-based learning can transform learning activities perceived as difficult into enjoyable challenges, promote active student engagement, and reduce psychological barriers such as fear and anxiety toward mathematics. Empirical studies consistently demonstrate that game-based learning media contribute positively to students' learning motivation, conceptual understanding, and participation in mathematics instruction (Wouters et al., 2013)

Based on the foregoing discussion, the development of innovative, interactive, and game-based mathematics learning media has become an urgent necessity, particularly in elementary education (Mayer, 2024). One promising alternative is the development of a mathematics-based snakes and ladders game that integrates mathematical concepts into enjoyable and meaningful play activities (Suh et al., 2010). This medium is expected to enhance students' learning motivation while supporting more concrete and meaningful understanding of mathematical concepts. Accordingly, this study focuses on the development of a mathematics snakes and ladders learning medium as an alternative instructional approach to improve the learning motivation of second-grade elementary school students.

Based on classroom observations conducted at SD Negeri 11 Taratak Surian, Pantai Cermin District, Solok Regency, mathematics instruction on addition topics was found to remain largely conventional and monotonous, relying predominantly on teacher-centered explanations and textbook-based activities. The learning media used were limited to printed textbooks and two-dimensional images provided in student worksheets, with minimal integration of interactive or manipulative learning resources. These findings were corroborated by interviews with second-grade teachers and students, which revealed that lesson planning and the use of instructional media had not been optimized to support students' learning needs (Schindler et al., 2017). This condition was further reflected in students' learning outcomes, as indicated by the results of the first-semester daily assessment (PH) for

the 2024/2025 academic year. Out of 19 second-grade students, only approximately 42% achieved scores above the minimum mastery criterion (KKM) of 71, while around 58% scored below the threshold. This indicates that more than half of the students did not achieve mastery in mathematics, particularly in addition concepts, suggesting low learning effectiveness and insufficient student engagement in the existing instructional approach (Hattie, 2008)

Based on observations and interviews conducted at SD Negeri 12 Jalan Balantai and SD Negeri 10 Koto Tinggi in Pantai Cermin District, Solok Regency, it was found that mathematics instruction in second-grade classrooms has not optimally utilized game-based learning media, particularly mathematics-based snakes and ladders games. Teachers tended to rely on conventional instructional methods supported by limited media, resulting in teacher-centered learning that emphasized content delivery rather than active student engagement. These findings were consistent with interview data from both teachers and students, which indicated that mathematics instruction had not been sufficiently effective in fostering students' learning motivation (Darling-Hammond et al., 2020).

Initial classroom observations further revealed that the game media used in instruction were overly simplistic, consisting of small printed snakes and ladders boards designed for a limited number of players and implemented individually (Plass et al., 2015). Such media provided minimal opportunities for students to engage in discussion, collaboration, or collective construction of mathematical understanding. Moreover, game mechanics that focused solely on reaching the finish line as quickly as possible emphasized individual competition rather than conceptual understanding of mathematics. This condition contributed to low learning motivation and suboptimal student participation in mathematics learning activities (Sailer et al., 2017).

From both theoretical and empirical perspectives, game-based learning has been shown to hold substantial potential for enhancing elementary students' motivation and conceptual understanding in mathematics (Hirsh-Pasek et al., 2015). Prior studies have demonstrated that mathematics-based snakes and ladders media are valid, practical, feasible, and engaging for classroom use. Research has shown that such media can effectively improve second-grade students' numeracy skills and learning engagement. These findings indicate that integrating traditional games into mathematics instruction can create learning experiences that align well with elementary students' cognitive and developmental characteristics.

Therefore, innovation in learning media is needed not only to create enjoyable learning experiences but also to promote active student engagement, collaborative concept construction, and enhanced motivation in mathematics learning (Plass et al., 2015). The development of a mathematics snakes and ladders game through a game-based learning approach designed for group play, encouraging peer discussion, and oriented toward conceptual score achievement offers a relevant instructional alternative. This medium is expected to function not merely as a game but also as an informal formative assessment tool for evaluating students' understanding of addition concepts.

