

**MAPPING UNDERSTANDING THE CONCEPT OF COMPLEX
NUMBERS OF TADRIS MATHEMATICS STUDENTS OF UIN K.H.
ABDURRAHMAN WAHID PEKALONGAN**

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ABSTRAK

Konsep dasar matematika dalam bilangan kompleks merupakan hal yang penting dalam memahami lebih lanjut apa itu materi bilangan kompleks pada matakuliah analisis kompleks. Tujuan penelitian ini adalah untuk memetakan pemahaman mahasiswa tadrис matematika UIN K.H. Abdurrahman Wahid Pekalongan pada konsep bilangan kompleks. Penelitian ini mengadopsi pendekatan kualitatif melalui deskriptif analisis. Subjek penelitian ini sebanyak 10 mahasiswa tadrис matematika yang mengambil mata kuliah analisis kompleks pada tahun akademik 2023/2024. Teknik pengumpulan data menggunakan lembar tes sebanyak 3 soal dan wawancara terhadap 5 mahasiswa. Teknik keabsahan data melalui triangulasi sumber dan teknik analisis data menggunakan tahapan kondensasi data, display data, dan penarikan kesimpulan. Hasil penelitian mengindikasikan bahwa pemahaman mahasiswa terhadap konsep dasar matematika dalam bilangan kompleks bervariasi. Sebagian mahasiswa menunjukkan pemahaman yang mendalam, sementara yang lain masih memerlukan pemahaman yang lebih baik. Penelitian ini memberikan kontribusi yang signifikan dalam menggambarkan pemahaman mahasiswa tadrис matematika UIN K.H. Abdurrahman Wahid Pekalongan terkait konsep matematika abstrak secara mendalam, yang merupakan dasar penting dalam memahami analisis kompleks. Penelitian ini memberikan kontribusi yang signifikan dalam menggambarkan pemahaman mahasiswa tadrис matematika UIN K.H. Abdurrahman Wahid Pekalongan terkait konsep matematika abstrak secara mendalam.

Kata kunci : Pemahaman konsep, bilangan kompleks

ABSTRACT

Basic mathematical concepts in complex numbers are important in understanding further what complex number material is in complex analysis courses. The aim of this research is to map the understanding

of mathematics students at UIN K.H. Abdurrahman Wahid Pekalongan on the concept of complex numbers. This research adopts a qualitative approach through descriptive analysis. The subjects of this research were 10 Tadris mathematics students taking complex analysis courses in the 2023/2024 academic year. The data collection technique uses a test sheet with 3 questions and interviews with 5 students. data validity techniques through triangulation of sources and techniques. The data analysis technique uses stages of data condensation, data display, and conclusion drawing. The research results indicate that students' understanding of basic mathematical concepts in complex numbers varies. Some students show deep understanding, while others still need better understanding. This research provides a significant contribution in describing the understanding of Tadris mathematics students at UIN K.H. Abdurrahman Wahid Pekalongan relates abstract mathematical concepts in depth, which is an important basis in understanding complex analysis. This research provides a significant contribution in describing the understanding of Tadris mathematics students at UIN K.H. Abdurrahman Wahid Pekalongan relates the concept of abstract mathematics in depth.

Keywords : *understanding concepts, complex numbers*

INTRODUCTION

Concepts in any subject are analogous to the basic building blocks for thinking, especially for higher-order thinking. The ability to understand concepts in depth is one of the main skills that must be developed by students who want to become teachers. Concept understanding is the ability to understand mathematical ideas thoroughly and functionally is part of the ability to understand concepts. Understanding mathematical concepts is a key foundation in learning and applying mathematics in a variety of contexts. These concepts include a variety of basic ideas, principles, and structures of mathematics that form the basis for the further development of mathematical knowledge and skills. In the context of education, understanding mathematical concepts is the main key in ensuring students can master the material thoroughly and are able to apply it in solving everyday life problems. Understanding the concept of complex numbers is one of the important aspects of learning advanced mathematics. This concept plays a crucial role in many fields, including physics, engineering, and computer science. A complex number is

a number consisting of a real part and an imaginary part. In its general representation, complex numbers are written in the form $a + bi$, where a is the real part and bi is the imaginary part with i as an imaginary unit (which is the square root of -1). In this definition, a and b are real numbers. Part a states the real component of complex numbers, while part bi states the imaginary component. If $b = 0$, then the complex number is equal to the real number. If $a = 0$, then the complex number is a purely imaginary number. In complex analysis, complex numbers are treated as a broad domain of study for complex functions, i.e. functions that map complex numbers to other complex numbers. A solid understanding of complex numbers in complex analysis helps in solving various problems in applied mathematics and other sciences, such as physics, engineering, and economics.

