

EXPLORING THE USE OF NUMBER CARD MEDIA FOR STRENGTHENING WHOLE NUMBER CONCEPTS IN ELEMENTARY SCHOOL MATHEMATICS

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ABSTRACT

Understanding whole number concepts is a fundamental prerequisite for developing mathematical reasoning and numeracy skills in elementary education. However, many students continue to experience difficulties in understanding place value, number ordering, number patterns, and basic arithmetic operations because these concepts are often presented in an abstract manner. This study aimed to explore the use of number card media for strengthening students' understanding of whole number concepts in elementary school mathematics. A qualitative descriptive approach was employed at MI Tarbiyatul Athfal involving two purposively selected elementary school students. Data were collected through classroom observations, semi-structured interviews, documentation, and numeracy tasks, and were analyzed using the interactive model of Miles, Huberman, and Saldaña. The findings suggest that number card media provided meaningful manipulative learning experiences that supported students in understanding place value, ordering whole numbers, identifying odd number patterns, representing hundreds, tens, and ones, and performing simple subtraction operations. The activities also encouraged active participation and engagement during mathematics learning. Rather than demonstrating instructional effectiveness, this study provides an in-depth description of how number card media can facilitate students' conceptual construction of whole number concepts through concrete learning experiences. The study contributes to the existing literature by offering qualitative evidence on classroom

implementation of manipulative media and highlighting their potential to support concept-oriented mathematics instruction in elementary schools.

Keywords: *number card media, manipulative learning media, whole number concepts, whole numbers, qualitative study*

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INTRODUCTION

Mathematics is a fundamental subject introduced from the elementary school level because it plays a crucial role in developing students' logical reasoning, critical thinking, problem-solving, and decision-making skills. At this level, understanding whole number concepts constitutes the foundation for learning more advanced mathematical topics, including arithmetic operations, fractions, algebra, and mathematical reasoning (Gasteiger et al., 2020). Whole number concepts encompass understanding place value, number ordering, number patterns, and basic arithmetic operations, all of which are essential components of numeracy. Mastery of these concepts enables students to apply mathematical knowledge in everyday situations and supports their long-term mathematical development.

Despite their importance, numerous studies have reported that elementary school students continue to experience considerable difficulties in understanding whole number concepts because mathematics is often presented in an abstract manner. Rather than developing conceptual understanding, students frequently memorize computational procedures without comprehending the underlying mathematical relationships (Rahma et al., 2023). Consequently, many students struggle with identifying place value, comparing numbers, ordering whole numbers, recognizing number patterns, and solving basic arithmetic problems (Asriyanti & Purwati, 2020). Similar findings by Aisyah

et al. (2024) who found that elementary students often experience difficulties in interpreting mathematical concepts and applying appropriate solution strategies when solving numerical problems. These findings indicate that students require instructional approaches capable of transforming abstract mathematical concepts into meaningful learning experiences.

The need for meaningful learning experiences is further supported by previous research demonstrating that students' mathematical difficulties frequently result from limited opportunities to interact with concrete representations of mathematical concepts. Alfiyah et al. (2021) argued that elementary students encounter difficulties in understanding mathematical symbols and procedures when instruction relies primarily on abstract explanations without adequate instructional media. Therefore, learning activities should provide opportunities for students to manipulate concrete objects and construct mathematical understanding through direct experiences that correspond to their cognitive development.

The importance of concrete learning experiences is supported by several major learning theories. According to Piaget in Madanagopal (2020), elementary school students are generally in the concrete operational stage, during which they understand mathematical concepts more effectively through direct interaction with tangible objects before progressing to abstract reasoning. Similarly, Bruner & Kenney Theory of Representation (1965) proposes that learning develops progressively through three modes of representation: enactive, iconic, and symbolic. Students first construct understanding through physical manipulation of objects, followed by visual representations, before finally developing abstract symbolic reasoning. From a sociocultural perspective, Vygotsky (1978) emphasized that learning occurs most effectively through social interaction and instructional scaffolding within learners' Zone of Proximal Development. Manipulative learning media therefore function as cognitive tools that support conceptual construction through guided interaction between teachers and students. Furthermore, contemporary mathematics education highlights the importance of developing number sense, which includes understanding numerical magnitude, place value, number

relationships, and flexible numerical reasoning as fundamental components of mathematical proficiency (Gersten et al., 2009). Collectively, these theoretical perspectives provide a strong rationale for employing manipulative learning media to facilitate conceptual understanding of whole numbers.

