ANALYSIS OF THE ABILITY OF CONCEPTUAL UNDERSTANDING AND MATHEMATICAL CONFIDENCE IN SOLVING PROBLEMS ON INTEGER OPERATIONS IN JUNIOR HIGH SCHOOL

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Abstract

This study aims to investigate the relationship between conceptual understanding and mathematical confidence in junior high school students in solving problems related to integer operations. This study involved 37 students who were measured using a quantitative approach through a descriptive correlational design. The instruments used included a test to measure conceptual understanding and a questionnaire to assess mathematical confidence. The results showed that most students had an adequate understanding of integer operations, although there were differences in their levels of mathematical confidence. Approximately 24% of students showed a very good understanding, while the other 32% obtained a good understanding. Correlation analysis showed a significant positive relationship between mathematical confidence and conceptual understanding, with a coefficient of r = 0.65, indicating that the higher the students' mathematical confidence, the better their understanding of integer concepts. Interviews with students also revealed that high levels of self-confidence encouraged them to be more active and confident in solving mathematical problems. Based on these findings, this study suggests that the development of students' mathematical confidence should be a primary focus in mathematics learning, through the implementation of problem-based learning methods and the provision of constructive feedback from teachers.

Keywords: Conceptual understanding, Mathematical beliefs, integer operations, junior high school students, correlation.

INTRODUCTION

Mathematics is one of the main subjects in the Indonesian education system, particularly at the junior high school (SMP) level. At this level, students are introduced to various basic concepts that serve as an important foundation for understanding more complex mathematical topics at the next level (Luthfiah et al., 2023). One such basic concept is integer operations, which include addition, subtraction, multiplication, and division. Although this material is considered fundamental, many students still struggle to understand it. This difficulty directly impacts their ability to solve more complex mathematical problems at the next level (Yanala et al., 2021).

Students' ability to understand mathematical concepts is influenced by various factors, such as learning styles, cognitive abilities, and levels of self-confidence or mathematical confidence in facing mathematical problems (Pratiwi & Imami, 2022). Mathematical confidence is a psychological aspect that plays an important role in determining how students face learning challenges. Students with high mathematical confidence are generally more confident, active, and do not give up easily when encountering difficulties, while students with low mathematical confidence tend to be hesitant, anxious, and less courageous in trying to solve problems (Hendriana & Kadarisma, 2019). Research by Hendriana & Kadarisma, (2019) also shows that high mathematical confidence is positively correlated with students' courage and perseverance in solving mathematical problems, including those on integer operations. This confirms that mathematical confidence not only influences students' attitudes in learning but also plays a role as a determining factor in their success in understanding concepts and solving

mathematical problems effectively. Thus, strengthening mathematical confidence needs to be an integral part of learning strategies, so that students are able to develop self-confidence while improving the quality of their conceptual understanding (Marasabessy, 2020).

The relationship between mathematical confidence and the ability to understand mathematical concepts becomes increasingly important when students are studying challenging material, such as integer operations. Low levels of *mathematical confidence* can exacerbate students' difficulties in understanding basic concepts, thus impacting their ability to solve more complex problems. Several studies have shown that many junior high school students struggle to understand basic concepts of integer operations, such as addition and subtraction (Akras et al., 2025). This usually occurs because their understanding of these basic concepts is still weak, resulting in difficulties when faced with more complex problems (Risnayati, 2021). Therefore, a deep understanding of integers is crucial, both in theory and in its application in solving more complex problems. Furthermore, research by Audina et al., (2023) shows that integer operations are an important foundation for students' logical and analytical thinking skills. However, in practice, many students still make repeated errors when solving integer problems, indicating a weak understanding of basic concepts. This difficulty is further compounded when students have low mathematical confidence, as they tend to hesitate and lack confidence in attempting to solve problems.

Another study by Putri et al., (2022) confirmed that mathematical beliefs significantly influence junior high school students' mathematical representation abilities. Students with high beliefs are better able to connect abstract concepts with concrete representations, thus more easily understanding integer operations. This is in line with the findings of Sriwahyuni et al., (2019) who stated that students' mathematical beliefs play a significant role in successfully solving mathematical problems. Thus, it can be concluded that students' difficulties in understanding integer operations stem not only from weak conceptual mastery but also from low mathematical beliefs. Therefore, effective learning strategies need to simultaneously integrate cognitive and affective aspects, so that students not only understand integer concepts theoretically but also have the confidence to apply them in solving more complex problems (Choirunisa et al., 2024).

