MATHEMATICAL PROFICIENCY: AN ANALYSIS OF PROSPECTIVE TEACHERS' ABILITY TO SOLVE MATHEMATICAL PROBLEMS

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Abstract: Mathematical proficiency is a determinant of students' success in mathematics learning. This research aims to describe the mathematical skills of prospective teacher students, so that they can reflect and take follow-up actions to improve their mathematical skills as preparation for teaching and educating students in schools. The type of research used is descriptive research with a qualitative approach.. The research subjects are second-year prospective teacher students, totaling 35 people. This research measures 4 strands of mathematical proficiency: (1) conceptual understanding, (2) procedural fluency, (3) strategic competence, and (4) adaptive reasoning. The research results indicate that students' mathematical proficiency is still relatively low, especially in conceptual understanding, procedural fluency, and strategic components. Meanwhile, the indicator of adaptive reasoning is categorized as moderate.

Keywords: mathematical proficiency, prospective teacher students, mathematical problems

Abstrak: Kecakapan matematis merupakan penentu keberhasilan siswa dalam pembelajaran matematika. Penelitian ini bertujuan untuk mendeskripsikan kecakapan matematis mahasiswa calon guru, sehingga dapat melakukan refleksi dan tindak lanjut untuk meningkatkan kecakapan matematis sebagai bekal ketika mengajar siswa di sekolah. Metode penelitian yang digunakan adalah penelitian deskriptif dengan pendekatan kualitatif. Subjek penelitian merupakan mahasiswa calon guru tingkat dua sebanyak 35 orang. Teknik pengumpulan data yang digunakan adalah tes dan wawancara, dengan instrument tes mengacu pada indikator kecakapan matematis. Penelitian ini mengukur 4 kecakapan matematis yaitu (1) pemahaman konseptual; (2) kelancaran procedural; (3) komponen Strategis; dan (4) penalaran adaptif. Hasil penelitian menunjukkan bahwa kecakapan matematis siswa masih tergolong rendah terutama pada pemahaman konseptual, kelancaran procedural, komponen strategis. Sedangkan pada penalaran adaptif tergolong cukup.

Kata kunci: kecakapan matematis, mahasiswa calon guru, masalah matematika

INTRODUCTION

Mathematics learning is a process to develop students' mathematical abilities. Learning mathematics is not just about memorization but prioritizes students' understanding of the concepts in the learning material. In addition, mathematics learning can require students to

think logically, analytically, systematically, and critically in solving mathematical problems (Harahap & Surya, 2017). According to Permendiknas No. 22 of 2006, the goal of mathematics education is for students to have the ability to understand mathematical concepts, use reasoning on mathematical patterns and properties, solve mathematical problems, communicate ideas and symbols, and appreciate the usefulness of mathematics in life.

Mathematics learning is often considered difficult by students. The difficulties experienced by students include understanding the problems, choosing the strategies to be used, and difficulties in executing the solution plan (Yulian & Wahyudin, 2018). To overcome these difficulties, mathematical abilities, also known as mathematical proficiency, are needed. Mathematical proficiency is an important skill that students must master to succeed in learning mathematics (Ashari & Salwah, 2024). One of the requirements for everyone to have strong learning outcomes in mathematics is mathematical proficiency, which can be used to characterize many facets of abilities, competence, and knowledge. (Zandy & Negara, 2024).

According to Kilpatrick et al. (2001)there are five components of mathematical proficiency: (1) Conceptual understanding is the understanding of mathematical concepts, operations, and relationships in mathematics; (2) procedural fluency is the skill in carrying out mathematical procedures flexibly, accurately, and efficiently; (3) strategic competence is the ability to formulate, represent, and solve mathematical problems; (4) adaptive reasoning is the capacity to think logically, reflect, explain, and justify; and (5) productive disposition is the tendency or habit of seeing mathematics as sensible, useful, and capable of fostering confidence and perseverance in learning.

Mathematical proficiency is a competency that needs to be developed by students in mathematics learning. This ability is a combination of students' knowledge, skills, abilities, and beliefs (Yulian & Wahyudin, 2018). Of the five indicators, there are four indicators related to cognitive aspects (conceptual understanding, procedural fluency, strategic competence, and adaptive reasoning) and one indicator related to affective aspects (productive disposition)(O'Connor, 2024). Although productive disposition falls within the affective domain, it contributes 84.3% to learning outcomes. Additionally, productive disposition is a component that provides space for intellectual elements in solving mathematical problems (Awofala et al., 2022).

