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Development of a Mathematics Spinning Wheel for Teaching Arithmetic in Grade II Elementary School

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ABSTRACT

This study aims to develop and evaluate the *Mathematics Spinning Wheel* as an instructional medium to enhance the learning outcomes of second-grade elementary school students in arithmetic operations, specifically addition and subtraction. Employing a research and development (R&D) methodology, the study adopts the ADDIE model, which consists of five phases: analysis, design, development, implementation, and evaluation. The research participants comprised 28 second-grade students from SD Negeri 211 Palembang. Data collection instruments included observations, interviews, validation questionnaires completed by subject matter and media experts, practicality questionnaires from teachers and students, and learning outcome tests. Validation results indicated a very high level of feasibility, with an average score of 82.69%. Practicality assessments showed the media was rated as highly practical, receiving scores of 90.4% from students and 91.3% from teachers. Effectiveness testing revealed a significant improvement in students' average scores, from 64.04 in the pre-test to 79.25 in the post-test, with classical completeness increasing from 28.57% to 85.71%. These findings demonstrate that the Mathematics Spinning Wheel is a valid, practical, and effective instructional medium. It offers a fun and interactive alternative for mathematics learning and holds potential for further development across different topics and educational levels.

Keyword:
Instructional media; spinning wheel; arithmetic operations; research and development; elementary school

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INTRODUCTION

Mathematics holds a strategic position in the elementary school curriculum, playing a crucial role in shaping students' abilities to think logically, systematically, and critically (Jamil et al., 2024; Kanwal et al., 2024). At the primary level, particularly in lower grades such as Grade II, the introduction of basic arithmetic operations—addition and subtraction—is essential (Ireniza & Subayani, 2024). Mastery of these foundational concepts is critical for supporting more complex mathematical learning in higher grades (Ireniza & Subayani, 2024; Temnikova, 2021). Therefore, instructional design at this stage must be carefully crafted to align with the developmental characteristics of young learners (Astini Ni & Purwati, 2020).

According to Piaget's Theory of cognitive development, children between the ages of 7 and 11 are in the concrete operational stage (Agustyaningrum et al., 2022; Astuti, 2018). At this stage, they tend to grasp abstract concepts more effectively through direct experiences with tangible objects (Nabila, 2021; Nuryati & Darsinah, 2021). Effective mathematics instruction should be student-centered and incorporate active learning methods such as discovery and contextual learning (Agustyaningrum et al., 2022). Teachers are expected to adapt their instructional approaches to students' cognitive development by employing a variety of models and strategies (Juwantara, 2019). These insights suggest that mathematics instruction can be significantly enhanced through the use of concrete teaching aids that students can physically manipulate. However, in practice, mathematics instruction in second-grade classrooms still heavily relies on conventional methods such as lectures and

repetitive exercises (Rahmawati & Wulandari, 2020; Sakilah & Magdalena, 2018). These approaches are often misaligned with the developmental needs of young learners, who require active, visual, and engaging learning experiences.

Numerous studies have shown that lower-grade students often struggle with understanding basic arithmetic operations. For instance, research by Rizqi et al. (2023) and Firdaus and Haliza (2024) revealed that many students face difficulties in grasping the concepts and relationships between addition and subtraction. Rather than understanding the underlying processes, students tend to rely on memorizing the results (Farizi et al., 2019). This issue is further exacerbated by the limited use of engaging, interactive learning media that align with the cognitive development stages of young learners (Herawati et al., 2024). Teachers frequently underutilize visual aids or educational games that could stimulate student engagement in the learning process.

Appropriate instructional media can support students in learning mathematics more meaningfully (Herawati et al., 2024; Ramlah et al., 2022; Wibowo et al., 2024). Such media can help transform abstract concepts into more tangible and appealing forms for young learners (Suri & Rachmadtullah, 2021). One promising type of medium is a game-based teaching aid, such as a mathematics-themed spinning wheel. This medium integrates visual elements, playful interaction, and direct engagement, which not only captures students' attention but also promotes active participation. Introducing variety and reducing monotony has the potential to enhance students' motivation and comprehension of fundamental mathematical concepts.

