ERROR ANALYSIS OF MATHEMATICS TADRIS STUDENTS ON THE LEVEL OF UNDERSTANDING IN SOLVING COMPLEX ANALYSIS PROBLEMS

Fifi Dwi Afianti[1], Wafiq Azizah[2], Umi Mahmudah[3]
UIN K.H. Abdurrahman Wahid Pekalongan
fifidwiafianti@mhs.uingusdur.ac.id , wafiqazizah@mhs.uingusdur.ac.id , umimahmudah@uingusdur.ac.id

ABSTRAK

Fokus pada penelitian ini adalah untuk mengukur tingkat kesalahan terhadap pemahaman mahasiswa dalam menyelesaikan soal analisis kompleks. Pembelajaran matematika dapat tercapai apabila mahasiswa dapat memahami, menyelesaikan dan mengaplikasikannya terhadap masalah yang ada. Tujuan dari penelitian ini adalah untuk menganalisis kesalahan matematis mahasiswa Tadris matematika UIN K.H. Abdurrahman Wahid Pekalongan terhadap pemahaman dalam menyelesaikan soal analisis kompleks. Penelitian ini menggunakan pendekatan kualitatif melalui deskriptif analisis. Subjek dalam penelitian ini sebanyak 15 mahasiswa semester enam Program studi Tadris matematika Tahun Ajaran 2023/2024. Teknik pengumpulan data menggunakan lembar tes dan wawancara terbuka. Keabsahan data dilakukan melalui triangulasi sumber dan teknik. Analisis data menggunakan tahapan: kondensasi data, displays data, dan penarikan kesimpulan. Hasil penelitian ini menunjukkan bahwa masih banyak mahasiswa yang melakukan kesalahan dalam menyelesaikan soal analisis kompleks, kesalahan yang sering terjadi yaitu kesalahan konsep, kesalahan perhitungan/prosedural hingga kesalahan sistematik/teknik. Manfaat dari penelitian ini yaitu dapat memberikan wawasan yang lebih dalam tentang aspek-aspek yang mempengaruhi pemahaman materi analisis kompleks. Dengan demikian, penelitian ini dapat membantu dalam merancang strategi pembelajaran yang lebih efektif untuk meningkatkan kualitas pembelajaran sehingga memberikan dampak langsung pada hasil belajar matematika di program Tadris Matematika.

Kata kunci: *kesalahan matematis, penyelesaian masalah, tingkat pemahaman, analisis kompleks*

ABSTRACT

The focus of this research is to measure the level of error in students' understanding in solving complex analysis problems. Mathematics learning can be achieved if students can understand, solve and apply it to existing problems. The purpose of this research is to analyze mathematical errors of mathematics Tadris students of UIN K.H. Abdurrahman Wahid Pekalongan towards understanding in solving complex analysis problems. This research uses a qualitative approach through descriptive analysis. The subjects in this study were 15 sixth semester students of

the Tadris Mathematics Study Program in the academic year 2023/2024. Data collection techniques using test sheets and open interviews. Data validity was done through triangulation of sources and techniques. Data analysis uses stages: data condensation, data display, and conclusion drawing. The results of this study indicate that there are still many students who make mistakes in solving complex analysis problems, errors that often occur are concept errors, calculation/procedural errors to systematic/technical errors. The benefit of this research is that it can provide deeper insight into the aspects that affect the understanding of complex analysis material. Thus, this research can help in designing more effective learning strategies to improve the quality of learning so that it has a direct impact on mathematics learning outcomes in the Tadris Mathematics program.
***Keywords**: mathematical errors, problem solving, level of understanding, complex analysis.*

INTRODUCTION

In learning we can learn various things, one of which is learning math. Learning is a process of changing behavior from not knowing to knowing and is expected to achieve the desired goals. Mathematics is a discipline that has peculiarities and one of the many peculiarities includes the presentation of systematic, deductive, and axiomatic material. Mathematics also has abstract concepts that are considered too difficult to understand and learn directly. Mathematics is also a universal science that underlies the development of modern technology, has an important role in various disciplines and advances human thinking. Mathematics is a basic science taught at all levels of education from elementary school to college. Mathematics has a strong and clear structure and links between its concepts that allow for critical thinking skills. There is a very strong relationship between one concept and another in mathematics which allows students to use it as a basis for thinking in solving problems. (Yolanda & Sthephani, 2021). As a prospective teacher who is the next generation to convey knowledge to students, mathematics education students must have qualified qualities so that they can convey knowledge well to students.