Someone with good mathematical proficiency is able to think logically, analytically, and systematically. Therefore, mathematical proficiency is important to develop in students. Students' mathematical proficiency can be developed with the help of teachers. Complex pedagogical skills and competency enhancement play a very important role in shaping students' mathematical proficiency (Groves, 2012; Sudiarta & Widana, 2019). The pedagogical skills of a teacher will impact the delivery to students so that students also have good mathematical proficiency. A lack of pedagogical skills and knowledge can affect the mathematical proficiency of students (Herlina & Juandi, 2022; Turmuzi & Kurniawan, 2021). Therefore, prospective teacher students must possess good mathematical proficiency to help their students develop their mathematical skills. The findings from Barham (2020), recommend qualitatively examining their mathematical proficiency in mathematics education.

Based on the above explanation about the importance of mathematical proficiency being mastered by prospective teacher students, the researcher is interested in examining the extent of their mathematical proficiency in solving mathematical problems. This study aims to describe the mathematical proficiency of prospective teacher students so that they can reflect

and take further action to improve their mathematical proficiency as preparation for when they teach and educate students in schools.

METHOD

The method used in this research is descriptive research with a qualitative approach. Descriptive research is a study aimed at explaining and detailing an object, phenomenon, or research problem without providing special treatment to the problem (Creswell & Creswell, 2018). Descriptive research with a qualitative approach in this study is to describe the mathematical proficiency of prospective teacher students in solving mathematical problems.

The subjects of this study are second-year prospective teacher students, totaling 35 people, at Universitas Maritim Raja Ali Haji. The selection of subjects was based on purposive sampling technique. The students' answers will be analyzed using indicators of mathematical proficiency. The strands of mathematical proficiency used in this research are conceptual understanding, procedural fluency, strategic competence, and adaptive reasoning. The description of each indicator can be seen in the table below:

No.	Mathematical Proficiency	Description
1.	Conceptual understanding	The ability to understand mathematical concepts and operations
2.	Procedural fluency	Skills in using flexible, accurate, efficient, and precise procedures or problem-solving steps
3.	Strategic competence	The ability to formulate, represent, and solve mathematical problems
4.	Adaptive reasoning	The ability to think logically, reflect, explain, and justify

Table 1. Strands Mathematical Proficiency

(Kilpatrick et al., 2001)

In this research, the researcher acts as the main instrument responsible for setting the research focus, collecting and analyzing data, and drawing conclusions. Meanwhile, the supporting instruments are tests and interview sheets. The test consists of 3 essay-type questions. The test used meets the criteria of a good instrument. The math problem test can be seen in the table below:

1 able 2. Main Problem 1es	Table	2.	Math	Problem	Test
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	Mat		Aathe	ematical		
No.	Question	Proficiency				
		1	2	3	4	
1.	Berilah tanda centang $()$ pada kotak di samping gambar	v				
	segitiga yang termasuk 30° – 60° – 90°. Jelaskan alasan					
	dari setiap pemilihan gambar!					





Data analysis is carried out through the stages of data reduction, data presentation, and conclusion drawing. At the data reduction stage, the researcher corrects the answers and then calculates the percentage for each strand. The results of the mathematical proficiency test are used as raw data that is transformed for subsequent interviews. The interview results are well-organized and simplified, then processed for use. At the data presentation stage, the test results, interviews, and analysis are presented in tables and descriptions. At the conclusion stage, the researcher draws conclusions from the data analysis. The research conclusions can be in the form of an analytical description of the data obtained during the research.

RESULT

Based on the data collection results from the mathematics problem test of 35 prospective teacher students, it was found that the indicator of mathematical proficiency most mastered by the prospective teacher students is adaptive reasoning. The results of the data processing for each indicator can be seen in the table below:

Mathematical proficiency	Total people	Percentage
Conceptual understanding	7	20%
Procedural fluency	8	22,8%
Strategic competence	6	17,1%
Adaptive reasoning	24	68,5%

Table 3.	Results of	Mathematical	Proficiency	Analysis
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For the description of each strand, it can be seen in the sample answer of one of the prospective teacher students.



