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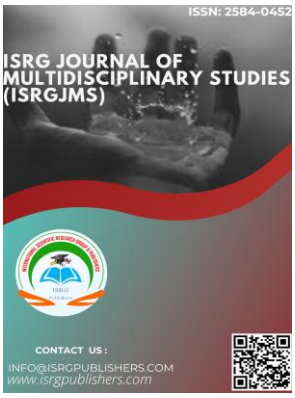

Construction of Students' Understanding of Positive and Negative Integer Addition Through Rope Media from a Kinesthetic Learning Style Perspective

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Abstract

Understanding integer concepts is an essential foundation for learning mathematics at the junior high school level. However, many students experience difficulties in performing integer addition operations, particularly those involving positive and negative numbers. These difficulties often arise because mathematical concepts are presented abstractly without sufficient concrete learning experiences. This study aimed to describe the process by which students construct their understanding of positive and negative integer addition through the use of rope media from the perspective of kinesthetic learning styles. The study employed a qualitative case study approach involving two seventh-grade students at SMP Negeri 1 Saluputti who were identified as kinesthetic learners through a learning style questionnaire. Data were collected through classroom observations, semi-structured interviews, and learning activity documentation. The data were analyzed using the interactive model of Miles and Huberman, consisting of data reduction, data display, and conclusion drawing. The findings revealed that students' understanding developed through three stages: initial exploration, conceptual association, and reflective abstraction. Rope media helped students visualize positive and negative directions through physical movement, enabling them to connect concrete experiences with abstract mathematical concepts. The use of rope media also increased students' engagement, concentration, and motivation during learning activities. Although students encountered difficulties in interpreting operations involving multiple negative numbers, they developed strategies such as repeating demonstrations, discussing with peers, and verifying solutions through concrete representations. The study concludes that rope media is an effective learning tool for facilitating kinesthetic learners' conceptual understanding of integer addition and supports the constructivist view that knowledge is actively constructed through experience and reflection.

Keywords: *integer addition, rope media, kinesthetic learning style, constructivism, mathematics learning, conceptual understanding.*

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INTRODUCTION

Mathematics plays a fundamental role in education because it develops students' logical, analytical, critical, and systematic thinking skills. At the junior high school level, understanding integers is one of the essential foundations for learning more advanced mathematical concepts, including algebra, linear equations, and proportional reasoning. However, many students experience difficulties when learning integer operations, particularly addition involving positive and negative numbers. These difficulties often result in misconceptions, such as assuming that the sum of negative numbers is always negative or failing to interpret negative signs as indicators of direction rather than merely numerical values.

One of the main causes of these difficulties is the abstract nature of mathematics instruction. In many classrooms, teachers tend to emphasize symbolic procedures and formula memorization without providing students with concrete learning experiences. As a result, students often struggle to connect mathematical symbols with meaningful representations. According to constructivist learning theory, knowledge is actively constructed through learners' interactions with their environment and experiences rather than being transmitted directly from teacher to student. Therefore, mathematics learning should provide opportunities for students to engage with concrete objects and meaningful activities that support conceptual understanding.

To address this challenge, learning media can be used to bridge the gap between abstract concepts and students' real experiences. One simple but effective medium is rope media, which can function as a physical representation of a number line. In this representation, movement to the right indicates positive numbers, while movement to the left indicates negative numbers. Through activities involving pulling, moving, and positioning the rope, students can directly experience the concepts of direction and displacement associated with integer operations. Such experiences are particularly beneficial for students who possess kinesthetic learning styles.

Kinesthetic learners tend to acquire knowledge more effectively through physical movement, hands-on activities, and direct interaction with learning materials. For these learners, abstract mathematical explanations are often less meaningful than learning experiences that involve bodily engagement. Consequently, rope media provides an appropriate instructional tool because it allows students to physically enact mathematical operations while simultaneously constructing conceptual understanding.

Several studies have highlighted the importance of concrete learning media in mathematics education. Research has shown that manipulative materials and visual representations can improve students' understanding of mathematical concepts and increase learning motivation. Furthermore, learning activities that involve physical engagement have been found to support kinesthetic learners in constructing meaningful mathematical knowledge. Despite these findings, limited studies have specifically examined how students with kinesthetic learning styles construct their understanding of positive and negative integer addition through rope media.