This study aims to develop a learning medium called the Mathematics Spinning Wheel, specifically designed for teaching addition and subtraction to second-grade elementary students. The development process follows the ADDIE model, encompassing the stages of analysis, design, development, implementation, and evaluation (Sari & Sakdiah, 2016; Sugihartini & Yudiana, 2018). Throughout its development, the medium undergoes expert validation and is evaluated for practicality and effectiveness through direct implementation involving both teachers and students. The Mathematics Spinning Wheel is intended as a practical and innovative solution that aligns with the developmental characteristics of elementary school-aged children.

Based on this background, the research question posed is: What are the levels of validity, practicality, and effectiveness of the Mathematics Spinning Wheel learning medium in improving second-grade students' learning outcomes on basic arithmetic operations? By addressing this question, the study seeks to contribute to the development of innovative, interactive instructional media that meet the demands of 21st-century education.

LITERATURE REVIEW

Teaching Aids in Mathematics Learning

Teaching aids play a vital role in mathematics instruction, particularly at the elementary school level. These tools serve as a bridge between abstract mathematical concepts and real-life experiences that students can observe, touch, and manipulate (Margareta & Mochtar, 2024). Teaching aids enhance conceptual understanding, student engagement, and active learning (Alshatri et al., 2019; Rusiman et al., 2017). Moreover, they support the development of metacognitive skills by helping students organize their thinking and improve problem-solving abilities (Anggo & La Arapu, 2018).

The use of teaching aids enables students to explore and relate mathematical concepts to everyday life (Luan et al., 2024). According to Sagita and Kania (2019), these aids provide multisensory learning experiences that activate not only vision and hearing but also movement and touch. Such sensory integration strengthens conceptual comprehension and improves students' retention of the material. Additionally, teaching aids facilitate collaborative learning and offer immediate feedback (Jagom et al., 2020), allowing students to engage in active, independent, and interactive learning within the classroom.

Despite these advantages, many instructional media used in classrooms remain passive and conventional (Hani et al., 2024), failing to fully accommodate the diverse learning needs of students (Novitasari & Fathoni, 2022). This fact underscores the pressing need for innovation in the form of more engaging teaching aids that can sustain students' attention and motivation. One promising innovation is the development of game-based teaching tools, such as the Mathematics Spinning Wheel.

Game-Based Learning

Game-Based Learning (GBL) has gained increasing recognition for its effectiveness in primary education. This approach integrates cognitive, affective, and psychomotor domains simultaneously within the learning process (Utami et al., 2024). GBL also promotes greater student engagement and participation in physical activities (Rejeki et al., 2024). According to Maimunah and Kusmiyati (2025), game elements such as challenges, competition, and rewards can enhance students' intrinsic motivation, which in turn fosters deeper engagement and improves information retention.

In the context of mathematics education, games serve not only as entertainment but also as practical tools for introducing concepts and practicing problem-solving skills (Andriani & Wahyudi, 2023; Wijayanti, 2021). Game-based media have been shown to significantly improve student learning outcomes compared to traditional lecture-based methods (Wijayanti, 2021). Games create a fun and stimulating learning environment. The elements of surprise and exploration within games help maintain students' focus, particularly in subjects that require repetitive practice, such as arithmetic operations.

The spinning wheel teaching aid falls under the category of game-based instructional media that is easy to implement in the classroom. It provides an engaging and active learning experience that remains aligned with the core objectives of mathematics instruction. The spinning wheel allows teachers to foster a competitive yet supportive classroom atmosphere, providing every student with an opportunity to participate in turn.

