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Implementation of Addition Suit Game as an Innovative Strategy to Foster Critical Thinking in Early Mathematics Learning

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Abstract

This study investigates the use of Addition Suit Game as a play-based learning strategy to enhance students' conceptual understanding, critical thinking, and motivation in early mathematics education. Using a qualitative design, data were collected through observation, semi-structured interviews, and documentation involving twenty students at first grade SDN Krapyakrejo II. The findings show that the game encourages a transition from intuitive understanding of addition toward analytical and reflective reasoning. Students have demonstrated progressive conceptual development through interpretation, strategy use, reasoning, and peer collaboration which reveals in six aspects of critical thinking; interpretation, analysis, evaluation, inference, explanation, and self-regulation. Moreover, the game has increased students' motivation and engagement; characterized by enthusiasm, collaboration, and enjoyment in learning. Overall, the playing-based learning highlights that structured play/ game effectively integrates cognitive, social, and emotional dimensions, transforming mathematics learning into a meaningful and enjoyable experience for young learners.

Keywords: *: Playing-Based Learning; Addition Suit Game; Critical Thinking; Innovative Strategy; First Grade SDN Krapyakrejo II*

INTRODUCTION

Mathematics education in primary school plays a crucial role in shaping students' foundational abilities, especially in logical reasoning and problem-solving. One of the most fundamental competencies that first-grade learners must acquire is the concept of addition. Despite its importance, national and international assessments indicate that Indonesian students continue to face difficulties in basic numeracy. Results from the Programme for International Student Assessment (PISA) reveal that Indonesia consistently scores below the OECD average in mathematics, reflecting limited mastery of basic mathematical concepts from early schooling (OECD, 2022). These findings strengthen the argument that meaningful mathematical understanding must be built from the earliest grades.

Although addition is essential, several studies show that early-grade students often depend on memorizing procedures rather than understanding the meaning of operations. Barham et al. find that many students in lower grades still rely on rote strategies without processing the conceptual basis of numerical relations. Strengthening conceptual understanding at this stage is vital because early numeracy proficiency predicts long-term mathematical achievement and cognitive development (Barham et al., 2019). This condition highlights the need for instructional strategies that not only emphasize learning outcomes but also develop children's mathematical reasoning and thinking processes from the outset (Lopez-pedersen et al., 2022).

Developing students' critical thinking skills has also become a core requirement of 21st-century education. Critical thinking in mathematics involves the ability to analyze information, interpret ideas, evaluate strategies, and reflect on decisions (Rochmad et al., 2018). These skills are essential even at the primary level, as early cognitive stimulation strengthens children's habits of reasoning, curiosity, and problem-solving (Rahma et al., 2025). Young learners are capable of developing these competencies when provided with learning experiences that encourage exploration, explanation, and justification of their thinking. However, classroom practice in early grades is often mechanistic: teachers explain procedures, students imitate steps, and assessments focus merely on answer accuracy. Such approaches limit opportunities for reflective and analytical thinking (Ismail et al., 2022).

To address these issues, many researchers have explored game-based learning as a strategy to improve engagement, conceptual understanding, and critical thinking. Prior studies demonstrate that game-based approaches can increase motivation and stimulate higher-order thinking among elementary students (Belova & Zowada, 2020; Hamidah et al., 2024; Kim et al., 2021). Nonetheless, most research has centered on digital games. Investigations on traditional or physical games especially those intentionally designed to cultivate analytical and collaborative reasoning remain limited. Several scholars highlight that non-digital, culturally relevant games have strong potential to create meaningful learning experiences, yet they are underrepresented in empirical studies (Hulaikah et al., 2020).

Children aged six to seven, who are situated in the concrete operational stage according to Piagetian developmental theory, learn best through hands-on activities, peer interaction, and concrete representations (Iswara et al., 2022). Traditional physical games, therefore, provide an appropriate bridge between concrete experience and abstract symbol manipulation. Such activities allow learners to practice reasoning, compare strategies, explain thinking, and regulate their decisions as core elements of critical thinking development. The Addition Suit Game introduced in this study is designed to integrate physical hand based play (suit) with mathematical reasoning. Through this strategy, students not only determine the result of the "suit addition" but also articulate their reasoning, justify their strategy, and reflect on outcomes during peer discussions. These activities support the emergence of essential components of critical thinking such as interpretation, analysis, evaluation, inference, explanation, and self-regulation(Facione, 2011).