Based on the above considerations, this study aims to develop a mathematics snakes and ladders learning medium through a game-based instructional approach for second-grade elementary school students. In addition, this study seeks to examine the validity, practicality, and effectiveness of the developed media in improving students' mathematics learning outcomes and learning motivation. The study is expected to contribute theoretically to the literature on mathematics learning media development and practically to support teachers in creating mathematics instruction that is more engaging, interactive, and meaningful

2. Methodology

This study employed a research and development (*Research and Development*) approach aimed at producing a mathematics-based snakes and ladders learning medium that is valid, practical, and effective in enhancing the learning motivation of second-grade elementary school students. The development process was guided by the ADDIE model, which consists of the stages of analysis, design, development, implementation, and evaluation. The ADDIE model was selected due to its systematic and iterative structure, which is widely recognized as appropriate for instructional media development.

The study was conducted in three public elementary schools located in Pantai Cermin District, Solok Regency, namely SD Negeri 11 Taratak Surian, SD Negeri 12 Jalan Balantai, and SD Negeri 10 Koto Tinggi. The analysis stage involved classroom observations and interviews to identify instructional needs in mathematics, particularly related to addition concepts up to 20. Based on the needs analysis, the mathematics snakes and ladders media were designed using a game-based learning approach and equipped with a large-scale game board, question cards, answer cards, penalty cards, and collaborative group-based game rules.

The designed media were then developed into a prototype and validated by subject-matter experts, media experts, and language experts to ensure content accuracy, instructional suitability, and clarity. The validation results served as the basis for revising and refining the media prior to implementation. The media were subsequently implemented with second-grade students in the participating schools, preceded by brief training sessions for teachers. Data were collected through observations, questionnaires, interviews, and pretest–posttest assessments to measure improvements in students' understanding of addition concepts.

Data from expert validation, observations, and questionnaires were analyzed using descriptive quantitative techniques based on percentage scores, while the effectiveness of the media was examined using normalized gain (N-gain) scores. In addition, paired-sample *t*-tests were conducted at a 0.05 significance level to determine whether there were statistically significant differences between students' pretest and posttest results after the implementation of the mathematics snakes and ladders learning media.

3. Results and Discussion

Product Development

The product design stage was carried out after completing the needs analysis, classroom observations, teacher interviews, and curriculum review. At this stage, the researcher developed the initial prototype of the Mathematics Snakes and Ladders learning media tailored to the characteristics of second-grade elementary school students. The design process aimed to create a learning medium that was interactive, practical, and aligned with the learning outcomes of Phase A Mathematics in the Merdeka Curriculum. The media was specifically designed to improve students' understanding of whole-number addition up to 20 through game-based learning activities.

The main component of the product was a large snakes-and-ladders game board measuring 2 × 2 meters and printed on banner material. The board consisted of 100 numbered squares equipped with snake, ladder, and question-mark symbols. Students acted directly as game pawns, allowing them to actively participate through physical movement and collaborative interaction. The game mechanism was connected to addition exercises, where students answered mathematical questions according to the squares they landed on. This design was intended to create a more enjoyable and meaningful learning experience while encouraging student engagement during mathematics lessons.

In addition to the game board, the media design included 37 addition question cards adapted to students' competency indicators and cognitive levels. Teacher answer cards were prepared to facilitate answer verification during the game process, while punishment cards contained light and enjoyable instructions such as "move back two steps" or "clap hands five times." A large dice numbered 1–6 was also included to determine player movement during the game. These components were designed not only to support mathematical learning but also to foster cooperation, discipline, and student motivation through interactive activities.

The researcher also designed a Student Worksheet (*LKPD*) as an evaluation and reflection instrument after the game session. The worksheet contained additional exercises and learning reflections to strengthen students' conceptual understanding of addition. Furthermore, a teacher guidebook was developed to provide instructions for implementing the media, explaining game rules, and assisting teachers in assessing cognitive, affective, and psychomotor aspects during learning activities. The integration of these supporting instruments ensured that the media could be implemented effectively and systematically in classroom learning.