Relevance to Constructivist Learning Theory

Constructivist learning theory emphasizes that knowledge is actively constructed by learners through interaction with their environment and direct experiences (Anjelita & Supriyanto, 2024). According to Abdiyah and Subiyantoro (2021), meaningful learning can only occur when students are engaged in constructing meaning through exploration and reflection. In this context, the spinning wheel teaching aid serves as an effective tool by encouraging students to think critically, explore solutions, and discover numerical relationships through concrete experiences.

Learning with manipulatives such as the spinning wheel aligns with the hands-on learning approach (Kholiyanti, 2018). This method enhances cognitive understanding by engaging students in the learning process through physical involvement (Yuliana & Supriati, 2022). Rather than passively listening to the teacher's explanations, students actively engage with the tool, touching, spinning, and solving problems (Cahyono et al., 2024). Such activities are especially suitable for second-grade elementary students, who rely heavily on real-world experiences to form abstract concepts.

Constructivist learning through the spinning wheel medium also promotes collaboration and peer discussion (Lanani, 2016). Through these activities, students not only develop mathematical skills but also enhance their social and communication abilities (Zenni & Arini, 2024). As such, the spinning wheel represents a learning medium that is not only academically effective but also contributes to the holistic development of learners' character and interpersonal competencies.

The Impact of Interactive Media on Math Anxiety

Math anxiety is a common issue that often hinders students' academic achievement (Jalal, 2020). A rigid learning environment and pressure to achieve high results can elevate student stress levels, obstructing cognitive processes and negatively affecting learning outcomes (Jalal, 2020; Saputra, 2014). Saputra (2014) found that the use of enjoyable and interactive media can help reduce students' anxiety toward mathematics. Attractive learning tools create a more relaxed and enjoyable learning atmosphere.

The spinning wheel teaching aid, as an interactive and game-based medium, can alleviate the pressure associated with mathematics learning by presenting content in a light and playful format (Tia et al., 2023). The act of spinning the wheel and answering questions in a friendly, competitive setting fosters greater student confidence (Hamzah et al., 2019). Additionally, the variety of questions and the dynamic nature of the game help prevent boredom and fatigue during lessons. Therefore, the spinning wheel not only enhances students' conceptual understanding but also addresses emotional barriers to learning mathematics.

State of the Art and Research Gap

Previous studies have demonstrated the effectiveness of teaching aids in enhancing students' understanding of mathematical concepts. For instance, research by Vermana and Mustika (2020) and Fendrik (2019) has highlighted the positive impact of manipulative tools, such as *Dakon*, on improving mathematics learning outcomes. However, most of these studies focused on conventional media and did not incorporate active, game-based elements that could make learning more enjoyable and engaging. Research specifically aimed at developing and testing a spinning wheel-based teaching aid in the context of basic arithmetic operations for second-grade students remains scarce.

However, game-based approaches—such as the use of a spinning wheel—are particularly well-suited for elementary school students, who are typically in the concrete operational stage of cognitive development. Such media provide an effective alternative for fostering students' holistic emotional, social, and cognitive engagement. Consequently, this study seeks to address a notable gap in the existing literature by developing and evaluating an interactive, contextually relevant, and developmentally appropriate mathematics learning tool tailored to the needs of young learners.

METHODOLOGY

Research Design

This study employs a research and development (R&D) design to produce an effective and feasible instructional medium in the form of a Mathematics Spinning Wheel, intended for teaching basic arithmetic operations in second-grade elementary classrooms. A descriptive qualitative approach was adopted, utilizing exploratory and evaluative strategies. This approach was chosen for its ability to provide a comprehensive depiction of the media development process while also assessing the feasibility and effectiveness of the product through the direct involvement of its intended users—students and teachers.

The development model used in this study is the ADDIE model, which consists of five systematic and interrelated phases: Analysis, Design, Development, Implementation, and Evaluation as presented in Figure 1. This model was selected due to its structured yet flexible framework for designing and testing instructional media. In the analysis phase, classroom observations and teacher interviews were conducted to identify instructional challenges and determine the need for media intervention. The design phase involved outlining the structure and components of the Mathematics Spinning Wheel based on the identified needs. During the development phase, the instructional media was created and refined through expert validation. The implementation phase consisted of classroom trials with students and teacher facilitation to assess usability. Finally, the evaluation phase measured the media's feasibility, practicality, and effectiveness through questionnaires and pre- and post-tests. Through this sequential and iterative process, the development was scientifically accountable and aligned with actual classroom needs.