This research contributes novelty by developing a traditional, interactive, and contextually grounded game based model aimed explicitly at stimulating critical thinking in early mathematics learning. While prior studies predominantly focus on digital game-based learning, this study emphasizes a low technology, socially interactive approach tailored to the developmental characteristics of young children. Based on this background, the research question formulated is: How does the implementation of Addition Suit Game enhance first-grade students' understanding of addition concepts and develop their critical thinking skills? This study aims to examine the effectiveness of the Addition Suit Game in: (1) strengthening students' conceptual understanding of addition; (2) fostering mathematical critical thinking skills; and (3) increasing students' motivation and engagement during learning activities. By positioning game-based learning as a pedagogical approach that integrates cognitive, social, and affective dimensions, this study is expected to provide practical implications for teachers in designing mathematics instruction tobe more enjoyable, meaningful, and developmentally appropriate for primary school learners.

METHODS

This study employed a qualitative approach intended to explore in depth the learning experiences of first-grade students during the implementation of the Addition Suit Game in mathematics lessons. The qualitative design was chosen to obtain a holistic understanding of how this strategy shapes students' conceptual comprehension of addition and stimulates their emerging critical thinking skills within a play-based learning environment. The research involved 20 first-grade students selected through purposive sampling based on their developmental appropriateness, as children at the concrete operational stage are highly responsive to direct, experience-based, and interactive learning activities. The study was conducted in a primary school that demonstrated openness and readiness to integrate activity-based instructional practices, and all data collection procedures were carried out after obtaining consent from the principal, classroom teacher, and parents.

Data were gathered through participatory observation, semi-structured interviews, and visual documentation, enabling the researcher to closely examine students' engagement, reasoning processes, and social interactions during the game. Observations focused on participation patterns, accuracy in addition, verbal explanations of reasoning, and collaboration with peers. Semi-structured interviews were conducted with the teacher and six selected students to deepen insights into their perceptions of learning through play, their experiences in understanding addition concepts, and their reflections on strategy used during the suit game activities. The interview guidelines were reviewed through an expert judgment process by two researchers in mathematics education to ensure the clarity, alignment, and relevance of the questions with the research objectives. Documentation in the form of photographs and field notes supported the analysis by providing contextual evidence of classroom dynamics.

Data were analyzed using the Interactive Model of Miles, Huberman, and Saldana which follows an iterative flow consisting of data reduction, data display, and conclusion drawing (Miles et al., 2014). Throughout data reduction, the researcher selected and condensed relevant information to identify emerging themes related to conceptual understanding and critical thinking. Reduced data were then organized into narrative matrices to visualize relationships between students' actions, verbal responses, and conceptual patterns. Conclusions were drawn through continuous verification by comparing patterns across data sources and aligning them with theoretical perspectives on early mathematics learning and cognitive development. Credibility of findings was strengthened through triangulation between methods (observation, interview, documentation) and sources (students, teacher, and researcher notes), as well as peer debriefing sessions with two qualitative research experts to ensuring analytical rigor and dependability.

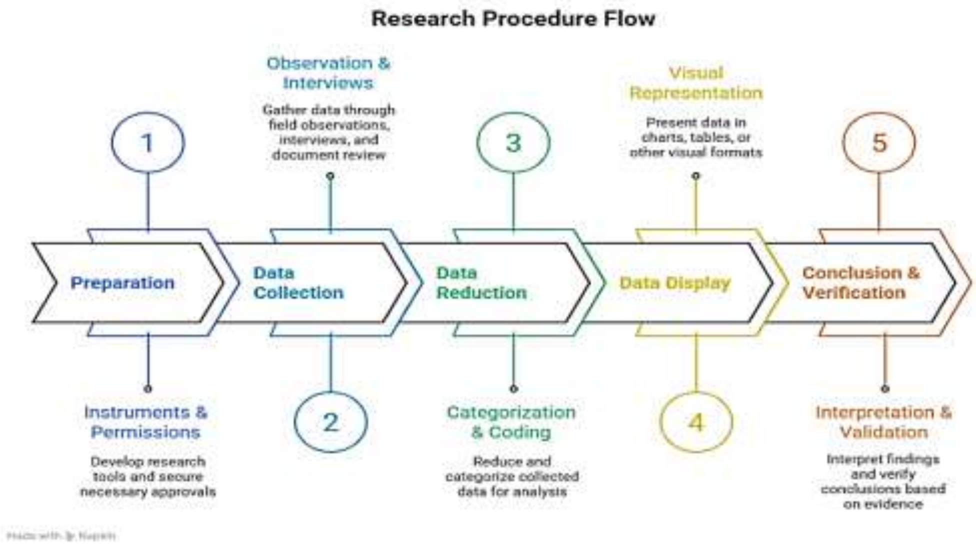

Figure 1. Research Procedure

RESULTS AND DISCUSSION

Results

The results of this study provide a comprehensive overview of how the Addition Suit Game as a play-based mathematics learning strategy enhances students' conceptual understanding of addition, fosters the development of critical thinking skills, and strengthens intrinsic motivation and classroom engagement. Through qualitative analysis involving classroom observations, semi structured interviews, and reflective documentation, three major themes emerged, as stated bellow;