Learning media function as instructional tools that facilitate the delivery of information while stimulating students' attention, motivation, and active participation during learning (Rahma, 2019). Among various manipulative learning media, number card media provide opportunities for students to manipulate numerical representations directly through activities involving arranging, ordering, grouping, and representing numbers according to place value. Such activities enable students to visualize numerical relationships and gradually develop conceptual understanding through concrete learning experiences. Previous studies consistently demonstrate that manipulative learning media contribute positively to students' conceptual understanding by connecting symbolic mathematical representations with concrete experiences (Ng & Rao, 2010; Schindler & Lilienthal, 2020). Interactive learning media have also been shown to enhance students' engagement, motivation, and mathematical exploration (Basyal & Mainali, 2022; Rahma et al., 2025). However, these studies have primarily examined manipulative media in general, with relatively limited attention given to how number card media specifically facilitate students' conceptual understanding of whole number concepts through classroom learning processes.

Preliminary classroom observations conducted at MI Tarbiyatul Athfal further confirmed the need for this study. Several students experienced persistent difficulties in understanding place value, ordering whole numbers, distinguishing odd and even numbers, and representing hundreds, tens, and ones. Mathematics instruction relied predominantly on teacher explanations and textbook exercises, while manipulative learning media were rarely integrated into classroom activities. During the initial observations, students frequently confused digit position with digit value and required repeated teacher guidance to complete simple whole number tasks. These findings indicate that students require more

concrete and interactive learning experiences to develop conceptual understanding of whole numbers.

Despite the growing body of literature on manipulative learning media in mathematics education, several important research gaps remain. First, previous studies have largely evaluated the effectiveness of different manipulative media without explaining **how** conceptual understanding develops through students' interactions with instructional media. Second, existing research has predominantly focused on general mathematics achievement rather than specific foundational concepts such as place value, number ordering, number representation, and number patterns. Third, qualitative evidence describing students' learning experiences while using number card media remains limited. Consequently, the pedagogical processes through which number card media facilitate conceptual understanding of whole number concepts have not yet been sufficiently explored.

This study addresses these gaps by qualitatively investigating how number card media support students' conceptual construction of whole number concepts during classroom learning. Unlike previous studies that primarily evaluated instructional effectiveness using quantitative approaches, the present study focuses on students' learning processes, interactions with instructional media, and conceptual development during mathematics instruction. By providing qualitative evidence regarding the classroom implementation of number card media, this study contributes to a deeper understanding of the pedagogical role of manipulative learning media in elementary mathematics education.

Therefore, this study aims to explore how number card media facilitate elementary students' conceptual understanding of whole number concepts through classroom implementation using a qualitative descriptive approach.

METHOD

This study employed a qualitative descriptive approach to explore how number card media facilitate elementary school students' conceptual understanding of whole number concepts during classroom learning. A qualitative descriptive design was

selected because the purpose of the study was not to measure the instructional effectiveness of number card media statistically but to obtain an in-depth understanding of students' learning experiences, interactions with instructional media, and conceptual development throughout the learning process. This approach enabled the researchers to describe naturally occurring classroom activities and interpret how students constructed their understanding of whole number concepts through direct manipulation of number card media.

The study was conducted at MI *Tarbiyatul Athfal*, an Islamic elementary school in Pasuruan, Indonesia. The participants consisted of two second-grade students (approximately 7–8 years old), including one male and one female student. Participants were selected using purposive sampling based on several criteria: (1) experiencing difficulties in understanding whole number concepts during preliminary classroom observations; (2) demonstrating low achievement in numeracy activities related to place value, number ordering, and basic arithmetic operations; (3) being recommended by the classroom teacher as requiring additional instructional support; and (4) obtaining parental consent to participate in the study. The small number of participants was intentionally selected because this study sought to obtain rich and in-depth qualitative data rather than statistical generalization. The focus of the study was to explore students' conceptual learning processes during classroom implementation of number card media. Data collection was continued until information obtained from multiple sources became repetitive and adequately explained the phenomena under investigation.