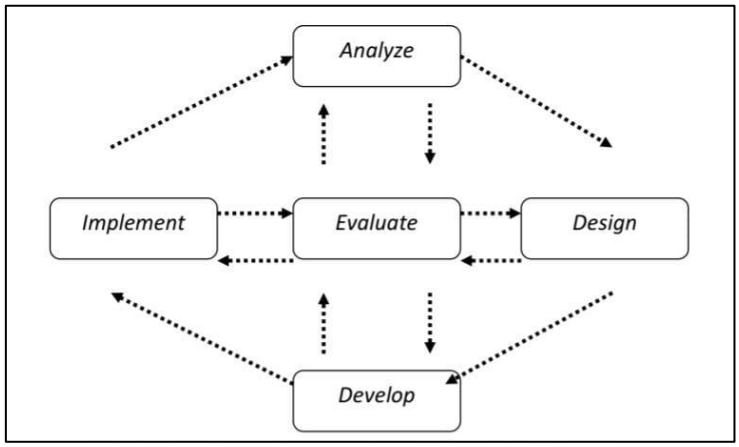

Figure 1. ADDIE Model Stages

Participants

This study was conducted at SD Negeri 211 Palembang during the second semester of the 2023/2024 academic year. The research participants included students from Class II-A and the classroom teacher responsible for mathematics instruction. Class II-A was purposively selected based on its demonstrated active participation in learning activities and prior exposure to basic arithmetic operations, making it a relevant group for piloting the instructional media.

The class comprised 28 students with diverse characteristics, including students with special needs. Their participation reflected the typical heterogeneity found in lower elementary school classrooms, encompassing a range of academic abilities, learning interests, and learning styles. The sampling technique employed was purposive sampling, which involves selecting participants based on specific criteria directly aligned with the study's objectives.

The classroom teacher also played a vital role in this research. The teacher served as the primary informant during the needs analysis phase and as a facilitator during the classroom implementation of the media. Additionally, the teacher provided assessments of the media's practicality and feasibility and observed changes in student learning behavior throughout the activities.

Data Collection

Data were collected using three primary techniques: observation, interviews, and questionnaires. Each method was employed at different stages of the study, aligned with its specific objectives. During the initial analysis phase, classroom observations and teacher interviews were conducted to identify challenges in teaching mathematics to second-grade students and to explore the need for innovative instructional media.

The observation instrument took the form of a structured observation sheet that recorded aspects such as student engagement, responses to the material, and the teaching methods used. Semi-structured interviews were conducted with the teacher to obtain deeper insights into instructional needs and student characteristics.

During the media development and validation phases, validation questionnaires were employed to assess the feasibility of the instructional media in terms of content, design, language, and usability. These questionnaires were administered to two expert validators—one specializing in subject content and the other in instructional media design. Each expert rated the media using a five-point Likert scale ranging from "very poor" to "very good."

Once the product had been validated and revised accordingly, it was implemented in the classroom. At this stage, practicality questionnaires were distributed to both students and the teacher to evaluate how easy the media was to use, how engaging it was, and how well it supported understanding of the material. To assess the effectiveness of the media on learning outcomes, a pre-test and post-test were administered based on indicators for learning addition and subtraction of whole numbers.

The data collection process spanned four weeks, covering the phases from needs identification to post-implementation evaluation. Ethical considerations were upheld throughout the study, including obtaining consent from the school principal, informing parents of the students, and ensuring the anonymity of student identities in all documentation and reporting. All participants provided informed consent, and student identities were presented anonymously using initials.