Before proceeding to the implementation stage, the initial product design was prepared for expert validation involving material, media, and language experts. This validation process aimed to ensure that the content, visual appearance, language clarity, and game mechanisms were appropriate, practical, and suitable for elementary school students. Feedback from experts became the basis for revising and improving the product prior to classroom trials. Overall, the design stage

emphasized the integration of play-based learning, physical activity, and contextual mathematical experiences to create an engaging and student-centered learning environment. The complete components of the developed Mathematics Snakes and Ladders media are presented in Table 1.

Table 1. Product Design Stage

Design Component	Design Description
Game Board	A 2 × 2 meter banner-based snakes-and-ladders board consisting of 100 numbered squares with snake, ladder, and question-mark symbols.
Question Cards	Consisted of 37 whole-number addition questions up to 20, adjusted to competency indicators.
Answer Cards (Teacher)	Used by the teacher to verify students' answers during the game.
Punishment Cards	Contained simple instructions such as "move back two steps" or "clap hands five times."
Large Dice	Dice numbered 1–6 used to determine player movement.
Student Worksheet (*LKPD*)	Individual worksheets containing follow-up exercises and learning reflection activities.
Teacher Guidebook	Included instructions for using the media, game rules, and assessment guidelines.

To support students' active participation during the game, the learning media was also equipped with a large dice numbered 1–6. The dice functioned as a tool to determine students' movement on the snakes-and-ladders board and added an element of excitement and unpredictability to the learning process. Its large size and colorful appearance were intentionally designed to attract students' attention and make the learning activities more engaging and interactive. The use of the dice also encouraged students to participate physically and collaboratively during the implementation of the game-based learning activities. The appearance of the dice used in the learning media is presented in Figure 1.

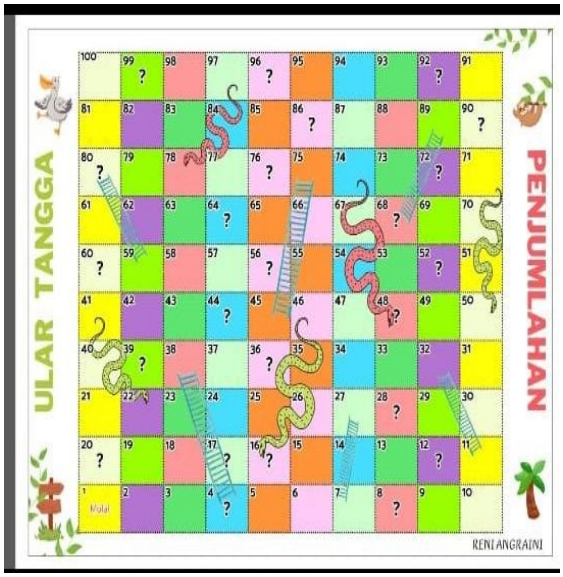


Figure 1. Large Dice Used in the Mathematics Snakes and Ladders Learning Media

Validity of the Mathematical Snakes and Ladders Media

The validity testing stage was conducted to evaluate the feasibility and quality of the Mathematics Snakes and Ladders learning media before its implementation in classroom learning. The validation process involved material experts, media experts, and language experts to ensure that the product met educational standards in terms of content accuracy, language clarity, and media design. The results of expert validation indicated that the developed media achieved a very valid category in all assessed aspects, demonstrating its suitability for second-grade elementary school mathematics learning.

Material validation was divided into two aspects, namely validation of the teaching material and validation of the instructional media. The validation of teaching materials obtained a score of 92.8%, categorized as *Very Valid*. The expert concluded that the addition problems presented in the media were aligned with the learning outcomes and cognitive characteristics of second-grade students. In addition, the media was considered effective in supporting mathematics learning objectives, particularly in teaching whole-number addition up to 20. No revision was required in this aspect because the content was already considered appropriate and systematic.

The validation of the instructional media by the material expert obtained a score of 90.9%, also categorized as *Very Valid*. The expert emphasized that the game board, question cards, and supporting components had been designed appropriately to facilitate active student interaction during the learning process. Furthermore, the game-based learning approach embedded in the media was considered capable of increasing students' engagement and participation in mathematics learning activities. Therefore, no revisions were recommended for the instructional media aspect.