Data were collected through classroom observations, semi-structured interviews, documentation, and numeracy tasks. Classroom observations were conducted using an observation guide focusing on students' participation, engagement, interactions with teachers and peers, manipulation of number card media, and conceptual understanding of whole number concepts. Semi-structured interviews were conducted with both the classroom teacher and participating students to explore students' learning difficulties, responses to the instructional media, and teachers' perceptions regarding changes in students' conceptual

understanding. Documentation, including photographs of learning activities, students' worksheets, and classroom records, was collected to support and verify the observational findings. In addition, students completed numeracy tasks designed to examine their understanding of place value, number ordering, number patterns, number representation using hundreds, tens, and ones, as well as simple subtraction involving whole numbers. Prior to implementation, the observation guide, interview protocol, and numeracy tasks were reviewed by two mathematics education experts to ensure their content validity and relevance to the research objectives.

The research was conducted in three stages. The first stage involved preliminary classroom observations to identify students' initial understanding of whole number concepts and determine participants who met the selection criteria. The second stage consisted of implementing classroom learning activities using number card media. During these activities, students were asked to arrange numbers, order numbers from the smallest to the largest value, identify odd and even numbers, construct numbers based on hundreds, tens, and ones, and solve simple subtraction problems using number cards as manipulative learning media. The third stage involved follow-up observations, interviews, documentation, and numeracy tasks to explore students' conceptual understanding after participating in the learning activities.

The collected data were analyzed using the interactive qualitative analysis model proposed by Miles, Huberman, and Saldaña (2014), which consists of data condensation, data display, and conclusion drawing and verification. During the data condensation stage, field notes, interview transcripts, students' worksheets, documentation, and numeracy task results were read repeatedly to identify meaningful information relevant to the research objectives. The researchers conducted open coding by assigning codes to significant statements related to students' conceptual understanding, learning engagement, interactions with number card media, and learning difficulties. Similar codes were subsequently grouped through axial coding into broader categories, including place value understanding, number ordering, number representation, learning engagement, and student interaction. These

categories were then synthesized into overarching themes describing how number card media facilitated students' conceptual understanding of whole number concepts. During the data display stage, the categorized findings were organized into descriptive narratives supported by observation notes, interview excerpts, students' work, and documentation. Finally, conclusions were drawn by continuously comparing findings across different data sources and verifying interpretations throughout the analysis process to ensure consistency and credibility.

To enhance the trustworthiness of the findings, several strategies commonly employed in qualitative research were implemented. Technique triangulation was conducted by comparing information obtained from observations, interviews, documentation, and numeracy tasks, while source triangulation was achieved by comparing students' responses with information provided by the classroom teacher. In addition, peer debriefing was carried out through discussions with fellow mathematics education researchers regarding the coding process, category development, and interpretation of findings to minimize researcher bias. Member checking was also conducted by confirming the interview summaries and observational interpretations with the classroom teacher to ensure that the findings accurately reflected the classroom learning conditions.

Prior to data collection, permission to conduct the study was obtained from the principal of MI Tarbiyatul Athfal and the classroom teacher. Written informed consent was also obtained from the parents of all participating students. Participation was entirely voluntary, and students' identities were anonymized throughout the research process to ensure confidentiality. All collected data were used solely for academic purposes and reported without revealing participants' personal identities.

RESULTS AND DISCUSSION

RESULT

1. Pre-Implementation Understanding of Whole Number Concepts

The preliminary observation aimed to identify students' initial understanding of whole number concepts, including place

value, number ordering, number patterns, and basic arithmetic operations. Data were collected through classroom observations, numeracy tasks, and semi-structured interviews prior to the implementation of number card media.

The findings indicated that both participants experienced difficulties in understanding several fundamental whole number concepts. During the numeracy task, the students were able to read three-digit numbers correctly; however, they demonstrated limited understanding of place value. For example, when asked to represent the number **245**, one participant initially arranged the digits according to their sequence rather than their positional value, indicating confusion between digit recognition and place value understanding. Similarly, both students encountered difficulties when ordering numbers from the smallest to the largest value and identifying odd number patterns.

