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ANALYSIS OF CONCEPTUAL UNDERSTANDING ABILITY AMONG STUDENTS IN THE MATHEMATICS EDUCATION PROGRAM TAKING THE NUMBER THEORY COURSE

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ABSTRACT

This study aims to analyze the conceptual understanding of students in the Mathematics Education Program with respect to the Number Theory course. The research method employed is quantitative descriptive analysis. The participants comprise 16 students in their second semester who enrolled in this course. The instrument utilized for the study is a written test consisting of descriptive questions designed to gauge conceptual understanding. The findings indicate that the average score for students' conceptual understanding in the Number Theory course is 64.75, which falls into the "Good" category. Specifically, the ability to explain concepts is categorized as "Good" with an average score of 61.25. The proficiency in using concepts averages at 69.5, and the capacity to extrapolate from a given concept is also rated "Good," with an average score of 63.5.

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Keywords: Conceptual Understanding, Mathematics Education, Number of Theory.

INTRODUCTION

In the realm of mathematics education, conceptual understanding is one of the key aspects that determine an individual's success in grasping and applying mathematical concepts across various contexts (Jeheman, et al., 2019). The ability to comprehend mathematical concepts is regarded as one of the indicators of success in mathematics learning (Yulianty, N., 2019). Conceptual understanding is not merely about recalling definitions or theorems, but rather it pertains to the ability to interrelate concepts and apply them in problem-solving (Fajar, A. P., et al., 2019). Therefore, conceptual understanding is a crucial component of learning, including at the tertiary education level.

In higher education, especially in the Mathematics Education program, there is a course that is fundamental in building students' logical thinking and essential theories, particularly in theorem proofs, namely the Number Theory course (Karim, A., & Nurrahmah, A., 2018). The Number Theory course serves as one of the crucial foundations in the curriculum of the Mathematics Education program. The concepts within Number Theory not only facilitate a basic understanding of mathematics but also prepare students to apply them in real-life situations, especially in the classroom. The ability to comprehend and apply concepts in Number Theory is not only vital for students' academic success but also for their capability to teach these concepts to future students as prospective educators (Nurrahmah, A., & Karim, A., 2018). Therefore, it's important for educators to understand the extent to which students grasp these concepts and any challenges they encounter during their learning process.

However, based on preliminary observations conducted by researchers in the Mathematics Education program at STKIP (Sekolah Tinggi Keguruan dan Ilmu Pendidikan) Taman Siswa Bima, there are still students

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who face difficulties in understanding and internalizing the concepts taught in this course. These observations indicate that students struggle with several Number Theory topics, such as understanding basic concepts like prime factorization. Some students mistakenly believe that all even numbers are prime, are unclear about the definition of relatively prime numbers, and how to determine them, among other difficulties. These struggles are not limited to mathematical operations but lean more towards a difficulty in grasping the basic concepts.

These student difficulties in understanding Number Theory raise concerns for advanced courses that require a grasp of Number Theory concepts as prerequisites. However, apart from those who struggle, there are also students who have a good grasp, correctly apply concepts, and solve problems accurately. Observing these two conditions, it's crucial to conduct a deep analysis of students' conceptual understanding abilities. This analysis is hoped to pinpoint the areas where students struggle and offer recommendations for refining teaching methods. In this research, the analysis of conceptual understanding ability refers to indicators of conceptual understanding.

Conceptual understanding indicators relate to one's ability to understand something, explain concepts in their own words, use information accurately in new contexts, create new analogies, and generalize (Diana, et al., 2020). Someone understands a mathematical concept when they can: (1) Restate a concept, (2) Classify objects according to certain properties of the concept, (3) Provide examples and non-examples of the concept, (4) Represent the concept in various mathematical forms, (5) Use, utilize, and select specific procedures or operations, and (6) Apply a concept or theorem to problem-solving (Kartika, 2018; Febriyani, 2022). Another perspective on indicators of mathematical conceptual understanding is the ability to explain a concept, apply the concept in various different situations, and develop some consequences of having a concept (Khairunnisa, et al., 2022). Based on the conceptual understanding indicators explained by several experts, in this research, the conceptual understanding ability is analyzed by referring to students' skills in explaining a concept, applying the concept in various different situations, and developing some consequences of a concept.