Based on this research gap, the present study aims to explore how students construct their understanding of positive and negative integer addition through the use of rope media. Specifically, this study investigates the stages of students' conceptual construction, the role of rope media in facilitating understanding, and the difficulties and strategies that emerge during the learning process. The findings are expected to contribute to the development of more effective mathematics learning strategies that accommodate diverse learning styles and promote meaningful conceptual understanding.

METHOD

This study employed a qualitative case study design to explore how students with kinesthetic learning styles construct their understanding of positive and negative integer addition through rope media. A qualitative approach was selected because the study focused on understanding students' learning experiences, thought processes, and conceptual development in depth rather than measuring learning outcomes quantitatively.

The study was conducted at SMP Negeri 1 Saluputti, Tana Toraja Regency, during the first semester of the 2025/2026 academic year. The participants consisted of two seventh-grade students identified as having kinesthetic learning styles based on the results of a Visual, Auditory, and Kinesthetic (VAK) learning style questionnaire. Purposive sampling was employed to select participants who met the research criteria, including active engagement in physical learning activities, interest in practical learning experiences, and prior exposure to integer concepts in school mathematics.

In qualitative research, the researcher served as the primary instrument for data collection and analysis. Supporting instruments included observation sheets, semi-structured interview guides, and learning activity worksheets involving rope media. Data were collected through classroom observations and interviews. Observations focused on students' physical activities, responses, and problem-solving strategies while interacting with the rope media. Semi-structured interviews were conducted to explore students' interpretations of positive and negative numbers, their understanding of integer operations, and their reflections on the learning process.

Data validity was established through source triangulation by comparing information obtained from observations and interviews. Data analysis followed the interactive model proposed by Miles and Huberman, which consists of three stages: data reduction, data display, and conclusion drawing. During data reduction, observation notes and interview transcripts were selected, categorized, and simplified according to the research focus. The reduced data were then organized into descriptive narratives and thematic categories to facilitate interpretation. Finally, conclusions were continuously verified throughout the analysis process to ensure the credibility and trustworthiness of the findings regarding students' conceptual construction of integer addition through rope media.

RESULTS AND DISCUSSION

The findings of this study were obtained through classroom observations, interviews, and students' performance during learning activities using rope media. The analysis revealed three major themes related to the construction of students' understanding of positive and negative integer addition: (1) initial exploration of integer concepts through physical movement, (2) conceptual association between movement and mathematical operations, and (3) reflective abstraction leading to conceptual understanding. In addition, the findings highlight the role of rope media in supporting kinesthetic learners and the challenges encountered during the learning process.

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Construction of Students' Understanding Through Rope Media

The process of students' conceptual construction occurred gradually through three interconnected stages.

Initial Exploration Stage

During the initial stage, students were introduced to rope media as a representation of a number line. The teacher explained that movement to the right represented positive numbers, whereas movement to the left represented negative numbers. At this stage, students primarily followed instructions mechanically without fully understanding the mathematical meaning behind the movements.

Observation data indicated that students were enthusiastic and actively participated in the activities. However, when asked to explain the relationship between their movements and integer operations, they tended to repeat procedural steps rather than provide conceptual explanations. This finding suggests that students initially relied on concrete actions rather than abstract reasoning.

From a constructivist perspective, this stage represents the activation of prior knowledge and the beginning of cognitive engagement. According to Piaget (1970), learners construct understanding by interacting directly with their environment and assimilating new experiences into existing cognitive structures.

Conceptual Association Stage

As students repeatedly engaged with rope-based activities, they began to associate physical movements with mathematical concepts. They gradually recognized that movement to the right increased numerical value, while movement to the left decreased it.

For example, when solving the operation:

-3+5=2

students first moved three steps to the left and then five steps to the right. Through observation of their final position, they concluded that the result was positive two.

Interview data revealed that students were able to predict outcomes before completing the movement activities. One student explained that "moving to the right means adding positive values, so the final position becomes closer to the positive side." This statement indicates that students had begun connecting concrete experiences with mathematical reasoning.

This stage reflects Vygotsky's concept of knowledge construction through active participation and meaningful interaction. Learning occurred not merely through observation but through engagement with physical experiences that enabled students to develop conceptual associations.

Reflective Abstraction Stage

The final stage involved reflective thinking and abstraction. Students became capable of explaining integer operations using their own words without relying entirely on rope manipulation.

For instance, when presented with the operation:

-4+(-3)=-7

students explained that both movements were directed toward the negative side, resulting in a larger negative value. Their explanations demonstrated an understanding of the relationship between direction and numerical value rather than simple procedural memorization.