Language validation achieved a score of 92.8%, categorized as *Very Valid*, although minor revisions were recommended. The language expert stated that the instructions and questions generally used communicative and student-friendly language suitable for elementary school students. However, several improvements were suggested, particularly regarding word separation and font size on the punishment cards to improve readability for students sitting farther from the game board. Meanwhile, media expert validation obtained a score of 87.5%, which was also categorized as *Very Valid*. The expert highlighted that the visual appearance, color combination, symbols, and overall layout were attractive and appropriate for elementary school students.

Overall, the expert validation results demonstrated that the Mathematics Snakes and Ladders media met the required standards for classroom implementation. The high validation scores reflected that the media was feasible, engaging, and pedagogically appropriate for mathematics learning at the elementary school level. The detailed results of the expert validation process, including the validation aspects, scores, categories, and revision status, are presented in Table 2. Only minor revisions

related to technical language aspects were required before proceeding to the implementation stage.

Table 2. Expert Validation Results

No	Validation Aspect	Validation Date	Score (%)	Category	Revision Status
1	Material Expert on Teaching Material	17 September 2025	92.8	Very Valid	No Revision
2	Material Expert on Instructional Media	17 September 2025	90.9	Very Valid	No Revision
3	Language Expert	9 September 2025	92.8	Very Valid	Partial Revision
4	Media Expert	15 September 2025	87.5	Very Valid	No Revision

Implementation of Mathematical Snakes and Ladders Media

The implementation stage was conducted to examine the application of the Mathematics Snakes and Ladders media in classroom learning activities. Data were collected through questionnaires distributed to teachers and second-grade students, as well as classroom observations during the learning process. The implementation focused on several aspects, including ease of use, learning benefits, student engagement, and the role of the media in supporting mathematics learning activities. The results showed that the developed media was successfully implemented in classroom learning and created an interactive and enjoyable learning environment for students.

Teacher questionnaire results demonstrated that the media was easy to apply in terms of preparation and classroom implementation. The average score for the "Ease of Use" aspect reached 4.6, categorized as Very Good. Teachers stated that the game rules were easy for students to understand, the media could be used individually or collaboratively, and the implementation time was compatible with classroom schedules. However, the availability of materials and tools received a slightly lower score, indicating that several components required additional preparation. Despite this limitation, teachers generally agreed that the media could be implemented effectively in daily classroom learning activities.

The "Learning Benefits" aspect obtained an average score of 4.73, categorized as Very Good. Teachers reported that the implementation of the media improved students' understanding of addition concepts, increased learning motivation, and encouraged active participation during mathematics lessons. The integration of question cards, answer cards, and punishment cards created a more interactive and enjoyable learning atmosphere. In addition, the game-based activities promoted cooperation and communication among students, supporting not only cognitive development but also social interaction during the learning process. The improvement in students' learning outcomes after the implementation of the Mathematics Snakes and Ladders media can be seen in Figure 2.

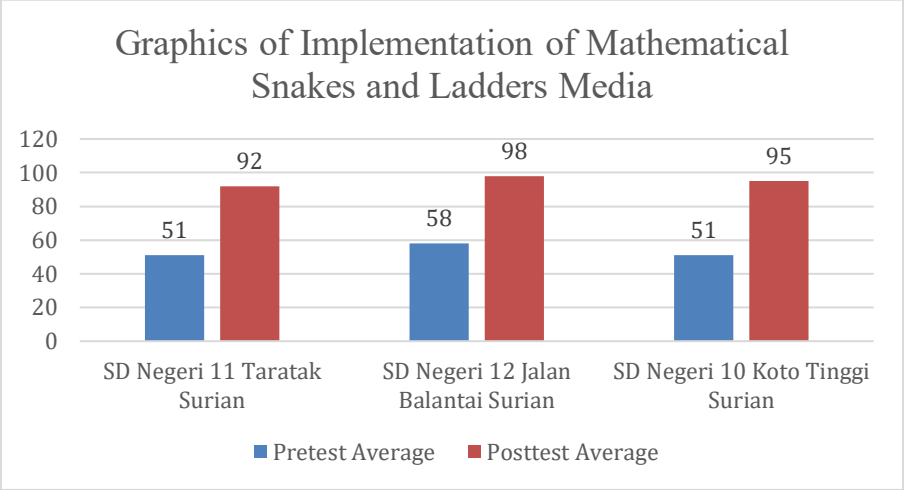


Figure 2. Average Pretest and Posttest Scores in the Prototype Testing Stage of the Mathematics Snakes and Ladders Media