1. The development of conceptual understanding

The implementation of the Addition Suit Game showed a clear progression in students' conceptual understanding of addition. Classroom observations, interview responses, and documentation indicated that students gradually moved from performing addition mechanically toward explaining their reasoning, and collaborating with peers. The coding analysis generated four categories describing this development.

Table 1. Conceptual Understanding Description

Code	Conceptual Description
A1	Initial interpretation of addition
A2	Suit strategies in performing addition
A3	Explanation of the reasoning behind the results

A4	Peer collaboration during the game

The coding results indicated a sequential progression in students' understanding of addition concepts. A1 captured students' initial tendency to approach addition mechanically guessing or recalling numbers without clear reasoning. As the sessions progressed. A2 emerged when students began to use the Suit Game strategically, showing awareness of numerical relationships and deliberate decision making. A3 represented a deeper level of conceptual understanding, where students articulated their reasoning, connected game outcomes with mathematical logic, and justified their answers verbally. Finally, A4 emphasized the collaborative dimension of learning, where social interaction and peer dialogue acted as catalysts for conceptual growth. Collectively, these codes illustrated a cognitive transition from intuitive and procedural responses toward reflective, analytical, and socially constructed mathematical understanding.

The illustration on how students began to verbalize their mathematical reasoning and connect concrete experiences with abstract numerical understanding can be seen in response to the question, Q: *"Can you explain how you got the number five?"*; A: *"The total is five because I combined three and two.* Another student described the way they decided on a card choice. Q: *"Why did you choose the 3 + 2 card during the game?"*; A: *"I chose the 3 + 2 card because my friend chose 3, so I added 2 to win."* These statements illustrate students' growing ability to articulate how they obtained results and why they made particular choices. Documentation also captured the increased peer interaction. For instance, one student questioned a peer's decision by asking, *"Why did you choose two? I chose three earlier, so I added one more…"* Teachers similarly reported higher levels of participation and noted that students who were previously passive began discussing their ideas more actively during the game.

Students expressed positive responses regarding their learning experiences. One student stated, *Q: "How do you feel about learning mathematics using the Addition Suit Game compared to regular lessons?"; A: "I like math lessons now because we can play and learn together. Before, we just listened to the teacher and counted in the book."* These comments indicate that students found the activity more enjoyable and felt more involved in the learning process. Overall, the empirical data demonstrated that students progressed through four conceptual stages (A1–A4), showing improvement in their ability to interpret addition, apply strategies, explain reasoning, and collaborate with peers during the implementation of the Addition Suit Game.

2. The progression of critical thinking competence

The analysis identified six behavioral and verbal indicators that reflected the emergence of higher-order thinking during students' participation in the Addition Suit Game. These indicators were categorized into six codes (B1–B6), as shown in Table 2.

Table 2. Critical Thinking Indicator

Code	Conceptual Description
B1	Interpretation of suit results and numerical relationships
B2	Analysis of peers' strategies and gameplay patterns
B3	Evaluation of personal decisions and strategy adjustments
B4	Inference and logical justification of choices
B5	Explanation. Ability to articulate reasoning and justify answers logically
B6	Self-regulation and reflective control of thinking

The details of each process are elaborated below.

a. Interpretation (B1)

At the beginning of the activities, students began interpreting numerical values by relating finger gestures or cards to quantities. Observational notes recorded students describing totals aloud, such as identifying the sum of two sets of raised fingers. One student stated, *"If I raise two fingers and my friend raises three, that means two plus three is five."* This statement showed that students were recognizing numerical relationships embedded within the game.

b. Analysis (B2)

As the sessions progressed, students showed behaviors indicating analysis of peers' strategies. Several students observed patterns in their peers' choices and attempted to anticipate upcoming moves. For example, one student commented, *"If you choose a big number, I'll choose a smaller one so it's different."* This field note indicated that students frequently compared their gestures or cards with others and adjusted their decisions based on observed patterns.