Students must prepare provisions that begin when students live their days as first semester students. The purpose of learning mathematics can be achieved if students can understand, solve and apply it to existing problems. Learning success can certainly affect learning achievement, factors that can affect learning

achievement in social cognitive theory according to Bandura are built through internal factors and external factors of students in learning. Internal factors from within learners such as self-confidence, learning independence, motivation, creative and critical thinking skills. While external factors come from outside the learners, such as parental attention, school environment and society.

But in reality, there are still many students who experience several mistakes in solving math problems given by lecturers, such as in the Complex Analysis course. Mathematical problems are experienced by students on problems or questions given by lecturers to answer. This problem arises when students have difficulty answering questions. This difficulty is due to the low understanding of student concepts. When solving mathematical problems, students should understand mathematical concepts, procedures and techniques so that mathematical errors can be avoided. Of course, this can have an impact on low student achievement, especially in complex analysis courses. The mistakes made by these students are very necessary to be immediately identified and found a solution.

The factors that cause errors made by students can occur, one of which is due to the students themselves, namely having the wrong habits in learning and understanding teaching materials that make students make types of mistakes when solving a problem (Andriani, 2019). In addition, another factor is that students do not master the concepts that become prerequisite material related to complex analysis material. To be able to take complex analysis courses, students must first take prerequisite courses, namely calculus and number theory. The relationship between these courses is very close. Usually the final results obtained in calculus and number theory courses are directly proportional to the results obtained in complex analysis courses. Then the material is abstract so that it makes it difficult for students to understand it accompanied by the lack of students practicing in solving complex analysis problems given by lecturers. This indicates the occurrence of errors in solving complex analysis problems. By knowing the various kinds of mistakes that have been made by students when solving problems given by lecturers can be used as a benchmark to determine the extent to which these students master and understand the existing material.

In the process of learning mathematics, understanding concepts, procedures and techniques is very helpful for students in solving the problems they face, but if an error occurs, it will have an impact on the results of the process and result in a decrease in grades in mathematics. Concept errors are related to errors in clarifying definitions or determining formulas, such as incorrectly determining rectangular shapes. Principle errors relate to linking facts or concepts, incorrectly using formulas. Meanwhile, skill errors are related to operation or calculation problems. Understanding of concepts and principles, as well as skills in mathematics becomes a benchmark in assessing student success in learning mathematics.

Based on the above background, researchers are interested in conducting research related to "Error Analysis of Tadris Mathematics Students on the Level of Understanding in Solving Complex Analysis Problems". The purpose of this research is to find out the mistakes made by Tadris Mathematics students in solving complex analysis problems, and to find out the factors that cause these errors.

This study used a qualitative approach through descriptive analysis. Such an approach is geared towards identifying the types of errors and misconceptions that students commonly encounter when they encounter complex mathematical material. This will involve tracing specific types of errors, conceptual analysis of why these errors occur, and will likely include recommendations for changing teaching or learning approaches to address these errors. According to Siswono (2010) Descriptive research is research that aims to describe current events or events. The process contains efforts to describe, record, analyze, and interpret events that currently exist or occur. Qualitative research methods are research methods based on the philosophy of postpositivism, which can be used to research on natural object conditions, (as opposed to experiments) where the researcher is the key instrument, for sampling data sources is done purposively. According to Notoatmodjo (2010) purposive sampling technique is a sampling technique based on a consideration, such as the characteristics or properties of a population. Data collection techniques use triangulation (combined), data analysis is inductive / quality, and qualitative research results emphasize meaning rather than generalization Sugiyono. The sampling technique in this study used purposive sampling technique.