Data Analysis

The data collected in this study were analyzed using both qualitative and quantitative descriptive techniques, depending on the type and purpose of each dataset. Qualitative analysis was employed to interpret observational data and interview transcripts, allowing for a deeper understanding of classroom dynamics, teacher perspectives, and student responses. Meanwhile, quantitative analysis was applied to the results of validation, practicality, and learning outcome assessments, providing measurable evidence of the media's feasibility and effectiveness. This combination of analytical approaches ensured a comprehensive evaluation of the instructional media from multiple perspectives.

Media Validation Analysis

Data from the validation questionnaires were analyzed using percentage calculations following the formula:

$$P = \frac{F}{N} \times 100\%$$

where P represents the percentage of validity, F is the actual total score assigned by the validators, and N is the maximum possible score. The results were then categorized into five levels: $81-100\%$ (very valid), $61-80\%$ (valid), $41-60\%$ (moderately valid), $21-40\%$ (less valid), and $0-20\%$ (not valid). These validation results served as the basis for revising the instructional media before its classroom implementation.

Practicality Analysis

Practicality questionnaires completed by both students and the teacher were analyzed using the same percentage formula. The resulting scores were interpreted using the following categories: $80-100\%$ (very practical), $60-79\%$ (practical), $40-59\%$ (moderately practical), and so on. This analysis provided insights into how effectively the media could be applied in a real classroom setting.

Effectiveness Analysis

The effectiveness of the media was evaluated based on students' learning outcomes before and after using the media, calculated using the classical mastery formula:

$$P = \frac{T}{N} \times 100\%$$

where T is the number of students achieving mastery (a score ≥ 75), and N is the total number of students. The effectiveness was classified as follows: $> 100\%$ (very effective), $70-100\%$ (effective), $60-69\%$ (moderately effective), $50-59\%$ (less effective), and $\leq 50\%$ (very ineffective). In addition, a descriptive analysis of the average score increase was conducted to assess the media's impact on students' understanding of the material.

All data were systematically analyzed to answer the research question. The findings derived from this analysis are expected to provide a scientific foundation for concluding the educational value of this learning medium in the context of elementary mathematics education.

RESULTS

This study aimed to develop and evaluate the Mathematics Spinning Wheel as an instructional medium for teaching addition and subtraction to second-grade elementary students. The development process followed the five stages of the ADDIE model: Analysis, Design, Development, Implementation, and Evaluation. This section presents the detailed findings from each stage, supporting the achievement of the study's objectives.

Needs Analysis

The initial phase of the study commenced with a needs analysis, which aimed to identify challenges in the mathematics learning process for Class II-A students at SD Negeri 211 Palembang. Observations and interviews revealed that teaching methods remained conventional, dominated by lectures and repetitive exercises. The teacher reported that students often struggled to grasp arithmetic concepts due to the lack of concrete and supportive instructional materials.

Most students tended to memorize arithmetic results rather than understand the underlying mathematical processes. This led to low mastery of learning, particularly in the context of problems that required reasoning. Additionally, students aged 7–8 are typically physically active and prefer play-based activities, making monotonous teaching approaches ineffective for their developmental stage.

The need for visual, interactive, and engaging learning media thus became increasingly evident. The teacher responded positively to the idea of developing game-based instructional tools that could enhance student participation. Accordingly, the needs analysis underscored the urgency of developing the spinning wheel teaching aid as a contextual and enjoyable learning medium.

Media Design

Based on the needs analysis, the Mathematics Spinning Wheel was designed with attention to visual, functional, and pedagogical aspects. The wheel was created in a circular form that could be spun and divided into colorful segments, each containing a fundamental math question. Bright colors, large numbers, and visually appealing designs were incorporated to increase the medium's attractiveness, as presented in Figure 2.

Figure 2. Design of the Mathematics Spinning Wheel instructional media

The media was also equipped with question cards, a small board for writing answers, and user instructions designed to be easily understood by both teachers and students. The design aimed to accommodate both individual and group learning activities. Furthermore, the interactive element of spinning the wheel introduced a playful dimension, aligning with the characteristics of elementary school learners.