c. Evaluation (B3)

Students also began evaluating the outcomes of their actions. Some students reflected on earlier decisions and identified moments when their choices were ineffective. A student expressed, *"I should not always choose big numbers because sometimes smaller ones make better combinations."* This evaluative statement emerged increasingly during later sessions, often following repeated rounds of gameplay.

d. Inference (B4)

Inference behaviors appeared when students predicted outcomes based on earlier rounds. Several students formulated expectations about results before revealing their gestures or cards. One student predicted the total by saying, *"If I pick three and my friend picks one, the total is four, so I'll probably win next round if I change my number."* Documentation also showed that such predictions became more frequent as students grew familiar with the rules and patterns of the game

e. Explanation (interwoven across B5)

Explanation was consistently observed throughout the activity. Students verbally justified their choices when prompted by peers or teacher. It could be seen from the statement such as, *"I added two because my friend had three."* These explanations were often followed by peer responses, leading to short discussions about differing strategies and outcomes.

f. Self-Regulation (B6)

Self-regulation behaviors appeared as students began correcting their own errors and adjusting strategies without external prompts. One student said, "*I counted wrong earlier; two plus three is five, not four."* Observational notes also recorded students maintaining focus after losing a round and demonstrating persistence in improving their performance in subsequent rounds. The behaviors coded as B1–B6 demonstrated a sequential pattern of development. Students initially interpreted numerical relationships, then analyzed peer strategies, evaluated outcomes, generated predictions, articulated explanations, and monitored their own thought processes. These behaviors emerged naturally throughout the gameplay and became more frequent over the course of the intervention.

3. The Enhancement of Learning Motivation and Engagement

The analysis of students' affective and behavioral responses during the Addition Suit Game identified four indicators of motivation and engagement, coded as C1–C4. These indicators were derived from observations, interview data, and documentation gathered throughout the intervention.

Table 3. Motivation and Engagement Description

Code	Conceptual Description
C1	Joyful participation and enthusiasm during play
C2	Social collaboration and peer support
C3	Comparison between traditional and play-based learning experiences
C4	Intrinsic motivation and reflective engagement after gameplay

a. Joyful Participation (C1)

At the beginning of the activities, students demonstrated high levels of excitement and eagerness to participate. Observation notes recorded multiple students volunteering immediately when the game began. The classroom atmosphere was lively, and most students maintained attention throughout the session. The teacher confirmed this during the interview, stating, *"The children were visibly excited. Usually, some remain silent or easily distracted, but now everyone wanted to play and learn."* This reflected a clear shift from passive behavior to active involvement.

b. Social Collaboration and Peer Support (C2)

Throughout the sessions, students frequently interacted with their peers by sharing strategies, offering help, and commenting on each other's gestures or card choices. Several instances of spontaneous collaboration were observed, such as students calling out to peers to coordinate their moves or discuss possible totals. One student expressed, *"Let's try together! If you choose two, I'll choose three so it becomes five!"* This interaction showed that students engaged collectively and supported one another during the activity.

c. Differences from Traditional Lessons (C3)

Observation data recorded that students remained focused for longer periods during the game compared to regular mathematics lessons. The teacher noted clearer behavioral differences, stating, *"During regular math lessons, some students quickly get bored. But with the game, everyone is involved and no one stays passive."* Documentation also showed fewer off-task behaviors during the gameplay sessions than during conventional instruction.

d. Intrinsic Motivation and Reflective Engagement (C4)

Students expressed enjoyment and a sense of personal satisfaction when they successfully solved addition tasks or improved from previous rounds. Interviews revealed that students valued understanding the process rather than solely competing. One student stated, *"I like this game because I can think while playing. When I get the answer right, I feel proud."* Several students were observed checking their own calculations and adjusting their strategies, indicating active involvement driven by personal interest rather than external rewards.

The indicators C1–C4 showed that students experienced increasing emotional involvement, social interaction, and personal investment in the learning process. Motivation and engagement were consistently strong across sessions, with students demonstrating enthusiasm, collaboration, focused attention, and reflective behaviors. These responses developed progressively throughout the implementation of the Addition Suit Game.

Discussion

The findings of this study demonstrate that the Addition Suit Game plays a significant role in enhancing early-grade students' mathematical learning experiences. The three clusters of results—conceptual understanding (A1–A4), critical thinking development (B1–B6), and learning motivation and engagement (C1–C4) are interconnected and collectively illustrate how a play-based instructional approach fosters active, meaningful, and student-centered learning. These findings align with constructivist principles and sociocultural learning theories, which emphasize that knowledge is formed through active experience, social interaction, and reflective processes.