Classroom observations also revealed that students frequently relied on memorized procedures rather than conceptual reasoning. When asked to explain why **245** is greater than **198**, the participants initially responded only by reading the numbers aloud without referring to the value of the hundreds digit. During the interview, one participant stated:

"I know 245 is bigger, but I don't know why."

This response indicates that students were able to recognize numerical symbols but had not yet developed a conceptual understanding of numerical relationships.

The classroom teacher also reported that students often experienced confusion when learning place value because mathematics instruction mainly relied on verbal explanations and textbook exercises.

"Students can usually read the numbers, but they often confuse the value of each digit when solving place-value problems." (Teacher Interview)

These findings suggest that students required more concrete learning experiences to connect numerical symbols with quantitative meaning before progressing to more abstract mathematical reasoning.

2. Implementation of Number Card Media in Teaching Whole Numbers

The implementation of number card media focused on helping students construct whole number concepts through direct manipulation of hundreds, tens, and ones cards. Learning activities consisted of arranging number sequences, constructing three-digit numbers, identifying odd numbers, and performing simple subtraction using the number cards.

Throughout the classroom activities, both participants demonstrated active engagement with the instructional media. Rather than immediately asking the teacher for answers, students attempted to manipulate the cards repeatedly until they obtained the correct numerical representation. Figure 1 illustrates students arranging whole numbers using number cards.



Figure 1. Students Ordering Whole Numbers

Observation notes showed that students frequently discussed the position of each card before arranging the final answer. During one activity, Student A initially placed the tens card before the hundreds card when representing the number **245**. After comparing the cards with the teacher's guiding questions, the student rearranged the cards correctly and explained:

"The red cards are hundreds, so they must come first."

This observation indicates that students gradually developed an understanding of positional value through direct

manipulation of the instructional media. The number cards also enabled students to visualize relationships among hundreds, tens, and ones. Figure 2 shows students representing three-digit numbers using the colored place-value cards.



Figure 2. Students Representing Hundreds, Tens, and Ones

Observation data further revealed that students became increasingly confident in identifying place values after manipulating the cards several times. Instead of simply memorizing the number structure, they were able to explain that changing the position of a digit changes the value of the entire number.

During subtraction activities, students manipulated the number cards step by step before writing the numerical solution. The classroom teacher observed that this activity reduced students' dependence on memorized algorithms and encouraged them to explain the reasoning behind each calculation.

Students also demonstrated greater participation throughout the lesson by asking questions, discussing possible answers with the teacher, and experimenting with different card arrangements before reaching a solution. These observations suggest that number card media created opportunities for students to actively explore whole number concepts through concrete learning experiences.

3. Post-Implementation Understanding of Whole Number Concepts

Observations and numeracy tasks indicated changes in students' conceptual understanding after participating in classroom learning using number card media. Both participants were able to correctly represent three-digit numbers using hundreds, tens, and ones cards. When asked to construct the number **245**, students independently selected two hundreds cards, four tens cards, and five ones cards without teacher assistance. They also successfully explained the contribution of each place value in forming the complete number.

Compared with the preliminary observations, students also demonstrated greater confidence in ordering numbers and identifying odd number patterns. During the interview, one participant explained:

"Now I know that the hundreds card tells us which number is bigger."

Similarly, the classroom teacher reported noticeable changes in students' participation during mathematics learning.

"The students became more willing to answer questions and explain their thinking because they could use the cards to show their ideas." (Teacher Interview)

Observation notes indicated that students increasingly relied on conceptual reasoning rather than memorized procedures. Instead of reading numbers mechanically, they explained numerical relationships by referring to hundreds, tens, and ones representations. Students also appeared more willing to test different numerical combinations before deciding on their final answers.

Although this qualitative study was not designed to measure instructional effectiveness, the findings suggest that classroom implementation of number card media **may support** students' conceptual understanding of whole number concepts by providing concrete opportunities to manipulate numerical representations, discuss mathematical ideas, and connect symbolic representations with quantitative meaning.