Although various previous studies have separately examined students' mathematical conceptual understanding and mathematical beliefs in mathematics learning, studies that simultaneously connect these two aspects are still limited, especially in the context of learning integer operations at the junior high school level (Murtiyasa & Sari, 2022). Most studies focus more on improving conceptual understanding through the application of specific learning methods, while the aspect of students' mathematical beliefs often receives less attention (Susino et al., 2024). However, conceptual understanding and mathematical beliefs are two interrelated factors that play a crucial role in determining students' success in solving mathematical problems. This condition indicates a research gap that needs to be filled through an in-depth study of the relationship between conceptual understanding and students' mathematical beliefs in learning integer operations.

This study distinguishes itself from existing literature by providing a more granular analysis of the cognitive-affective link specifically within integer operations. Unlike the research conducted by Jatisunda (2017) which primarily examines the impact of mathematical beliefs on general motivation and broad problem-solving , this study narrows the focus to how these beliefs interact with specific conceptual hurdles in integer arithmetic. Furthermore, while Pratiwi & Imami (2022) focused on student persistence , this research seeks to uncover the pedagogical reasons why 43% of students still fail to achieve mastery despite showing moderate to high levels of confidence.

Based on the description, this study aims to analyze the relationship between conceptual understanding and students' mathematical confidence in learning integer operations at the junior high school level.

Through this analysis, it is hoped that a comprehensive picture of the relationship between students' cognitive and affective factors will be obtained, which can be the basis for developing more effective mathematics learning strategies oriented towards increasing students' understanding and confidence.

METHOD

This study used a quantitative approach with a descriptive correlational design. The main objective of the study was to analyze and describe the relationship between students' understanding of mathematical concepts and their self-confidence (mathematical confidence) in solving problems, particularly on integer operations. The study was conducted in several junior high schools (SMP) in Landak Regency, focusing on seventh-grade students.

The selection of 37 students as the research sample was determined based on the accessibility of subjects who met the specific criteria for the stratified random sampling technique within the selected schools in Landak Regency. While the sample size is limited, it is considered sufficient for this preliminary correlational study as the quantitative findings are deeply supported by qualitative data from interviews with 12 students (approximately 32% of the sample). This focused sample size also allowed for more rigorous control during the data collection process, contributing to the high reliability scores of 0.78 for the conceptual understanding test and 0.82 for the mathematical confidence questionnaire.

The data collection instrument consisted of two parts: a conceptual understanding test and a mathematical belief questionnaire. The conceptual understanding test focused on integer operations, including multiple-choice questions to measure mastery of basic concepts and descriptive questions to assess students' ability to apply these concepts to more complex problems. The mathematical belief questionnaire was used to measure students' confidence in solving mathematical problems involving integers. This questionnaire was constructed using a Likert scale with a score range of 1 to 5, where low scores indicate weak mathematical beliefs and high scores indicate strong mathematical beliefs.

Tabel 1. Likert Scale

Scale	Description
1	Very Unconfident (Not confident at all in solving questions)
2	Lack of Confidence (Often feels doubtful and has difficulty in solving problems)
3	Quite Confident (Sometimes feel confident, but have doubts)
4	Self-Confident (Usually confident and able to solve problems well)
5	Very Confident (Very confident and feel capable of solving the problem easily)

The initial step in this research was to conduct a pilot test of the instrument to ensure that the test items and questionnaire had adequate validity and reliability. After the instrument was declared suitable for use, a conceptual understanding test was administered to students after they had studied the material on integer operations. A mathematical belief questionnaire was then administered after the test. Additionally, additional interviews were conducted with 12 students (approximately 10% of the total sample) who showed significant differences in conceptual understanding and mathematical belief scores, with the aim of delving deeper into the factors underlying the results.

Instrument Validation Results

Validation is conducted by experts (expert judgment) to assess the suitability of the test items to the indicators being measured. Validation results are scored using a scale (e.g., 1–5) and then averaged.

Table 2. Concept Understanding Test Validation

Rated aspect	Average Score	Category
Compliance with indicator	4.5	Very good
Clarity of language	4.3	Good
Difficulty level question	4.2	Good
Relevance to the material	4.6	Very good
Overall average	4.4	Good

Table 3. Validation Table Questionnaire belief Mathematical

Rated aspect	Average Score	Category
Compliance indicator	4.4	Good
Clarity statement	4.5	Very good
Relevance with variables	4.6	Very good
Overall average	4.5	Very good

Validation test results showed that the conceptual understanding test and the mathematical belief questionnaire had average scores in the good to excellent category. Thus, both instruments were declared valid and suitable for use in research.