The progression in conceptual understanding shown in A1–A4 indicates that students have constructed their understanding of addition gradually through concrete, hands on experiences and collaborative exploration. Initially, students rely on intuitive interpretations, but as the sessions progressed, they begin applying strategies, articulating reasons, and developing shared understanding through peer dialogue. This pattern reflects the constructivist view of mathematical learning, in which concepts emerge through exploratory activities grounded in real experiences. Murtafiah et al (2019) affirm that contextual and collaborative tasks help students link concrete representation with symbolic forms, resulting in deeper conceptual comprehension.

Similarly, Blyznyuk (2019) and Rufiana et al (2024) highlight that active learning strengthens conceptual mastery more effectively than procedural drills. Within this context, the Addition Suit Game functions as a constructive medium that enables students to develop addition concepts through staged experiences, strategic thinking, and reflective discussion.

The emergence of critical thinking skills across indicators B1–B6 further shows that the game stimulates higher-order cognitive processes rather than simple mechanical responses. During the game, students engage in interpretation, analysis, evaluation, inference, explanation, and self-regulation core components of critical thinking, as identified in Facione (2011) consensus framework. These indicators appear naturally as students interact, exchange reasoning, and respond to peers' strategies. Prior studies by Rahma & Riono (2024) and by Susandi et al (2019) support this finding, noting that critical thinking develops when learners are placed in situations requiring justification, argumentation, and analytical decision-making. (Adharini & Herman (2020). further emphasizes the role of reflective discussion in nurturing metacognitive awareness, which is clearly observed as students correct their own errors and adjust strategies during the game. The combination of concrete gameplay and social interaction creates a natural environment for the progressive emergence of critical thinking skills (Chikiwa & Schäfer, 2018).

In addition to cognitive gains, the increase in student motivation and engagement observed in C1–C4 underscores the importance of an enjoyable and interactive learning climate. Students display excitement, active participation, and willingness to collaborate—behaviors that are fundamental to effective learning. Altun & Yildirim (2023) and(Chikiwa & Schäfer, 2018) highlight that interactive learning environments enhance students' confidence and emotional engagement, aligns with the patterns observed during the gameplay. Motivational gains become especially evident when students express pride in understanding mathematical ideas, reflecting the emergence of intrinsic motivation. This finding is consistent with Su et al (2016), who assert that learning environments that encourage interaction and reflection tend to elevate students' interest and motivation. Additionally, as noted by Lin et al (2020), social cooperation can directly strengthen students' persistence and commitment to understanding mathematical concepts and outcome clearly supported by the collaborative atmosphere in this study (Jin & Harp, 2020).

Viewed together, the convergence of findings across conceptual (A), critical thinking (B), and motivational (C) domains indicates that the Addition Suit Game successfully established a meaningful learning environment, such an environment is characterized by active participation, social interaction, reflective reasoning, and contextual relevance. Cevikbas & Kaiser (2022) and Rovan et al (2021) explain that meaningful mathematical learning emerges when students have opportunities to manipulate concrete objects, negotiate meaning, articulate reasoning and self-correct, and build understanding through direct experience all of which occurred consistently during the game's implementation (Jin & Harp, 2020).

Overall, the integration of the A, B, and C findings demonstrates that a simple traditional game can function as an effective pedagogical tool for supporting conceptual development, fostering critical thinking, and enhancing motivation in early mathematics learning. The interplay between concrete activity, social interaction, and reflective discourse creates a holistic learning experience that aligns strongly with constructivist and active learning principles. This suggests that playing-based approaches such as the Addition Suit Game hold considerable potential for enriching primary mathematics instruction.

CONCLUSION

The findings of this study demonstrate that the Addition Suit Game effectively enhances first grade students' mathematical learning by simultaneously improving their conceptual understanding of addition, fostering the development of critical thinking skills, and increasing motivation and engagement in the classroom. Students construct their understanding of addition progressively through concrete experiences and collaborative interactions, while the game's interactive structure naturally elicits essential dimensions of critical thinking such as interpretation, analysis, evaluation, inference, explanation, and self-regulation. Additionally, the enjoyable and socially supportive learning environment cultivated by the game has successfully strengthened students' intrinsic motivation, focus, and willingness to participate. Taken together, these outcomes indicate that a simple, play-based instructional model grounded in hands-on activity, peer interaction, and reflective dialogue can create a meaningful and holistic learning experience aligns with constructivist and active learning principles

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