Figure 3. Students Representing Hundreds, Tens, and Ones Cards

DISCUSSION

The findings of this study suggest that the use of number card media may support elementary school students' conceptual understanding of whole number concepts by providing opportunities to manipulate numerical representations directly. Rather than relying solely on memorization of procedures, students constructed their understanding through activities involving arranging numbers, representing hundreds, tens, and ones, identifying number patterns, and performing simple subtraction using manipulative media. These learning experiences enabled students to connect numerical symbols with their corresponding quantitative meanings, indicating that conceptual understanding developed through active engagement with concrete representations rather than passive reception of information.

From the perspective of Piaget's cognitive development theory, these findings are consistent with the characteristics of children in the concrete operational stage, in which learners develop mathematical understanding more effectively through direct interaction with tangible objects before progressing to abstract reasoning (Piaget, 1971). During the classroom activities, students demonstrated greater confidence in explaining place value after physically arranging hundreds, tens, and ones cards. This finding suggests that concrete manipulation enabled students to internalize numerical relationships that had previously been difficult to understand through verbal explanation alone. Rather than

merely recognizing numerical symbols, students began to interpret the meaning of each digit according to its positional value.

The observed learning process also reflects Bruner's Theory of Representation (Bruner & Kenney, 1965), which proposes that conceptual understanding develops progressively through enactive, iconic, and symbolic representations. During the implementation of number card media, students first manipulated physical cards (enactive representation) by arranging and grouping hundreds, tens, and ones. Subsequently, they recognized the visual arrangement of the cards as representations of place value (iconic representation) before interpreting the corresponding numerical symbols (symbolic representation). This sequential progression appears to facilitate students' transition from concrete experiences toward abstract mathematical reasoning. The findings therefore suggest that number card media provide an instructional bridge between concrete manipulation and symbolic understanding of whole numbers.

The findings are also consistent with Vygotsky's sociocultural theory, which emphasizes that conceptual development occurs through social interaction and instructional scaffolding within learners' Zone of Proximal Development (ZPD) (Shabani, 2010). Throughout the learning activities, students frequently discussed the arrangement of number cards with the teacher, asked questions, and revised their responses after receiving guiding prompts. Rather than providing direct answers, the teacher encouraged students to explore alternative arrangements until they identified the correct numerical representation. Such interactions indicate that conceptual understanding was constructed collaboratively through guided learning experiences. Consequently, number card media functioned not only as manipulative tools but also as mediating artifacts that supported dialogue, reflection, and mathematical reasoning.

From a constructivist perspective, the findings further indicate that students actively constructed mathematical knowledge through exploration rather than simply receiving information from the teacher (McNall & Rice, 2020). By manipulating number cards, comparing numerical values, and discussing alternative solutions, students reorganized their existing understanding of whole

numbers and gradually refined their conceptual structures. This process supports the constructivist assumption that meaningful learning occurs when learners actively construct knowledge based on direct experiences and prior understanding. Therefore, the instructional value of number card media lies not only in providing visual representations but also in encouraging learners to engage in cognitive activities that promote conceptual development (Farhana et al., 2022).

The present findings are generally consistent with previous studies reporting the educational benefits of manipulative learning media in mathematics instruction. Farhana et al.(2022) concluded that manipulative media facilitate conceptual understanding by linking abstract mathematical symbols with concrete experiences. Similarly, Nurhayati and Rahardi (2021), reported that concrete instructional media enable learners to visualize mathematical relationships more effectively, while Sofyannuddin et al. (2025) found that interactive learning media increase students' engagement during mathematics instruction. However, unlike these previous studies, which primarily evaluated learning outcomes or the effectiveness of manipulative media, the present study provides qualitative evidence illustrating how students gradually constructed their understanding of whole number concepts through classroom interaction with number card media. This process-oriented perspective represents an important contribution by demonstrating the pedagogical mechanisms underlying conceptual development rather than merely reporting instructional outcomes (Choi & Young, 2021).