Figure 1. Answer to question 1

2.	Ami boros air, Karena jika IX mandi setengah ember
	Ami monghabistan 251 air uniuk ix mandi, ahinggo utik 2x
	mondi Ami munghobolton so l oir, dim setiop hari Ago.
	1/4.50 = 12,5% Amil botos air, karons kita bisa monsulcipining
	hanys gel potheri, stallingter Ami menghabilitar 12,5 e oir
	utanik ik euci piting
	1/8-50 = 6,25 / Ami boros air, Farana hango ix nguper
	dia munghabistan air 6.25 l
	2x 50 = 100 l Ami boros air, uhr moncuci boju biso sampai
	lo d all solvinggo biss dibousear ami boros air, souri nya
	ami hos mencuci paraian z harl sebali agar baju hidat menumpat
	de lange marge worken eit.

Figure 2. Answer to question 2



Figure 3. Answer to question 3

Conceptual Understanding

Table 3 shows that there are 7 prospective teacher students who are able to master the Conceptual Understanding indicator with a percentage of 17.9%. Based on the analysis of the

answers to question 1, it shows that the prospective teacher students have not yet been able to understand the concept of trigonometry well. This is marked by the students' inability to determine the 30-60-90 angles from various sizes of right triangles.

The answer to question 3 shows that the prospective teacher students do not understand the concept of volume. The prospective teacher students made mistakes in using the volume formulas for a hemisphere and a cone. From the interview results, it was found that the they forgot the volume formula. In addition, they do not understand the concept of radius well, leading to errors in substituting the radius value.

Procedural Fluency

On the Procedural Fluency, there are 8 prospective teacher students who are able to master this strands. From the analysis of the answers, it is evident that the students have not yet developed the skills to use the procedures. This is shown in the answers of the prospective teacher students on question 3, where the prospective teacher students are unable to complete the solution steps. In addition, the prospective teacher students have not yet been able to choose and use effective problem-solving steps to solve the problems.

From the interview results, it was found that prospective teacher students are not yet able to choose and use effective problem-solving steps due to a lack of understanding of the presented problems, and therefore are not yet able to solve problems well.

Strategic Competence

On the Strategic competence, there are 8 prospective teacher students who are able to master this strands with a percentage of 17.1%. From the analysis of the answers, the prospective teacher students are already able to understand the problem.

However, they are not yet able to represent it in the form of mathematical symbols. In line with the interview results, students are not yet able to present problems in symbolic form; sometimes they are confused with the symbols used.

Adaptive Reasoning

Adaptive reasoning is the strands most mastered by prospective teacher students, at 68.5%. Prospective teacher students are already able to think logically about the problem given regarding water conservation recommendations. They can explain well and draw conclusions from the given statements. This is evident from their answers, as they can provide evidence for the truth of a statement by connecting concepts and situations given.

DISCUSSION

Mathematical proficiency is an important skill that prospective teachers must possess before entering the field as teachers. Research results show that the mathematical proficiency of prospective teacher students is still low, with 3 strands having percentages below 50%. These findings are also similar to the research results Altarawneh & Marei (2021). On the Conceptual Understanding, they have not yet been able to understand concepts and apply formulas well. Besides that, the inability to understand concepts is caused by mistakes in comprehending information in the questions (Elvi & Siregar, 2023). In terms of procedural fluency, they have not yet been able to choose and use effective problem-solving steps to address this issue due to their inability to understand the concept. In line with the research

Firdaus (2019), the procedural fluency of prospective teacher students has not met expectations.

According to Rittle-Johnson & Schneider (2015) conceptual understanding and procedural fluency have a bidirectional relationship. Someone with good conceptual understanding will have skills in problem-solving procedures, so mastering concepts is an effort that can be made to improve the low mathematical procedural fluency of students (Firdaus, 2019). The inability in this strands affects Strategic competence; the selection of inappropriate methods and steps in problem-solving makes students unable to present problems in various forms of representation. On the Adaptive reasoning, prospective teacher students are already able to think logically from the given problems, in addition, they are able to provide evidence of the truth of a statement by connecting between concepts and the given situations.

CONCLUSION

Based on the results and discussion, it is known that the mathematical proficiency of prospective teacher students is still low in terms of conceptual understanding, procedural fluency, and strategic competence. Meanwhile, adaptive reasoning is sufficiently mastered by the prospective teacher students, as more than half of them are able to master this indicator. In Conceptual understanding, they have not yet been able to grasp the concepts. In procedural fluency, they have not yet been able to choose and use effective problem-solving steps. In Strategic competence, the selection of methods and problem-solving steps is not appropriate. Adaptive reasoning, they are already able to think logically from a problem and provide evidence for the truth of a statement.

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