The design of the Mathematics Spinning Wheel prioritized not only aesthetics but also students' cognitive engagement. It was intended to introduce challenges, enhance learning motivation, and encourage active thinking in solving mathematical problems. Thus, the media design fulfilled the principles of educational game-based learning.

Development and Validation

Following the completion of the media design, the next phase involved product development and validation. A physical prototype of the instructional media was constructed and assessed for feasibility by two experts—one specializing in subject content and the other in instructional media. Both experts used a five-point Likert-scale questionnaire to evaluate the content, visual design, language clarity, and usability of the media.

The validation results showed a score of 77.38% from the content expert and 88% from the media expert, with an average score of 82.69%, as presented in Table 1. According to the predetermined criteria, this score falls within the "very valid" category, indicating that the media is highly appropriate for classroom use. This validation outcome reinforced confidence that the media had met both substantive and technical standards adequately.

Based on the feedback received, minor revisions were made to enhance visual appeal and clarify instructional guidance. The validation results served as the foundation for proceeding to the next stage—media implementation in the classroom. With a strong validity rating, the media was deemed ready for field testing in an actual instructional setting.

Table 1. Validation Scores from Content and Media Experts

No.	Validator	Score
1	Subject matter expert	77,38%
2	Media expert	88%
	Average	82,69%

Classroom Implementation

The Mathematics Spinning Wheel was implemented in a second-grade classroom (Class II-A) to support lessons on addition and subtraction of whole numbers. The teacher began by explaining the rules of the activity, then allowed each student to take turns spinning the wheel and solving the math problem indicated by the pointer. The activity was conducted both individually and in groups.

During implementation, students demonstrated high levels of enthusiasm and engagement. They were eager to spin the wheel and solve the problems that appeared. The teacher functioned as a facilitator—guiding the learning process, providing support when students encountered difficulties, and fostering a positive and supportive learning environment.

Observation data revealed that the classroom atmosphere became more dynamic and participatory. Students appeared more focused and confident in answering questions and were supportive of one another during group activities. The implementation of this media provided evidence that the Mathematics Spinning Wheel effectively increased student engagement in the learning process.

Media Practicality

Following the implementation phase, the practicality of the media was assessed using questionnaires administered to both students and the classroom teacher. These questionnaires evaluated the ease of use, attractiveness, and the extent to which the media supported students' understanding of the material. The average score obtained from student responses was 90.4%, as presented in Table 2. Meanwhile, the teacher's assessment yielded an average score of 91.3%. According to the established criteria, both scores fall within the "very practical" category.

Table 2. Practicality Questionnaire Results from Students

No	Test Type	Score
1	One-to-One Trial	89,9%
2	Small Group Trial	90,9%
	Average	90,4%

These results indicate that the media was not only well-received by students but also considered adequate by the teacher in supporting instructional delivery. The teacher noted that the media was easy to operate and could be used without the need for complex instructions. Students expressed that the activity was enjoyable and made learning feel less monotonous.

The high level of practicality reinforces the media's potential for integration into regular classroom instruction. It offers a creative and innovative alternative to conventional teaching methods. With its excellent practicality ratings, the Mathematics Spinning Wheel holds promise for broader application in elementary school classrooms.

DISCUSSION

The results of this study demonstrate that the Mathematics Spinning Wheel is effective in improving second-grade students' learning outcomes in addition and subtraction. This effectiveness is evidenced by an increase in the average student score from 64.04 on the pre-test to 79.25 on the post-test. Additionally, classical mastery improved significantly, from 28.57% to 85.71%. These findings confirm that instructional media that integrate game elements, visual aids, and interactivity can effectively support the achievement of mathematics learning objectives in lower elementary grades.