Instrument Reliability Results

Reliability tested use Cronbach's Alpha. A value ≥ 0.70 is considered reliable.

Table 4. Instrument Reliability Table

Instrument	Cronbach's Alpha	Category
Test Understanding Draft	0.78	Reliable
Questionnaire Belief Mathematical	0.82	Reliable

The instrument is declared reliable because the Cronbach's Alpha value is > 0.70. Thus, the research instrument is suitable for measuring junior high school students' understanding of concepts and mathematical beliefs in the material on integer operations.

The collected data were analyzed using descriptive and inferential statistical approaches. Descriptive statistics were applied to describe the distribution of values for the two research variables, namely conceptual understanding and student beliefs, by calculating the mean, median, mode, and standard deviation. Meanwhile, inferential statistics were used to test the relationship between variables by applying the Pearson correlation test using IBM SPSS Statistics software version 25. The formula Pearson correlation applied is as following :

$$r = \frac{n(\sum XY) - (\sum X)(\sum Y)}{\sqrt{[n\sum X^2 - (\sum X)^2][n\sum Y^2 - (\sum Y)^2]}}$$

Where :

r = correlation coefficient
n = number of samples
X = conceptual understanding score
Y = student's mathematical confidence score
$\sum XY$ = sum of the products of the scores X and Y

Based on the results of the correlation test indicating a significant relationship, a simple linear regression analysis was then conducted to measure the magnitude of the influence of beliefs (mathematical beliefs) on students' conceptual understanding in solving mathematical problems related to integers. As for the qualitative data collected through interviews, thematic analysis was applied with the steps of data reduction, data presentation, and drawing conclusions. This method was applied to interview transcripts with 12 students to identify themes related to factors that influence students' conceptual understanding and mathematical beliefs.

This research will last for three months. The first month will focus on instrument preparation and pilot testing. The second month will be devoted to data collection through tests and questionnaires, while the third month will be devoted to data analysis and the preparation of the research report. To ensure the quality of the instrument, its validity and reliability will be tested using content validity techniques and Cronbach's alpha coefficient to assess the internal consistency of the instrument.

RESULTS AND DISCUSSION

Student Concept Understanding Data

Of the 37 students who participated in this study, the results of the conceptual understanding test regarding integer operations showed significant variation. Data regarding students' conceptual understanding can be presented in the following categories.

Table 5. Understanding Data Draft Student

Category Understanding	Amount Student (%)	Comprehension Score (0-100)
Very good	24%	85-100
Good	32%	70-84
Enough	19%	55-69
Not enough	24%	0-54

A total of 24% of students scored in the Very Good category , indicating that they have a deep understanding of integer operations. The Good category was filled by 32% of students, indicating that most students have adequate understanding, although there are still some areas that need improvement. Meanwhile, 19% of students were in the Fair category , indicating the need for additional understanding of basic concepts. Finally, 24% of students showed difficulty in understanding the material, which is reflected in the Poor category .

Research conducted by Mada et al., (2024) shows that students tend to struggle to understand basic mathematical concepts if they lack the appropriate learning approach. This aligns with the findings of Ruben & Desfitri (2021), who emphasized that poor understanding of integer concepts is often caused by a lack of interest in learning, poor student concentration during instruction, and limited teacher strategies in explaining the material. Furthermore, Audina et al., (2023) emphasized that integer operations are an essential foundation for students' logical and analytical thinki ng skills.

However, in practice, many students still make repeated errors when solving integer problems, which indicates a weak mastery of basic concepts. This finding is supported by Salmawati, S., Kaharuddin et al., (2024) who stated that differences in conceptual understanding abilities between students can lead to variations in perceptions in solving problems, so that more adaptive learning strategies are needed to overcome these gaps . In line with that, Jatisunda, (2017) added that the application of a guided discovery learning model can improve the ability to understand mathematical concepts in junior high school students, because students are encouraged to discover concepts themselves so that they are more meaningful.