Based on Ika Wahyuni's research, it is stated that students still have difficulty in connecting between objects and concepts which is one indicator of concept understanding. This is related to the ability to understand students' concepts is fairly low where the test results in research conducted by Ika Wahyuni show that only a small number of students can answer correctly, and most others are still lacking in utilizing their concept understanding abilities. This concept is important for students to understand because it can be used as a benchmark for the success of student learning outcomes. In addition, understanding concepts is one of the skills that students must acquire as prospective teachers. The ability to understand correctly and convey it to others through oral and written communication improves knowledge skills.

Therefore, it is important to understand the extent to which mathematics education students understand this concept, as this can affect their ability to understand further material that makes use of complex numbers. In the Indonesian context, especially in mathematics learning at UIN K.H. Abdurrahman Wahid Pekalongan, mapping the understanding of complex number concepts is an important subject. Tadris Mathematics students at the institution are prospective mathematics teachers at the secondary school level, who will later be responsible for conveying mathematical concepts to future generations.

This study aims to map the understanding of complex number concepts in Tadris Mathematics students at UIN K.H. Abdurrahman Wahid Pekalongan. Through this mapping, it is hoped that they can know the extent of their understanding of the concept, as well as what factors affect their understanding. This mapping also contributes to our understanding of how best to teach complex number concepts to mathematics education students, so that they can become qualified teachers in delivering the material to the next generation. In this introduction, we will describe the background of the problem, research objectives, and methodology used in mapping the understanding of complex number concepts in Tadris Mathematics students at UIN K.H. Abdurrahman Wahid Pekalongan.

The method used in this research is a qualitative method with a type of research mapping. Qualitative research is an approach to understanding complex phenomena in a natural context. One type of qualitative research is mapping research, which aims to describe and understand certain phenomena in a broad context. Mapping research with analysis is an approach used in qualitative research to compile a comprehensive picture of a particular phenomenon or topic by analyzing the data that has been collected. This method involves in-depth analysis of various aspects or dimensions of data to understand emerging patterns, relationships, or themes. This mapping research was designed using procedures conducted by Whiston and Li (2011: 273-279) consisting of 7 stages as follows: (1) formulating research questions, (2) determining the most appropriate meta-analysis approach, (3) searching and identifying literature related to research, (4) determining inclusion criteria and developing manual coding, (5) extracting and coding data, (6) data analysis, and (7) write meta-analysis results.

The study will be conducted in March 2024 which coincides with UTS time. The research place is at the Faculty of Tarbiyah and Teacher Training, State Islamic University KH. Abdurrahman Wahid Pekalongan. The subject of this study was a 6th semester Tadris Mathematics student who was taking the Complex Analysis course. Researchers used incidental sample collection techniques of 10 students to do 3 lambing questions from Complex Number material. Data collection is used with documentation techniques because data sources are ex-post facto.

DISCUSSION

This study aims to map the understanding of complex number concepts in Tadris Mathematics students at UIN K.H. Abdurrahman Wahid Pekalongan. Such mapping is important because the concept of complex numbers is a crucial part of advanced mathematics learning and has wide applications in fields such as physics, engineering, and computer science. Through a qualitative approach with descriptive analysis, this study involved 10 students who took the Complex Analysis course in the academic year 2023/2024. The results of this study provide a comprehensive picture of understanding the concept of complex numbers in Tadris Mathematics students at UIN K.H. Abdurrahman Wahid Pekalongan. It was found that although there were some students who showed a deep understanding of the concept, there were still others who needed a better understanding. Field results show that most students are able to prove an equation true by substituting the problem into the equation, but difficulties arise when simplifying the initial and second fractions and simplifying the 3rd problem. This is because most students do not multiply the conjugate of each denominator, causing errors in the simplification process.