Student questionnaire results also showed highly positive responses toward the implementation of the media. Most students stated that they enjoyed playing the Mathematics Snakes and Ladders game, found the rules easy to understand, and felt more motivated to learn mathematics after participating in the activity. Students also expressed enthusiasm for collaborative learning with their peers during the game. The overall average score reached 93.2, indicating that the media was well accepted by students and capable of creating a fun and engaging mathematics learning experience. Nevertheless, several students still required additional explanations regarding the game procedures, suggesting the need for minor adjustments to improve inclusiveness for all learners.

Observation results conducted in three elementary schools further supported the successful implementation of the media. The prototype feasibility percentages reached 97.33% at SDN 11, 93.33% at SDN 12, and 92.00% at SDN 10, all categorized as highly feasible. Teachers observed that students were more attentive, enthusiastic, and actively involved during mathematics learning activities using the media. The game also facilitated collaborative learning and improved students' ability to solve addition problems up to 20. Overall, the findings indicated that the Mathematics Snakes and Ladders media was successfully implemented and contributed positively to elementary school mathematics learning activities.

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Table 3. Ease of Use Assessment

No	Aspect Evaluated	Average Score	Category
1	Media preparation before learning	5.00	Very Practical
2	Game rules are easy to understand	4.33	Very Practical
3	Materials and tools are easy to obtain	4.00	Practical
4	Media is easy to use individually or in groups	4.67	Very Practical
5	Implementation time matches lesson allocation	5.00	Very Practical
	Overall Average	**4.60**	**Very Practical**

Beyond the technical aspects of implementation, the learning benefits assessment further demonstrated that the media contributed positively to the mathematics learning process. As shown in Table 3 teachers perceived that the media improved students' understanding of addition concepts and strengthened their counting skills through interactive learning activities. Furthermore, the game components successfully created a more engaging classroom atmosphere, encouraging students to participate actively during lessons. The collaborative nature of the game also promoted communication and teamwork among students, allowing learning to occur not only individually but also socially. The detailed results of the learning benefits assessment are presented in Table 4. Consequently, the overall findings suggest that the Mathematics Snakes and Ladders media supported both cognitive and social dimensions of learning in elementary classrooms.

Table 4. Learning Benefits Assessment

No	Learning Benefits	Average Score	Category
1	Improves students' understanding of addition	4.67	Very Practical
2	Increases students' enthusiasm in mathematics learning	4.33	Very Practical
3	Improves students' counting skills	5.00	Very Practical
4	Creates interactive learning through game components	5.00	Very Practical
5	Encourages cooperation and communication among students	4.67	Very Practical
	Overall Average	**4.73**	**Very Practical**

In line with the teacher assessments, student responses also reflected highly positive perceptions toward the use of the media. Table 4 shows that students enjoyed participating in the Mathematics Snakes and Ladders activities and found the game rules easy to understand. Students also expressed greater interest in mathematics learning after using the media and demonstrated enthusiasm for collaborative learning with peers. Interestingly, most students indicated that they wanted to play the game again, suggesting that the media successfully created an enjoyable and motivating learning experience. These responses illustrate that game-based learning can increase students' engagement and reduce negative perceptions of mathematics learning at the elementary level. The detailed results of students' practicality responses toward the Mathematics Snakes and Ladders media are presented in Table 5.

Table 5, Student Practicality Results

No	Statement	Average Score
1	Students enjoyed playing the game	0.40
2	Students understood the game rules easily	0.46
3	Question cards were easy to answer	0.47
4	Students became more interested in mathematics	0.43
5	Students enjoyed group collaboration	0.44
6	Students wanted to play the game again	0.48
	Overall Average	**93.2**

To strengthen the practicality findings, classroom observations were conducted across three elementary schools during the implementation process. As presented in Table 5 all participating schools achieved high prototype feasibility percentages, indicating that the media functioned effectively in real classroom settings. Students were observed to be more attentive, enthusiastic, and actively involved during mathematics learning activities. At the same time, teachers reported that the media facilitated smoother classroom interaction and encouraged collaborative participation among students. The consistency of these findings across different schools suggests that the Mathematics Snakes and Ladders media possesses strong practical value and can be implemented successfully in various elementary school contexts.