To support the findings of this research, the researcher refers to several related studies that provide insights into the factors influencing conceptual understanding. One such study is titled "Analysis of the conceptual understanding abilities of mathematics students at PGSD (Pendidikan Guru Sekolah Dasar) STKIP Persada Khatulistiwa Sintang," published in the Jurnal Pendidikan Dasar Perkhasa: Research Journal of Basic Education (Rismawati & Hutagaol, 2018). Another relevant study is "Analysis of problem-solving abilities of students in the number theory course" Setiawan, E., et al (2021) and "Analysis of students' errors in solving number theory problems based on Kastolan stages, viewed from gender" and Meilanawati, P & Pujiastuti, H (2020). Although previous studies exist, there remains a need for a more specific examination of the conceptual understanding in the Number Theory course within the context of the Mathematics Education Study Program.

As a result, the objective of this research is to present an analysis of the conceptual understanding abilities of students in the Mathematics Education Study Program concerning the Number Theory course. It is hoped that these findings can serve as a basis for evaluation and provide recommendations for improving future learning processes.

METHODS

This research is a descriptive study employing a qualitative approach. In this study, the researcher conducts an in-depth analysis regarding students' conceptual understanding and their feedback on the Number Theory course (Unaenah, E., & Sumantri, M. S, 2019). The population of this study comprises all students of the Mathematics Education Study Program who are currently enrolled in the Number Theory course. Using purposive sampling technique, the sample selected involves 16 second-

semester students, consisting of 7 male students and 9 female students.

For this research, the investigator utilizes a conceptual understanding test, which includes 4 descriptive questions to measure students' grasp of the main topics in Number Theory. The students' responses are assessed based on indicators: 1) the ability of students to explain a concept, 2) the application of the concept in various distinct situations, and 3) the development of several consequences arising from a concept. Therefore, for each question tackled by the students, the researcher applies these indicators. For each indicator, the researcher uses an average comparison, establishes criteria, and draws conclusions. The evaluation of students' understanding is based on categories/criteria (Rismawati & Hutagaol, 2018) as follows in **Table 1**.

Table 1 Criteria for Conceptual Understanding Ability

Interval	Category
81-100	Excellent
61 - 80	Good
41 - 60	Fair
21- 40	Poor
0 - 20	Very Poor

The written test was analyzed to determine which conceptual areas often pose difficulties for students, which will subsequently serve as feedback and input for the university and the course instructor.

RESULTS AND DISCUSSION

This research was conducted from February to July 2023 at STKIP Taman Siswa Bima, specifically in the Mathematics Education Study Program for the second semester. There were 16 students involved in this program. After attending 14 lecture sessions, the students were then given a test to assess their understanding of the number theory material that had been taught. The test consisted of four essay questions. The students' work was analyzed based on indicators of conceptual understanding and evaluated using a grading rubric. Analysis was performed using an average comparison for each indicator. Below is an analysis of the students' conceptual understanding in the number theory course based on each question item.

Question No. 1

Jika p dan q bilangan-bilangan bulat, buktikan bahwa ada bilangan-bilangan bulat x dan y sedemikian sehingga px+qy= r jika dan hanya jika (p,q) | r

From the given questions, the following details the students' work results and its analysis using the indicators of conceptual understanding:

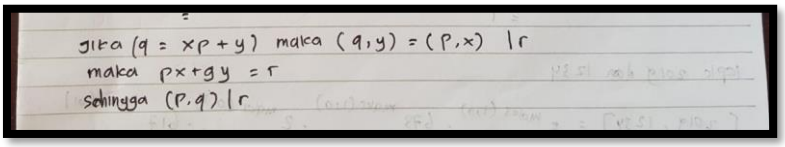

Figure 1 Student's Answer to Question No. 1

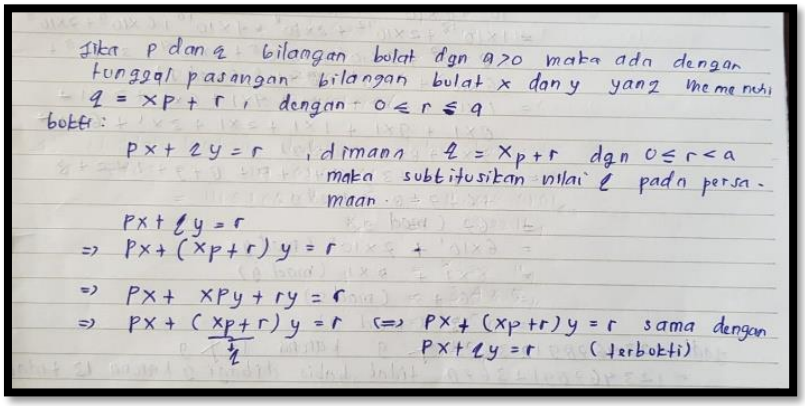

Figure 2 Student's Answer to Question No. 1

From **Figure 1** and **Figure 2** above, we can observe the variance in students' ability to grasp and apply concepts when solving problems. In **Figure 1**, it's unclear which mathematical concept the student used and how they applied it. Conversely, in **Figure 2**, the student seems able to articulate and apply the concept, progressing through the problem, even though the final solution isn't entirely accurate. Out of the 16 students who attempted the problem, an analysis of their conceptual understanding is presented as follows:

Table 2 Analysis of Students' Conceptual Understanding for Question No.1

No.	Indicator	Analysis Results	Category
1	Ability to Explain Concepts	57	Fair
2	Ability to Use Concepts	68	Good
3	Developing Implications from a Concept	53	Fair
Mean		**59.33**	**Fair**

From **Table 2** above, it can be inferred that for question No. 1 related to the proof of divisibility, out of 16 students, the understanding ability for indicator I reached an average score of 57, which falls into the "Fair" category. Meanwhile, for indicator 2, the average score is 68, placing it in the "Good" category, and for indicator 3, the average score is 53. Therefore, for question No. 1, the overall conceptual understanding ability of the students is categorized as "Fair" with an average score of 59.33.

Question No. 2

Jelaskan apakah 12346789123678 habis dibagi oleh 2 dan 9.

For question number 2, students were asked to determine if the integer 12346789123678 is divisible by 2 and 9. This material relates to the application of congruence. The analysis of students' ability to understand the application of congruence can be analyzed as follows:

Table 3 Analysis of Students' Conceptual Understanding for Question No.2

No.	Indicator	Analysis Results	Category
1	Ability to Explain Concepts	61	Good
2	Ability to Use Concepts	68	Good
3	Developing Implications from a Concept	68	Good
Mean		**65.66**	**Good**

From **Table 3** above, it's evident that for question number 2, which pertains to the application of congruence, the understanding of the concept among the 16 students (for indicator I) has an average score of 61, falling into the "good" category. For indicator II, the average score is 68, which is also categorized as "good", and for indicator III, the average score is 68. Consequently, based on question number 2, the students' conceptual understanding level is rated as "good" with an average score of 65.66. This indicates that the students have a strong grasp of the congruence application concept.