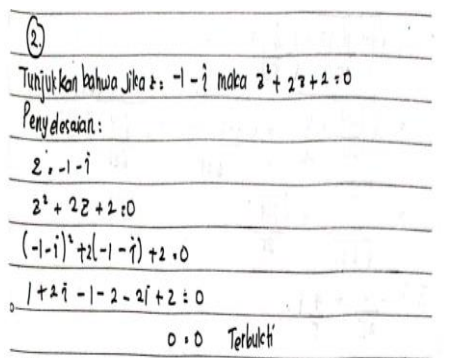
Table 1. Assessment of field results

Explanations for each category:

No	Ability	Incomplete	Enough	Good
1	Proving the Equation True	0	0	10
2.a	Simplifying the Fraction of the Initial Part	2	0	8
2.b	Simplifying Fractions Part two	2	7	1
3	Simplifying the Problem by Multiplying Conjugates	9	0	1

1. Incomplete: Students are unable to perform these abilities or perform with significant errors.
2. Sufficient: Students perform these abilities, but there are significant errors or deficiencies in workmanship.
3. Good: Students perform these abilities well and precisely.

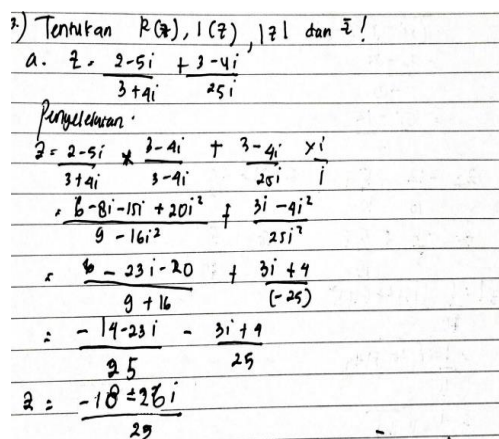
Here are the answers from students:



2)
 Tunjukkan bahwa jika $z = -1 - i$ maka $z^3 + 2z + 2 = 0$
 Penyelesaian:
 $z = -1 - i$
 $z^3 + 2z + 2 = 0$
 $(-1 - i)^3 + 2(-1 - i) + 2 = 0$
 $1 + 2i - 1 - 2 - 2i + 2 = 0$
 $0 = 0$ Terbukti

Figure 1. The result of the answer to the first question

The ability of students to prove an equation true by substituting the problem into the equation shows a good understanding of basic concepts in complex numbers. This process involves the application of basic mathematical rules and the ability to perform algebraic operations precisely. At this stage, students are tested in their ability to apply the given equations to existing problems. The substitution process requires a strong understanding of complex number concepts and skills in performing basic operations such as addition, subtraction, multiplication, and division of complex numbers. With the success of all students in proving an equation true, it can be concluded that they have been able to apply the basic concepts of complex numbers well.



3) Tentukan $\Re(z)$, $\Im(z)$, $|z|$ dan \bar{z} !
 a. $z = \frac{2-5i}{3+4i} + \frac{3-4i}{25i}$
 Penyelesaian:
 $z = \frac{2-5i}{3+4i} \cdot \frac{3-4i}{3-4i} + \frac{3-4i}{25i} \cdot \frac{25i}{25i}$
 $= \frac{6-8i-15i+20i^2}{9-16i^2} + \frac{3i-4i^2}{25i^2}$
 $= \frac{6-23i-20}{9+16} + \frac{3i+4}{-25}$
 $= \frac{-14-23i}{25} - \frac{3i+4}{25}$
 $z = \frac{-18-26i}{25}$

Figure 2. The answer to the second question part A

The results show that there is a fairly good understanding from some students in simplifying the fraction of the initial part by multiplying the conjugate from the denominator of the beginning of the problem, which is $3 + 4i$. This demonstrates

their understanding of the concept of complex numbers and the application of rules in simplifying algebraic forms. However, there is confusion in the simplification of the second part, where most students make the mistake of multiplying by i . This indicates confusion in applying the correct steps in simplifying the form. In addition, it was found that there was one student who had understood to simplify by dividing each term by $25i$, but there was an error in the calculation process. One other student managed to give the correct answer on the simplification. This illustrates the need for more practice and a deep understanding in applying complex number concepts, particularly in properly simplifying algebraic forms.

$$\begin{aligned}
 \text{b.) } \frac{12-5i}{(1+i)(1+2i)(1+3i)} & \quad \text{dg } i^2 = -1 \\
 & \frac{12-5i}{(1+i)(1+2i)(1+3i)} \\
 & \frac{12-5i}{1+2i+1-2 \times 1+3i} \\
 & \frac{12-5i}{(3i-1)(1+3i)} \\
 & \frac{12-5i}{3i^2-9-1-3i} \\
 & \frac{12-5i}{-10} \\
 & = \frac{5i-12}{10}
 \end{aligned}$$