The findings also support the principles of Realistic Mathematics Education (RME), which emphasize that mathematical concepts should be introduced through meaningful and contextually relevant experiences before progressing toward formal mathematical representations (Coles et al., 2020). The use of number card media enabled students to interact directly with numerical representations, thereby reducing the cognitive gap between concrete experiences and abstract mathematical concepts. Such learning experiences may contribute to the development of number sense, particularly students' understanding of numerical magnitude, place value, number relationships, and flexible

numerical reasoning (Deslis & Desli, 2023; Kroesbergen et al., 2022). Consequently, the findings suggest that manipulative learning activities may provide an appropriate foundation for strengthening early numeracy learning in elementary education.

Despite these positive findings, several practical challenges should also be acknowledged. During classroom implementation, students required sufficient time to become familiar with the procedures for manipulating number cards, particularly when representing three-digit numbers. The effectiveness of the learning activities also depended on the teacher's ability to provide appropriate scaffolding and facilitate classroom discussion. In addition, preparing and organizing the manipulative materials required additional instructional time compared with conventional teacher-centered instruction. Furthermore, because students demonstrated different levels of prior mathematical understanding, some learners required more intensive guidance before they were able to manipulate the cards independently. These findings suggest that successful implementation of (Lyublinskaya & Kaplon-schilis, 2022) .

Several limitations of this study should be considered when interpreting the findings. First, the study involved only two participants from a single elementary school; therefore, the findings are not intended for statistical generalization but rather for providing an in-depth understanding of students' conceptual learning processes. Second, the classroom implementation was conducted over a relatively short period, making it difficult to observe long-term conceptual development. Third, the findings were derived from a single instructional context and should therefore be interpreted cautiously. Future studies involving larger participant groups, multiple school settings, and longer implementation periods are recommended to provide more comprehensive evidence regarding the pedagogical role of number card media in supporting elementary mathematics learning.

Overall, the findings suggest that number card media may serve as a valuable instructional resource for supporting students' conceptual understanding of whole number concepts. Rather than functioning merely as visual teaching aids, the media created opportunities for students to manipulate numerical representations,

discuss mathematical ideas, and construct conceptual understanding through meaningful learning experiences. These findings contribute to the growing body of research on manipulative learning media by providing qualitative evidence regarding the processes through which concrete instructional materials may support conceptual development in elementary mathematics classrooms.

CONCLUSION

This study suggests that the use of number card media may support elementary school students' conceptual understanding of whole number concepts by providing meaningful opportunities to manipulate numerical representations directly. Through activities involving arranging numbers, representing hundreds, tens, and ones, identifying number patterns, and performing simple arithmetic operations, students appeared to develop a better understanding of place value, number relationships, and whole number representation while actively participating in the learning process. Rather than functioning solely as visual instructional aids, number card media created learning experiences that encouraged students to explore, discuss, and construct mathematical meaning through direct interaction with concrete materials.

The findings contribute to the existing literature on elementary mathematics education by providing qualitative evidence regarding **how** manipulative learning media support the conceptual construction of whole number concepts. Drawing on the perspectives of Piaget's cognitive development theory, Bruner's theory of representation, Vygotsky's sociocultural theory, and constructivist learning theory, the study demonstrates that concrete manipulation, guided interaction, and progressive representation may facilitate students' transition from concrete experiences to symbolic mathematical understanding. Practically, the findings suggest that number card media may serve as an accessible instructional resource for teachers seeking to promote conceptual understanding and active student engagement in elementary mathematics classrooms.

Several limitations should be acknowledged when interpreting these findings. First, the study involved only two

participants from a single elementary school, limiting the transferability of the findings to broader educational contexts. Second, the qualitative descriptive design was intended to provide an in-depth understanding of students' learning processes rather than to establish causal relationships or measure instructional effectiveness. Third, the classroom implementation was conducted over a relatively short period, making it difficult to examine the long-term development of students' conceptual understanding.

Future research is recommended to involve larger and more diverse participant groups across multiple school settings to improve the transferability of the findings. Studies employing quasi-experimental, mixed-methods, or longitudinal designs may provide stronger evidence regarding the instructional effectiveness of number card media. In addition, future investigations could explore the integration of digital manipulative media, augmented reality, or other interactive mathematics learning technologies, as well as compare the pedagogical effectiveness of different types of concrete and digital mathematics learning media in supporting students' conceptual understanding and numeracy development

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