Evaluation of Mathematical Snakes and Ladders Media

The evaluation stage was conducted to examine the implementation and outcomes of the Mathematics Snakes and Ladders media in improving students' learning motivation and mathematics achievement. The implementation process began with a pretest to measure students' initial understanding of addition concepts, followed by learning activities using the game-based media, and concluded with a posttest to evaluate students' learning progress. During the implementation, observations were also carried out to assess students' cognitive, affective, and psychomotor responses. The findings indicated that the use of the Mathematics Snakes and Ladders media contributed positively to students' understanding of whole-number addition up to 20 and created a more engaging learning atmosphere.

The pretest and posttest results demonstrated a substantial improvement in students' achievement after using the media. The overall average pretest score of 15 students was 44, while the average posttest score increased to 81.33, resulting in an average gain of 37.33 points. Students from all participating schools experienced score improvement, particularly those with low initial achievement. For example, several students who initially scored 20 increased their posttest scores to 80 or even 100. These results suggest that the Mathematics Snakes and Ladders media helped transform abstract mathematical concepts into more concrete and understandable learning experiences.

The evaluation results were also supported by classroom observations conducted during the implementation process. The observation instrument assessed student activity and media performance throughout the learning activities. The total observation score reached 49 out of 50, with a prototype feasibility percentage of 98%, categorized as Very Good. Students demonstrated strong attention, enthusiasm, active participation, and collaborative interaction during the learning process. The media also facilitated active and enjoyable learning while encouraging students to think critically and solve addition problems interactively.

Descriptive statistical analysis further supported the evaluation results of the media implementation. The average pretest score before implementation was 53.93, while the average posttest score increased significantly to 95.36. In addition, the posttest standard deviation was lower than the pretest standard deviation, indicating that students' learning outcomes became more consistent after using the media. Although normality and homogeneity tests showed that the data did not meet parametric assumptions, the paired sample analysis still demonstrated a clear difference between pretest and posttest results, indicating notable improvement in students' mathematical understanding after participating in game-based learning activities.

The N-Gain analysis also supported the positive evaluation results of the Mathematics Snakes and Ladders media. Individual N-Gain scores ranged from 0.5 to 1.0, while the average class N-Gain score reached 0.92 or 92%, categorized as High. These findings indicate that the media provided meaningful support in improving students' understanding of addition concepts and increasing their learning motivation. Overall, the evaluation results confirmed that the Mathematics Snakes and Ladders media was appropriate, engaging, and suitable for mathematics learning in second-grade elementary school classrooms. The improvement in students' learning outcomes before and after using the media can be seen in Table 6, which presents the comparison between pretest and posttest scores.

Table 6. Pretest and Posttest Results

Indicator	Pretest	Posttest	Gain
Average Score	44.00	81.33	37.33
Highest Score	60	100	60
Lowest Score	20	60	20

The media encouraged collaboration and helped students understand mathematical concepts more easily. In addition, the game created a more enjoyable and interactive classroom atmosphere. The results of classroom observations conducted during the implementation of the Mathematics Snakes and Ladders media are presented in Table 7. These observations assessed various aspects of student engagement, learning effectiveness, and the overall feasibility of the media in supporting mathematics learning activities.

Table 7. Observation Results of Media Implementation

Aspect	Score
Student Attention	5
Student Participation	5
Student Enthusiasm	5
Ability to Solve Addition Problems	4
Collaboration Among Students	5
Media Helps Understanding Concepts	5
Attractive Visualization	5
Active and Enjoyable Learning	5
Effective Time Allocation	5
Encourages Critical Thinking	5
Total Score	**49/50**
Prototype Feasibility	**98%**

Furthermore, the N-Gain analysis confirmed the effectiveness of the media in improving students' learning outcomes. The N-Gain score was categorized as high, indicating that students experienced substantial learning improvement after using the Mathematics Snakes and Ladders media. In addition, the percentage interpretation of the N-Gain score was used to evaluate the overall effectiveness of the learning media. The findings showed that the Mathematics Snakes and Ladders media achieved the effective category, indicating that the media successfully improved students' mathematics learning outcomes.