The improvement in learning outcomes was not only quantitative but also reflected enhanced quality in the learning process. Through the use of the spinning wheel, students became more actively engaged, motivated to participate, and showed heightened curiosity when presented with randomly generated problems. This finding aligns with the cognitive developmental characteristics of elementary-aged students, who are in the concrete operational stage and benefit most from hands-on, experience-based learning (Agustyaningrum et al., 2022; Nabila, 2021; Nuryati & Darsinah, 2021). Previous studies have likewise shown that concrete teaching aids can significantly improve young learners' understanding of abstract mathematical concepts (Alshatri et al., 2019; Margareta & Mochtar, 2024; Rusiman et al., 2017).

Student engagement also served as an indicator of the media's success in creating a fun, low-pressure learning environment. Rather than solving problems mechanically, students engaged in decision-making and group discussions, providing opportunities to construct their understanding through direct experience. This approach is consistent with constructivist principles, which emphasize active learner involvement in the meaning-making process (Abdiyah & Subiyantoro, 2021; Anjelita & Supriyanto, 2024). Other studies on game-based learning have similarly found that such approaches can

reduce math anxiety and boost student confidence in problem-solving (Hamzah et al., 2019; Jalal, 2020; Saputra, 2014; Tia et al., 2023).

The media validation results, with an average score of 82.69% from both content and media experts, reinforce the conclusion that the Mathematics Spinning Wheel meets standards for both content accuracy and technical quality. This validation is crucial in ensuring that the media is not only visually appealing but also conceptually accurate and aligned with the fundamental competencies outlined in the curriculum (Sari & Sakdiah, 2016; Sugihartini & Yudiana, 2018). Previous studies on media development also emphasize the importance of expert validation to ensure the instructional quality of educational products before classroom implementation (Herawati et al., 2024; Wibowo et al., 2024). As such, the feasibility testing conducted in this study provides a solid foundation for teacher and student confidence in the instructional media.

Practicality was another key focus of this study. The practicality scores of 90.4% from students and 91.3% from the teacher indicate that the media was highly user-friendly and well-received. This finding suggests that the spinning wheel's interactive yet simple design successfully met user expectations in the classroom. The teacher was able to operate the media without specialized training, and students easily understood how to use it without significant difficulty. Similar findings have emerged in other studies involving the development of educational game media, which have shown that ease of use greatly influences successful classroom implementation (Herawati et al., 2024; Wibowo et al., 2024; Wijayanti, 2021). Furthermore, intuitive and enjoyable media naturally increase student participation and engagement in learning (Maimunah & Kusmiyati, 2025).

From an effectiveness standpoint, the observed 57.14% increase in student mastery represents a key indicator of the media's success in achieving learning objectives. Notably, even students who initially scored low demonstrated significant improvement after using the spinning wheel. This finding suggests that the media can accommodate diverse learning abilities within the classroom. Previous studies have highlighted that interactive media tailored to students' learning styles can help bridge academic achievement gaps in heterogeneous classrooms (Ramlah et al., 2022; Suri & Rachmadtullah, 2021). Additionally, game-based learning approaches have proven effective in engaging students across various skill levels through flexible and appealing learning experiences (Rejeki et al., 2024; Utami et al., 2024).

It is essential to recognize that improved learning outcomes are not solely the result of using the media itself, but also depend on how the media is effectively integrated into teaching strategies. In this study, the teacher played an active role as a facilitator, guiding the learning process and providing reinforcement. This approach aligns well with 21st-century learning principles, which emphasize the role of teachers as learning partners (Juwantara, 2019). Other pedagogical research has similarly shown that the success of instructional media is greatly influenced by the quality of interaction among teachers, students, and the media (Margareta & Mochtar, 2024; Zenni & Arini, 2024). When teachers strategically integrate instructional tools and respond to students' learning needs, the overall effectiveness of instruction increases significantly.