The subjects of this study were sixth semester students of Tadris Mathematics FTIK UIN K.H. Aabdurrahman Wahid Pekalongan in the academic year 2023/2024, totaling 15 people. The research time started from April 2024 to May 2024. The data described are mathematical errors of sixth semester students of mathematics tadris UIN K.H. Abdurrahman Wahid Pekalongan in solving complex analysis. Student mathematical error data were collected using interviews and tests.

1. Interview guidelines, interview guidelines are designed to facilitate researchers in digging up student information about diagnostic tests related to complex analysis.
2. Test Planning: Math problem tests are designed to measure students' understanding of a particular topic. Problems are designed to challenge their understanding in depth and often include open-ended problems or different types of problems that require reasoning and mastery of concepts.

DISCUSSION

Based on the results of research from the test of complex analysis questions that have been given to 15 Tadris Mathematics students, where the test questions consist of 3 questions. All student answers are examined and then their mistakes are compiled so that conclusions can be drawn from the overall answer. Based on the test results, it can be concluded that students who work on math problems related to mathematical understanding and reasoning skills, only a small proportion of students can answer correctly, and not a few others are still lacking in their understanding and reasoning skills. The difficulties that are often experienced by students in understanding complex analysis material are such as concept errors, procedural errors or steps and technical errors. So that from the results of observations through interviews and test results, for mathematical understanding ability shows that students are still lacking and have not been able to optimally achieve understanding indicators.

In solving complex analysis problems, students often make several common types of errors which will be presented in the table below:

Table 1 Error Types and Indicators

Type of error	Indicator
Conceptual error	1. Misunderstanding the basic ideas and principles of a concept 2. Misunderstanding the relationship between ideas and principles
Procedural error	Misapplying rules or algorithms/formulas or step by step
Technique error	1. Performing the wrong operation 2. Incorrectly solve the equation

The test result documents were checked and then coded. Based on the test results, there are three categories of errors, namely: (1) conceptual errors (Code 1), procedural errors (Code 2), technical errors (Code 3). If the student is correct in answering the question, it is indicated by Code 4 and if the student does not write the answer to the question, it is given Code 5. In general, students' errors in solving the problem are summarized in Table 2.

Table 2 Student Errors

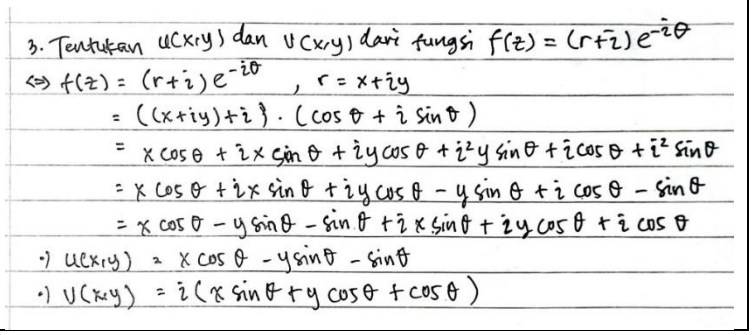
Student number	Type of error		
	Problem 1	Problem 2	Problem 3
1	4	3	1
2	3	2	2,3
3	3	2	5
4	4	3	2,3
5	2	2	1,3
6	4	4	3
7	4	4	2
8	3	2	4
9	3	5	5
10	3	3	3
11	3	2	1,3
12	4	3	2,3
13	2	3	1,3
14	4	3	4
15	3	3	2,3

The data contained in Table 2 explains that there are differences in student errors for each item. Student number 1 answered the question correctly and coherently. For question number 2, student number 1 made a technical error (code 3). For question number 3, students made conceptual errors (code 1). Based on Table 2, it can be seen that there are variations in the errors of each student for each

problem given. Table 2 also shows that most errors are technical errors. The description based on the test results for conceptual errors, procedural errors and technical errors will be explained below.

Conceptual Error

According to Elfiah et al., 2020 in the journal (Daswarman, 2022) conceptual errors are caused by errors in determining the right formula for the given problem. Students' factual errors in understanding a definition can occur, due to the distortion of the definition, which is the process of changing the definition that is relevant to the problem solution. (Mataheru, Huwaa, & Matitaputty, 2021). Conceptual errors in mathematics are one type of error that is often made by students in answering questions. This error occurs because students do not correctly understand the mathematical concepts underlying the given problem**.** As a result, they choose the wrong strategy or formula to solve the problem, even though they may do the calculations correctly.