Question No. 3

Tentukan FPB dan KPK dari 2019 dan 1234 dengan menggunakan Konsep keterbagian

Question number 3 pertains to the concept of divisibility. Students were asked to determine the Greatest Common Divisor (GCD) and the Least Common Multiple (LCM) of the given numbers, which are 2019 and 1234. An analysis of the students' understanding of the divisibility concept can be presented as follows:

Table 4 Analysis of Students' Conceptual Understanding for Question No.3

No.	Indicator	Analysis Results	Category
1	Ability to Explain Concepts	63	Good
2	Ability to Use Concepts	70	Good
3	Developing Implications from a Concept	65	Good
Mean		**66**	**Good**

From **Table 4** above, the results indicate that for question number 3, which pertains to the concept of divisibility, the understanding ability of 16 students regarding the divisibility concept in the given material has an average score of 63 for indicator I, falling into the "good" category. Similarly, for indicator II, the average score is 70, also categorized as "good", and for indicator III, the average score is 65. Therefore, for question number 3, the students' conceptual understanding level is rated as "good" with an average score of 66. In conclusion, it can be inferred that the students' ability to comprehend the divisibility concept, particularly in determining the Greatest Common Divisor (GCD) and the Least Common Multiple (LCM), is categorized as "good".

Question No. 4

Ubahlah lambang Bilangan dalam basis yang diketahui ke basis yang diminta:

a. 7105_8 = ……$_2$ =……$_4$ = ……..$_{16}$.

b. 30021_4 = ……$_2$ =……$_8$

Question number 4 was given to the students with the aim of measuring their conceptual understanding of the material on integer bases. From the answers provided by the 16 students, the analysis is as follows:

Table 5 Analysis of Students' Conceptual Understanding for Question No.4

No.	Indicator	Analysis Results	Category
1	Ability to Explain Concepts	61	Good
2	Ability to Use Concepts	72	Good
3	Developing Implications from a Concept	68	Good
Mean		**67**	**Good**

From **Table 5**, the results indicate that for question number 4, which focuses on understanding the concept of integer bases, the understanding ability of 16 students regarding the material has an average score of 61 for indicator I, falling into the "good" category. Moreover, for indicator II, the average score is 72, which is also categorized as "good", and for indicator III, the average score is 68. Therefore, for question number 4, the students' conceptual understanding level is assessed as "good" with an average score of 67. Consequently, it can be concluded that the students' ability to comprehend the concept of integer bases is in the "good" category.

In general, the results of students' conceptual understanding abilities in the Mathematics Education Program for the second semester can be categorized as follows:

Table 6 Analysis of Students' Conceptual Understanding Abilities in the Number Theory Course

No.	Indicator	Analysis Results	Category
1	Ability to Explain Concepts	61.25	Good
2	Ability to Use Concepts	69.5	Good
3	Developing Implications from a Concept	63.5	Good
Mean		**64.75**	**Good**

From **Table 6**, it can be stated that students' conceptual understanding abilities in the Number Theory course have an average of 64.75, placing them in the "Good" category. The breakdown is as follows: the ability to explain concepts falls within the "Good"

category with an average of 61.25, the ability to use concepts is in the "Good" category with an average of 69.5, and the ability to develop implications from concepts is categorized as "Good" with an average of 63.5.

The results of this study indicate that students' conceptual abilities remain a particular concern. Despite being categorized as "Good," there is still a need for reinforcement, especially in the indicator of explaining concepts. Based on previous research, there are several ways that can be undertaken to enhance conceptual understanding, such as maximizing Microsoft Mathematics (Mendezabal & Tindowen, 2018), utilizing Geogebra software (Zulnaidi & Zamri, 2017), and incorporating instructional content in mathematics education (Rittle-Johnson, et al., 2016).

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CONCLUSION

From the analysis of the results of the conceptual understanding test for students in the Number Theory course, it can be concluded that the students' conceptual understanding abilities fall within the "Good" category with an average score of 64.75. Breaking down the results, the ability to explain concepts is rated as "Good" with an average of 61.25. The ability to use concepts is in the "Good" category with an average of 69.5, and the ability to derive implications from concepts is also categorized as "Good" with an average of 63.5.

Author's declaration

Authors' contributions and responsibilities

The authors made substantial contributions to the conception and design of the study. The authors took responsibility for data analysis, interpretation and discussion of results. The authors read and approved the final manuscript.

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All data are available from the authors.

Competing interests

The authors declare no competing interest.

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