The problem with the percentage of students' conceptual understanding covers several important aspects. First, there is an imbalance in the distribution of

understanding, where although 24% of students are in the Very Good category and 32% in the Good category , there are still 43% of students (categories Sufficient and Less) who have not mastered the concept of integer operations well. This condition indicates that almost half of the study participants still face difficulties in understanding the basic material. Second, there is a gap in ability between students, as indicated by a significant difference between the group of students with high understanding and the group with low understanding. This reflects the uneven quality of learning received by students.

Third, there are implications for further learning, where students in the Sufficient and Poor categories are likely to experience greater difficulties when faced with more complex mathematical material. This is because integer operations are the foundation for subsequent topics, such as algebra and equations. Furthermore, Audina et al., (2023) emphasize that integer operations are an important foundation for logical and analytical thinking skills, yet many students still make repeated errors, indicating a weak mastery of basic concepts. Nalman & Susanta, (2023) argue that the application of a guided discovery learning model can improve students' understanding of mathematical concepts because they are encouraged to discover the concepts themselves, making them more meaningful. Similarly, Salmawati, S., Kaharuddin et al., (2024) emphasizes that differences in conceptual understanding abilities between students can lead to variations in perceptions in solving problems, so adaptive learning strategies are needed to address these gaps.

Thus, the results of this study indicate that there are groups of students who have a good understanding of the concepts, but almost half of the students still fall into the Sufficient and Insufficient categories . This is a serious problem because it can hinder their success in learning more complex mathematics material. In line with expert opinion, appropriate, adaptive learning strategies are needed, oriented towards strengthening basic concepts and increasing students' mathematical confidence to minimize gaps in understanding.

Student Questionnaire Results Data (Mathematical Beliefs)

Data from a questionnaire measuring students' self-confidence (mathematical confidence) in solving integer problems shows the following distribution.

Table 6. Questionnaire Result Data Student

Category Belief mathematical	Amount Student (%)	Confidence Score mathematics (1-5)
Very high	24%	5
Tall	35%	4
Currently	32%	3
Low	8%	2

Most students (59%) showed high or very high *Mathematical Confidence* , reflecting their strong confidence in dealing with mathematical problems related to integers. Thirty-two percent of students had moderate levels of *Mathematical Confidence* , indicating that although they were quite confident, they felt hesitant when facing more difficult problems. Eight percent of students felt less confident, as reflected in low *Mathematical Confidence scores* , which may have affected their performance in solving problems. Research conducted by Jatisunda, (2017) revealed that students with high *Mathematical Confidence* tended to show greater levels of motivation and were better able to solve mathematical problems, a finding also reflected in the findings obtained from this study.

The results of the study indicate an imbalance in the level of mathematical confidence among students. Although the majority of students (59%) have high or very high confidence, there are still 40% of students who are in the medium and low categories. This condition creates a gap in

students' mental readiness when facing math problems. According to Bandura (1997), self -*efficacy* directly influences students' motivation, effort, and persistence in completing tasks. Students with low confidence tend to avoid challenges, while students with high confidence are more persistent in the face of difficulties.

Students with moderate levels of confidence often exhibit doubt when faced with more complex problems. This doubt can hinder critical thinking and reduce learning effectiveness. This aligns with the findings of Salmawati, S., Kaharuddin et al., (2024) who emphasized that differences in confidence levels between students can lead to variations in learning outcomes. Therefore, teachers need to implement adaptive learning strategies to reduce this gap.

Meanwhile, students with low self-confidence tend to avoid difficult problems, give up quickly, and rely on help from teachers or classmates. This condition can hinder the development of understanding of basic mathematical concepts. Jatisunda (2017) added that students with low mathematical confidence not only lack self-confidence but also have weak learning motivation, resulting in low performance in solving math problems.

The implications of this condition are quite serious. Low mathematical confidence has the potential to reduce learning motivation and result in difficulty understanding more complex material (Sunaryo, 2017). Because self-confidence is closely related to motivation and perseverance, students with low confidence are at risk of falling behind in learning. Mada et al., (2024) emphasized that implementing problem-based learning methods can increase mathematical confidence while strengthening students' conceptual understanding. By actively involving students in problem-solving, their self-confidence can grow. Mazaly et al., (2021) argue that guided discovery learning *helps* students build self-confidence because they discover concepts independently, resulting in more meaningful understanding.