Discussion

The findings of this study indicate that the Mathematics Snakes and Ladders media effectively improved students' understanding of addition concepts in elementary mathematics learning. The improvement in students' learning outcomes demonstrates that game-based learning can transform abstract mathematical concepts into more concrete and meaningful learning experiences (Plass et al., 2015). Through direct interaction with the game board, question cards, and collaborative activities, students were encouraged to actively construct their understanding during the learning process.

The effectiveness of the media was also consistently observed across different schools and student ability levels. Students with lower initial understanding showed substantial improvement after participating in learning activities using the Mathematics Snakes and Ladders media. This finding suggests that game-based instructional media can provide inclusive learning opportunities by helping students who previously experienced difficulties in mathematics learning (Qian & Clark,

2016). The collaborative and interactive nature of the game also created opportunities for peer learning through discussion and teamwork.

In addition to improving learning outcomes, the Mathematics Snakes and Ladders media also contributed positively to students' learning motivation. During the implementation process, students showed enthusiasm, active participation, and confidence in solving mathematical problems. The enjoyable and pressure-free learning environment encouraged students to engage more actively in classroom activities without fear of making mistakes (Wang & Tahir, 2020).

The findings further demonstrate that motivation and learning achievement are closely interconnected. Students who were actively involved and motivated during the learning process tended to show better conceptual understanding and stronger participation in classroom activities. The game elements embedded in the media, such as challenges, movement, collaboration, and immediate feedback, helped students maintain focus and persistence during learning (Tokac et al., 2019).

Compared with previous studies, this research highlights the importance of integrating learning outcomes and motivational aspects in evaluating instructional media effectiveness. The Mathematics Snakes and Ladders media was not only effective in improving mathematics achievement but also successful in building students' confidence, engagement, and collaborative skills during learning activities (Medina et al., 2024).The active involvement of students in physical and social interaction throughout the game created a more student-centered learning process. The findings are also supported by previous studies on educational board games, which revealed that game-based learning media can improve students' attitudes, participation, and numeracy development in classroom instruction (Hutagaol & Suwarjo, 2025). Educational games encourage collaborative learning experiences that support both social and cognitive development among learners.

Furthermore, the development of educational game tools such as the "Fun Mathematic Board" has shown that interactive mathematics media can strengthen early numeracy understanding and make learning activities more enjoyable for children (Agya et al., 2025). This supports the use of Mathematics Snakes and Ladders as an innovative instructional medium in elementary mathematics classrooms. Theoretically, the findings reinforce constructivist learning theory and motivational learning theory, which emphasize that knowledge is actively constructed through meaningful experiences and active engagement. The results also indicate that game-based learning can integrate cognitive, affective, and social dimensions within mathematics instruction (Qian & Clark, 2016). Practically, the findings suggest that the Mathematics Snakes and Ladders media can serve as an innovative and contextual instructional alternative for elementary school teachers.

4. Conclusion

In conclusion, the development of the Mathematics Snakes and Ladders media through a game-based learning approach was successfully implemented as an

alternative instructional medium for second-grade elementary school mathematics learning. The findings demonstrated that the developed media fulfilled the criteria of validity, practicality, and effectiveness in supporting mathematics instruction, particularly in learning addition concepts up to 20. The media was able to create a more interactive, engaging, and student-centered learning environment that encouraged active participation, collaboration, and learning motivation among students. The implementation of the media also showed that game-based learning can help students understand mathematical concepts more concretely through direct learning experiences. Teachers and students responded positively to the use of the media because it was easy to use, enjoyable, and capable of increasing classroom interaction during mathematics lessons. In addition, the learning activities supported students not only cognitively but also socially through cooperative play and communication within groups. Overall, this study confirms that the Mathematics Snakes and Ladders media can be used as an innovative learning medium to support elementary mathematics instruction. The study also contributes to the development of game-based learning media that are meaningful, enjoyable, and suitable for the characteristics of elementary school students.

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