Figure 3. The answer to the second part B

From the results, it can be seen that most students have difficulty in simplifying the problem because they do not multiply the conjugate of each denominator correctly. This shows the shortcomings in their understanding of the concept of complex number operations. However, one student managed to simplify the problem in the right way, namely by multiplying the conjugate of each denominator. This shows that there is variation in understanding and ability between students from one another. There needs to be more intensive learning and a clearer approach in conveying this concept so that all students can master the correct steps in simplifying complex number forms by using conjugates from each denominator.

Overall, the results of the practice test showed that most students still had low comprehension and difficulty in understanding and reasoning related to

complex numbers. Only a small percentage of students achieve grades that meet the graduation criteria. The implication of these findings is the need for a more in-depth learning approach and oriented towards the application of concepts in problem solving. In addition, efforts are needed to improve students' ability to better connect objects and concepts. Meanwhile, from the results of the interview, there were variations in student opinions related to understanding the concept of complex numbers. Some admit difficulties in solving problems related to the concept, while others feel that they already understand the material well. Students with low understanding tend to have difficulty in connecting complex number concepts to complex analysis, while those with high understanding feel that the material is easy to understand because it has operating properties similar to real numbers.

This mapping of understanding complex number concepts makes a significant contribution to our understanding of how best to teach complex number concepts to mathematics education students. These findings also provide valuable information for curriculum development and learning at UIN K.H. Abdurrahman Wahid Pekalongan. With a better understanding of students' level of understanding of complex number concepts, institutions can identify areas that need to be strengthened in learning, as well as develop more effective learning strategies to improve students' understanding of concepts. Overall, the mapping of understanding the concept of complex numbers in Tadris Mathematics students at UIN K.H. Abdurrahman Wahid Pekalongan provides a comprehensive picture of the understanding of the concept. These findings could serve as a basis for the development of more effective learning strategies, as well as for improved understanding of abstract mathematical concepts more broadly at the institution.

Analysis of students' mathematical comprehension and reasoning abilities in complex number system material in the results showed that most students are still not optimal in mathematical comprehension and reasoning abilities, especially in complex number system material. Students have difficulty meeting mathematical concepts and analyzing mathematical situations, and the average test scores of mathematical comprehension and reasoning skills are still below standard. Students also still have difficulty doing practice questions about complex number systems

and complex functions, often copy friends' work, and cannot do the questions perfectly. Evaluation by lecturers and more detailed and gradual explanations are needed to improve the learning outcomes of these students. Errors in doing problems can be overcome with clearer explanations, describing complex functions, and the use of innovative learning methods to help students understand the material and students also need encouragement or enthusiasm, students can also do peer tutoring about complex numbers with fellow friends so that there can be discussions, recollections and evaluating a problem related to complex numbers.

Why is it important to analyze students' errors in this complex numbers course because it provides insight into their misunderstandings and weaknesses in solving problems related to complex numbers material by understanding these errors, educators can adjust their teaching strategies to overcome certain areas of difficulty which in turn can increase students' understanding and attractiveness related to problems in complex numbers material. This research can contribute to improving understanding by identifying common errors, developing targeted interventions and encouraging a deeper understanding of complex number concepts

CONCLUSION

Based on the results of the study, it can be concluded that the understanding of the concept of complex numbers in Tadris Mathematics students at UIN K.H. Abdurrahman Wahid Pekalongan varies. Although some students show a deep understanding of the concept, there are still others who need a better understanding. These findings indicate a need for a more intensive learning approach oriented towards the application of concepts in problem solving. It is important to ensure that all students can master the correct steps in simplifying complex number forms by using conjugates of each denominator. Implications of these findings include the need for more effective curriculum development and learning, as well as efforts to improve students' understanding of concepts through clearer and more intensive approaches.

In addition, the results of the study also highlight variations in understanding and ability between students with one another. This demonstrates the importance of learning approaches that are inclusive and adapt to individual needs. Efforts are

needed to improve students' ability to better connect objects and concepts, as well as provide additional support to students who have difficulty in understanding complex number concepts. These findings make a significant contribution to our understanding of how best to teach complex number concepts to mathematics education students, as well as to the development of more effective learning strategies at UIN K.H. Abdurrahman Wahid Pekalongan.

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