The spinning wheel, designed as a game, introduced elements of surprise and challenge that kept students engaged throughout the learning process. With each spin, students could not predict which question would appear, maintaining their alertness, motivation, and willingness to participate. This unpredictability fostered a healthy sense of competition and stimulated exploratory learning behaviors (Wijayanti, 2021). Moreover, this mechanism enabled repetitive practice in an enjoyable, non-monotonous, and stress-free environment. Repetition in a playful context is particularly beneficial for developing automatic and accurate arithmetic skills, as supported by mathematics education research, which indicates that game-based repetition strengthens both retention and procedural fluency (Andriani & Wahyudi, 2023; Wijayanti, 2021).

Despite the high level of effectiveness observed, some students still failed to reach mastery after using the media. This finding suggests that not all learners respond to instructional media in the same way. Other influencing factors, such as academic background, psychological condition, self-confidence, and home support, can significantly impact learning outcomes (Jalal, 2020; Saputra, 2014). Therefore, the use of instructional tools, such as the Mathematics Spinning Wheel, should be complemented by differentiated instruction and individualized support. Similar findings in adaptive learning studies emphasize the need for additional interventions for students who do not achieve optimal outcomes, even when the learning media is well-designed (Herawati et al., 2024; Ramlah et al., 2022).

Overall, the Mathematics Spinning Wheel has proven effective in meeting the need for a fun, participatory learning experience that positively impacts student achievement. These findings contribute to the development of interactive, game-based mathematics learning media at the elementary level. Furthermore, the study reinforces the notion that mathematics education can be made more engaging without compromising the conceptual depth students are expected to master. In line with this, previous research has emphasized that when students are happy, motivated, and interested, their ability to absorb new material increases significantly (Hamzah et al., 2019; Maimunah & Kusmiyati, 2025; Tia et al., 2023).

This media also has the potential to be adapted or replicated for other subject areas or educational levels. Future development could include technological integration, such as digitizing the spinning wheel via interactive software or applications. This direction aligns with the growing demand for technology-based learning and supports greater flexibility across different learning contexts. In this way, the instructional media not only addresses current educational challenges but also remains adaptive to future demands—particularly in the advancement of technology-enhanced and student-centered learning.

CONCLUSION

This study successfully developed and evaluated the Mathematics Spinning Wheel, an instructional medium designed to enhance second-grade elementary students' understanding of addition and subtraction. Based on the analysis, the media was rated as highly valid by experts and highly practical by both teachers and students, and was found to be effective in improving learning outcomes. The average student score increased by 15.21 points from the pre-test to the post-test. In contrast, the percentage of students achieving classical mastery rose from 28.57% to 85.71%, indicating a significant positive impact on students' mathematical achievement. Overall, the Mathematics Spinning Wheel proved to be a practical, applicable, and developmentally appropriate medium for early-grade mathematics instruction.

Nevertheless, several limitations of this study must be acknowledged. One major limitation is the relatively small sample size—only 28 students from a single class at one school—which restricts the generalizability of the findings to broader educational contexts. Additionally, the evaluation of effectiveness was conducted over a short period, which was insufficient to determine the long-term impact on concept retention or mathematical skills. Another limitation lies in the content scope, which was restricted to basic arithmetic operations without testing the media's applicability to other mathematical concepts.

To address these limitations, future research should involve a larger number of schools and classrooms from diverse social and geographical backgrounds to test the consistency of the findings. Employing longitudinal evaluation methods is also recommended to assess the long-term effects of the media on conceptual understanding and retention of learning. Furthermore, future development could explore adapting the spinning wheel for other mathematics topics or integrating digital features to align with technological advancements in education.

The implications of this study can be observed across several dimensions. Theoretically, it supports the view that game-based learning and the use of concrete media can reinforce concept acquisition during the concrete operational stage of cognitive development. Practically, the media offers an engaging and easy-to-implement alternative for teachers in primary mathematics instruction. It also serves as inspiration for the development of other interactive teaching aids tailored to the characteristics of young learners. From a policy perspective, the findings may encourage schools and educational policymakers to integrate innovative learning media into teacher training programs and learning resource procurement strategies.

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