Correlation Analysis Results Data

A Pearson correlation analysis was conducted to explore the relationship between students' conceptual understanding and mathematical beliefs. The analysis revealed a significant positive relationship between the two variables, with an r value of 0.65, indicating a moderate correlation. This indicates that the higher students' mathematical beliefs, the better their understanding of the concept of integer operations. This finding is consistent with Bandura's (1997) theory, which states that self -*efficacy* is directly related to increased motivation and persistence in solving mathematical problems. In other words, students who have greater confidence in their ability to solve mathematical problems tend to have a better understanding of the concepts being taught.

Similarly, research by Jatisunda (2017) showed that students with high mathematical confidence were not only more motivated but also more capable of solving math problems independently than students with low confidence. This corroborates the correlation findings in this study, which show that self-confidence is a crucial factor in successfully understanding concepts.

Furthermore, emphasized that implementing problem-based learning methods can increase mathematical confidence and strengthen students' conceptual understanding. By actively involving students in the problem-solving process, they not only feel more confident but also deepen their understanding of the material (Mada et al., 2024).

Another opinion was put forward by Nalman & Susanta (2023), who stated that guided discovery learning *can* help students build self-confidence because they discover concepts independently. This is in line with the results of this study, which found that high mathematical confidence was shown to contribute to improved conceptual understanding.

Interview Results to Support Data

Interviews were conducted with 12 students who showed marked differences in their conceptual understanding and mathematical confidence scores. Some

factors found during interview is as following:

a. Students with high mathematical confidence feel more comfortable and motivated when solving math problems. They also actively ask questions and seek solutions when faced with difficulties, demonstrating a persistent attitude. This aligns with Bandura's (1997) assertion that students with high *self-efficacy* tend to be more persistent and able to overcome academic challenges.
b. Students with low mathematical confidence feel intimidated by more difficult problems and often hesitate to try solving them without help from teachers or classmates. This can hinder the development of basic conceptual understanding. This finding is supported by Jatisunda (2017) who stated that students with low confidence have weak learning motivation, resulting in low performance in solving math problems.
c. Several students expressed that the problem-based learning method and positive feedback from teachers were very helpful in boosting their self-confidence. Teacher support through positive interactions has been shown to contribute to a better understanding of integer operations. This aligns with Mada et al., (2024) findings, which state that implementing problem-based learning methods can strengthen conceptual understanding and increase students' mathematical confidence.
d. The interview results diagram shows that factors such as problem-based learning methods, positive interactions with teachers, and a supportive learning environment significantly influence students' understanding and self-confidence. This finding also aligns with the opinion of Nalman & Susanta (2023), who emphasized that guided discovery learning *can* help students build self-confidence because they discover concepts independently. Thus, this interview strengthens the evidence that mathematical confidence not only influences motivation but also plays a crucial role in deepening understanding of mathematical concepts.

A deeper pedagogical analysis of the 43% of students in the "Fair" and "Poor" categories reveals that their primary difficulties stem from procedural errors involving negative and positive signs. Many students demonstrated a fundamental misconception during subtraction of negative integers, often assuming that the result must be smaller than the original value, which indicates a weak mental representation of the number line. The interview data corroborated these findings, showing that students with lower mathematical confidence often experienced "sign anxiety," leading them to rush through calculations or avoid attempting problems with complex sign combinations altogether.

CONCLUSION

This study aimed to investigate the relationship between conceptual understanding and mathematical confidence of junior high school students in solving problems related to integer operations. The analysis showed a significant positive correlation with an r value of 0.65, indicating a moderate relationship between the two variables. This finding suggests that the higher a student's mathematical confidence, the better their understanding of the concept of integer operations. The distribution of students' mathematical confidence levels also showed quite clear variations. The majority of students (59%) had high or very high confidence, reflecting their confidence in facing mathematical problems. However, 40% of students still had medium and low levels of confidence, creating a gap in mental readiness to face more complex problems. The problem that emerged was the presence of doubt in students with medium confidence, which often hampered critical thinking processes and reduced learning effectiveness. Meanwhile, students with low confidence tended to avoid difficult problems, gave up quickly, and relied on help from teachers or friends. This could hinder the development of understanding of basic mathematical concepts. Supporting factors identified through interviews indicated that problem-based learning methods and positive feedback from teachers significantly influenced the increase in students' self-

confidence. Thus, it can be concluded that improving students' mathematical confidence should be a focus of learning strategies. Educators need to create a supportive learning environment, provide constructive feedback, and implement problem-based learning and guided discovery methods. These efforts are expected to improve students' understanding of mathematical concepts more effectively and sustainably, while minimizing the gaps that occur between students with different levels of confidence.

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