Problem:	student answers:
Find u(x,y) and v(x,y) of the function $f(z) = (r+i)e^{-i\theta}$	

3. Tentukan u(x,y) dan v(x,y) dari fungsi $f(z) = (r+\bar{i})e^{-\bar{i}\theta}$

$\Leftrightarrow f(z) = (r+i)e^{-i\theta}$, $r = x+iy$

$= ((x+iy)+i) \cdot (\cos\theta + i\sin\theta)$

$= x\cos\theta + ix\sin\theta + iy\cos\theta + i^2 y\sin\theta + i\cos\theta + i^2\sin\theta$

$= x\cos\theta + ix\sin\theta + iy\cos\theta - y\sin\theta + i\cos\theta - \sin\theta$

$= x\cos\theta - y\sin\theta - \sin\theta + ix\sin\theta + iy\cos\theta + i\cos\theta$

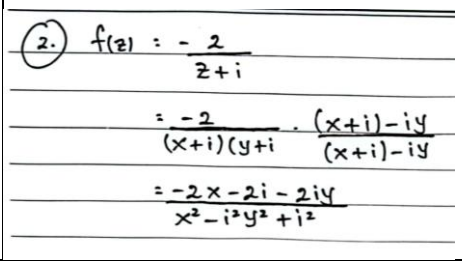
•) $u(x,y) = x\cos\theta - y\sin\theta - \sin\theta$

•) $v(x,y) = i(x\sin\theta + y\cos\theta + \cos\theta)$

Based on the answers to the questions above, it can be seen that there are conceptual errors made by students on the complex number function formula. Students misconceive the concept of $(r + i)$ which is converted to the form $\big((\mathrm{x} + \mathrm{iy}) + \mathrm{i}\big)$, which is not in accordance with the concept that should $(r + i)$ does not need to be changed. Students' inability to understand the question or question instruction well can cause them to choose an inappropriate formula. This can happen because they cannot identify relevant information from the problem or misinterpret what is asked. So that the student's solution answer is wrong because it is not in accordance with the proper concept. Students' weak understanding of the concept of complex number functions results in errors in determining a suitable formula based on the question asked.

Procedural error

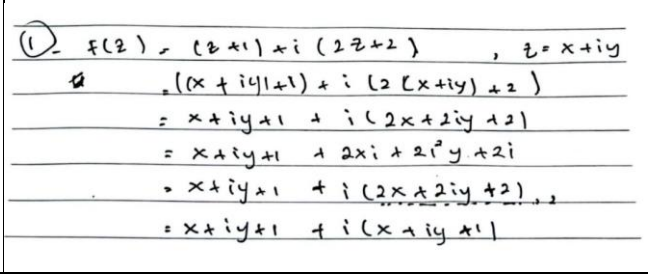
According to Luthfia & Zanthy (2019) in the journal (Daswarman, 2022) stated that procedural errors are caused by students not being able to write down things that are known about the problem and have not completed the problem to completion. Procedural errors are caused by students not writing things that are known to the problem and have not completed the problem to completion. Lack of accuracy in reading problems, understanding problems, and performing calculations can cause students to make procedural errors.

Problem:	**Student answer**:
Find u(x,y) and v(x,y) of the function $f(z) = -\frac{2}{z+i}$	

On the answer sheet, it can be seen that students do not write what is the question of the problem, so that the answers given by students are incomplete or inaccurate because they do not focus on what is asked. students should write the question of the problem, namely $u(x,y)$ dan $v(x,y)$. This can help students focus more on what they have to solve from the problem. In addition, the student's answer also did not finish until it was finished.

Technical Errors

Technical errors are caused by student errors that occur during the process of working on the problem, not because of a lack of understanding of the concept. This technical error can occur because students make incorrect calculations or are not careful in writing answers.

