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Analysis of Student's Mathematical Problem Solving Abilities Based on Heuristic Strategy of Krulik and Rudnick Types

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Abstract

This research explores the multifaceted concept of translanguaging in the context of teaching English as a foreign language in three universities in North Sumatra. Translanguaging, a term encompassing various aspects of multilingualism, is examined as a pedagogical approach that utilizes multiple languages within a classroom setting. The study investigates translanguaging practices among lecturers and aims to address three key research questions: the types of translanguaging practices, perceptions of lecturers and students, and the motivations behind incorporating translanguaging in teaching and learning activities. The research method is a qualitative method with a case study approach model focusing on the exploration of a "bounded system" on one specific case or on some cases in detail by exploring data in depth. Through a combination of surveys and interviews with lecturers, the study identifies eight motivations for the intentional use of translanguaging practices. These motivations include adjusting to students' proficiency levels, clarification, and emphasis, translanguaging as an academic strategy, providing challenges for student growth, considering diverse student demographics, expressing firmness and solidarity, addressing real lexical needs in communication, and expressing group identity. The findings reveal positive responses to translanguaging from both lecturers and students, highlighting its versatility in meeting educational objectives and fostering effective communication in diverse learning environments. The motivations align with existing literature, emphasizing the adaptability and significance of translanguaging in enriching the teaching and learning experience. The study concludes with several insights into translanguaging practices in North Sumatra's universities and recommends possibilities for future research and practical implementation. The proposed recommendations include professional development for lecturers, curriculum design, student training, and calls for more studies in tranlanguaging. Overall, this research contributes to the understanding of translanguaging motivations and offers practical suggestions for enhancing its integration in higher education institutions.

Keywords: Lecturers' Perspectives, Students' Perception, Translanguage, Translanguaging Practices, Multilingualism teaching, Universities in North Sumatera

INTRODUCTION

The role of mathematics in the discipline of economics is inseparable from how students perceive mathematics itself. The perception of the difficulty of mathematics makes students not interested in economics mathematics lessons. In fact, mathematical strategies can make it easier to understand economics and analyze economic phenomena (Novita &; Gunawan, 2022). Mathematics is also a basic science that has an important role to achieve mathematics learning goals, so various mathematical abilities are needed, one of which is the ability to solve mathematical problems (Dina &; Siregar, 2022). The ability to solve mathematical problems has become very desirable in the 21st century because it is very functional in improving mathematical skills, but in reality this ability is still very low (Herman &; Fatimah, 2023). In fact, problem-solving ability is an important aspect of mathematical activities, where this ability can be practiced using heuristic strategies in learning (Rosyada &; Retnawati, 2021).

Heuristic strategies are defined as innovative learning approaches in which students develop self-reliance and self-direction. Heuristic strategies are generally a tool in problem solving where the steps to solve the problem are sequential and havevarious typess (Vongyai &; Noparit, 2019). Heuristics is a strategy that has rules in certain situations and is used as a problem-solving technique so that complex problems can be simpler and limit the number of possible answers so that they are easier to manage (H.C. LALZAWMLIANA, 2022). The application of heuristic strategies in learning can be seen from the steps for solving problems as explained by Polya (Rosyada &; Retnawati, 2021) that heuristic strategies in learning consist of four stages, namely: 1) wondering/reading the problem, 2) designing/exploring and selecting a strategy, 3) investigating/solving, and 4) discovering/looking back. While Krulik & Rudnick explain heuristic strategies in various typess including: 1) read and think, 2) explore and plan, 3) select a strategy, 4) find and answer, 5) reflect and extend. However, the way mathematics teaching and learning activities are presented to students can make them hate or like the lesson (Iwuanyanwu, 2021).

Several studies have been conducted on mathematical problem-solving abilities, such as students' problem-solving abilities in terms of self-efficacy (Gusti et al., 2023). Analysis of students' mathematical problem-solving abilities based on Krulik &; Rudnick's theory in terms of student creativity (Ardani &; Yulianti, 2022). Students' mathematical problem-solving ability with heuristic strategies is better than learning done without using heuristic strategies (Tambunan, 2020). Even heuristic strategies are used as a guidance strategy in training and mentoring mathematical olympiads (Taufik &; Susanti, 2023).

The difference between the research conducted and the pre-existing research lies in the types of heuristic strategy types of Krulik & Rudnick and the review of students' mathematical problem-solving abilities based on gender, as well as mathematics majors and scores at the education level before entering college.