This finding indicates that students had successfully internalized the concepts represented through rope media. According to constructivist theory, reflective abstraction occurs when learners reorganize concrete experiences into abstract mathematical knowledge. Therefore, the rope media functioned as a bridge between physical experience and symbolic understanding.

The Role of Rope Media in Supporting Kinesthetic Learners

The findings demonstrate that rope media played a significant role in facilitating learning among students with kinesthetic learning styles. Students appeared more engaged and focused during activities involving physical movement than during conventional instruction.

Several observations support this conclusion. First, students actively participated throughout the learning process and showed enthusiasm when interacting with the rope media. Second, physical movement helped students remember the meaning of positive and negative directions. Third, students reported that mathematics became easier and more enjoyable because they could directly experience the concepts being learned.

These findings are consistent with studies suggesting that kinesthetic learners benefit from instructional approaches involving movement, manipulation, and direct interaction with learning materials. The rope media transformed an abstract mathematical concept into a concrete experience that aligned with students' preferred learning styles.

Furthermore, the use of rope media provided visual and physical representations of mathematical operations, reducing cognitive barriers associated with abstract symbolic notation. This result supports Bruner's theory that learning should progress from enactive representation (action-based learning) to iconic representation (visual learning) before reaching symbolic representation.

Students' Difficulties and Learning Strategies

Although students demonstrated positive progress, several challenges emerged during the learning process. One common difficulty involved determining movement directions when solving operations containing multiple negative numbers.

For example, students occasionally experienced confusion when working with:

-3+(-2)=-5

Some students initially attempted to move in opposite directions because they focused on the addition symbol rather than the sign of the second number. This misconception illustrates the complexity of interpreting negative numbers and operation symbols simultaneously.

To overcome these difficulties, students developed several learning strategies. These included repeating rope demonstrations, discussing solutions with peers, and using rope media as a verification tool after solving problems mentally. Such strategies indicate that students were actively monitoring and regulating their own learning processes.

The emergence of these strategies suggests that rope media not only supports conceptual understanding but also encourages

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reflective thinking and collaborative learning. Students became active participants in constructing knowledge rather than passive recipients of information.

DISCUSSION

The findings indicate that students construct their understanding of integer addition through a progressive process involving concrete experience, conceptual association, and reflective abstraction. This process aligns closely with constructivist learning theory, which emphasizes that meaningful learning occurs when students actively engage with learning experiences and build their own understanding.

The study further demonstrates that rope media serves as an effective instructional tool for kinesthetic learners because it integrates physical movement, visual representation, and mathematical reasoning. By transforming abstract concepts into concrete experiences, rope media enables students to develop a deeper understanding of integer operations.

Overall, the findings suggest that incorporating concrete learning media into mathematics instruction can enhance students' conceptual understanding, motivation, and engagement. Such approaches are particularly valuable for learners who prefer active and experiential forms of learning. Therefore, teachers should consider integrating movement-based and manipulative learning activities into mathematics classrooms to support diverse learning styles and promote meaningful mathematical understanding.

CONCLUSION

This study explored how students with kinesthetic learning styles construct their understanding of positive and negative integer addition through the use of rope media. The findings revealed that students' conceptual understanding developed progressively through three stages: initial exploration, conceptual association, and reflective abstraction. Through repeated interaction with rope media, students gradually connected physical movements with mathematical meanings, enabling them to understand integer operations more conceptually rather than procedurally.

The study also demonstrated that rope media plays an important role in facilitating learning for kinesthetic students. The use of physical movement, concrete representations, and direct experiences increased students' engagement, concentration, and motivation during mathematics learning. Rope media helped students visualize positive and negative directions, making abstract concepts more accessible and meaningful.

Although several difficulties were identified, particularly when students encountered operations involving multiple negative numbers, they were able to develop learning strategies such as repeating demonstrations, discussing with peers, and verifying solutions using concrete representations. These strategies contributed to the development of reflective thinking and deeper conceptual understanding.

Overall, the findings support constructivist learning theory, which emphasizes that knowledge is actively constructed through experience and reflection. Therefore, rope media can be considered an effective instructional tool for supporting conceptual understanding of integer operations, especially among students with kinesthetic learning styles. Future research may involve a larger number of participants and explore the effectiveness of rope media across different mathematical topics and learning styles.

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