Problem:	**Student answer**:
Find u(x,y) and v(x,y) of the function $f(z) = (z+1) + i(2z+2)$	

From the student's answer, it can be seen that there is a wrong calculation, namely in i^2. Where the student is not careful in paying attention to the concept of

imaginary numbers of i^2 which should be the result of $i^2 = -1$, but the student considers saying imaginary "i" as an ordinary variable that cannot cause wrong calculations. The cause of the error is the lack of accuracy in calculating, resulting in an incorrect answer.

By analyzing the answers of each student, it can be concluded that there are many mistakes made by students in answering each question given. The mathematical errors found in students' answers include lack of accuracy in the operation of algebraic forms, not understanding the concepts in the algebraic properties of complex numbers, the exponent properties of complex numbers, complex functions and complex function transformations, describing complex functions / complex function transformation maps on the complex plane, and forgetting or misconceptions.

It can be seen from the discussion above that there are still many students who do not understand the complex analysis function material well, this is due to students who still have difficulty in understanding a problem and lack of carefulness in reading the questions and even basic concepts related to the nature of complex numbers, some students are still wrong. So that what is asked and what students answer is still not interrelated. In addition, students are still lacking in doing practice problems. Most students only practice and do problems when given assignments by lecturers. From most of these assignments, there are still many who have not been able to work perfectly, even some students copy the work of their classmates. This affects their understanding of complex number systems and complex functions. Because basically students will understand and understand if they practice working on problems a lot. So it can be said that the ability of students' understanding of the material still needs to be improved again, especially for complex analysis function material.

This shows that evaluation is important for lecturers. Because with the evaluation, lecturers can find out how far the results have been achieved in the implementation of the learning process. Thus, lecturers have the capital to be able to improve learning outcomes at a later stage. In addition, with the evaluation, lecturers should know and determine some strategies for groups that have the same ability. The strategy can be in the form of innovation in mathematics learning

models or by developing teaching material designs that are able to facilitate student learning obstacles related to material in Complex Analysis courses.

According to (Wahyuni & Karimah, 2017) Solutions that can be applied by students so that they do not make mistakes include:

1. Lack of accuracy in the operation of algebraic forms can be overcome by providing a more detailed explanation between the stages of completion so that students can be clearer and more thorough in solving the problem.
2. Not understanding the concepts in algebraic properties of complex numbers, exponent properties of complex numbers, complex functions and complex function transformations, it is better to convey the concepts in stages clearly, so that students can clearly understand how the concepts are explained in solving problems related to algebraic properties of complex numbers, exponent properties of complex numbers, complex functions and complex function transformations.
3. Forgetting or misconceptions can be overcome by trying the discovery method, which is a deductive learning approach. With this method, lecturers can provide examples that are cases then students find the nature of the case which is expected to find their own conclusions, with these conclusions students can distinguish which concept for the problem they will solve.

CONCLUSION

From the results of research conducted on the analysis of Tadris Mathematics students' errors in solving complex analysis problems, it was found that students often make mistakes in various aspects. These errors can be grouped into conceptual, procedural, and technical errors. Conceptual errors occur when students do not have a deep understanding of the basic concepts that form the basis for solving complex analysis problems. This can lead to difficulties in identifying the steps needed to solve the problem correctly.

In addition, procedural errors also often occur where students are often wrong in following the steps of solving problems correctly and systematically. Students can be trapped in errors in solving steps that are not in accordance with applicable mathematical rules. In addition, technical errors also often occur where students make mistakes in mathematical calculations that should be avoided. These errors

are often caused by a lack of caution or a less in-depth understanding of the mathematical concepts used.

By knowing the types of errors that often occur, it is hoped that teachers can provide more effective and efficient learning in improving student understanding of complex analysis material. There needs to be a different approach in learning to help students overcome the mistakes that often occur. In addition, it is also important to provide special coaching and guidance to students so that they can avoid the same mistakes in the future.

With these efforts, it is expected that the level of understanding of students in solving complex analysis problems can increase significantly. Students are expected to be able to identify errors that often occur and be able to overcome them properly. Thus, students can be more confident and competent in solving complex analysis problems properly and correctly.

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