This research was conducted because there are still many students who do not solve mathematical problems given systematically in accordance with problem solving through Krulik & Rudnick types heuristic strategies that have been carried out in learning. One example is the application of linear functions in economics. Even though the lecturer has explained the heuristic strategy of the Krulik & Rudnick types in solving mathematical problems faced by students clearly through the help of textbooks, even the lecturer clarifies back to students before solving a problem given via whatsapp group (WAG) class. However, there are still many students who do not solve problems systematically for various reasons, such as still not understanding the given problem in terms of using symbols to write down what is known and asked on the problem and do not even know which mathematical formula should be used in solving the problem. There are also students who solve questions by answering directly without writing down what is known and asked from the questions given. Problems regarding mathematical problem solving skills are also categorized as still low and the teaching materials used cannot be studied independently (Pramuditya et al., 2022).

Based on the description above, further research is needed related to the analysis of students' mathematical problem-solving abilities related to indicators that are met and not fulfilled based on the Krulik & Rudnick types heuristic strategy in terms of gender, majors and mathematics scores at the previous education level, as well as the reasons that underlie students not solving problems systematically. So it can be categorized how many students have

mathematical problem solving skills based on high, medium, and low Krulik & Rudnick heuristic strategies in terms of gender, major, and math scores at the previous education level.

RESEARCH METHODS

The research method used is a qualitative research method with a descriptive approach. This research was carried out at the Jam'iyah Mahmudiyah Islamic College Tanjung Pura for the academic year 2022/2023. Participants in this study were students majoring in Islamic banking semester 1 (one) totaling 20 students who were included in the category came from different majors and had good and excellent mathematics scores at the previous level of education. The data collection techniques used in this study were documentation, tests and interviews. Research procedures include filling in student data through g-form, determining test indicators, developing test instruments, developing interview guidelines, determining subjects, administering tests, data collection and interviews. Research instruments in the form of student data output, learning outcomes tests of mathematical problem solving skills, and guided interviews. This research data was collected through google form to find out students' majors and mathematics scores at the previous education level, learning outcomes tests, and interviews with 2 high category students, 2 medium category students, and 4 low category students. Then data analysis is carried out during data collection in the field and after all data is collected with interactive model analysis techniques through stages 1) data reduction; 2) presentation of data; 3) inference and verification; and 4) final conclusions (Sujarweni, 2019).

RESULT AND DISCUSSION

Research Results

Based on research that has been conducted on the first semester students of the shari'ah banking study program, Jam'iyah Mahmudiyah Islamic College, Tanjung Pura, Langkat Regency for the academic year 2022/2023, the following research results were obtained:

Table 1. Participant Categories by Gender

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Man	4	20,0	20,0	20,0
	Woman	16	80,0	80,0	100,0
	Total	20	100,0	100,0	

Table 1 above shows the frequency of participants in terms of gender, namely the frequency of men as many as 4 people or 20% and the frequency of women as many as 16 people or 80%.

Table 2. Participant Categories Reviewed from the Last Education Origin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	MA	6	30,0	30,0	30,0

	SMA	9	45,0	45,0	75,0
	SMK	5	25,0	25,0	100,0
	Total	20	100,0	100,0	

Table 2 above shows the frequency of participants in terms of the origin of the last education, namely the frequency of MA (Madrasah Aliyah) as many as 6 people or 30%, the frequency of SMA (High School) as many as 9 people or 45%, and the frequency of SMK (Vocational High School) as many as 5 people or 25%.

Table 3. Participant Categories Reviewed from the Last Education Department

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	IPA	9	45,0	45,0	45,0
	IPS	5	25,0	25,0	70,0
	Religion	1	5,0	5,0	75,0
	Vocational	5	25,0	25,0	100,0
	Total	20	100,0	100,0	

Table 3 above shows the frequency of participants in terms of the last education major, namely the frequency of science (natural sciences) as many as 9 people or 45%, the frequency of social studies (social sciences) as many as 5 people or 25%, the frequency of religion is only 1 person or 5%, and the frequency of vocational is 5 people or 25%.

Then the results of research related to the mathematical problem solving ability of students based on heuristic strategies of the Krulick & Rudnick types in terms of gender obtained the following results:

Table 4. Categories of Results of Student Mathematical Problem Solving Ability in Gender

Category	**Gender**	
	Man	**Woman**
High	0	5
Medium	1	3
Low	3	8
Sum	**4**	**16**

Table 4 above shows the results of the category of mathematical problem solving ability of students based on heuristic strategies of the Krulik & Rudnick types in terms of gender. The ability categories are divided into 3, namely high, medium, and low with details of the high category obtained by 5 female students or 25%, the medium category obtained by 1 student and 3 female students or 20%, and the low category obtained by 3 students and 8 female students or 55%. This can be seen from the indicators that are met and not fulfilled in solving mathematical problems in the mathematics economics course, the material for the application of functions in the economic field.

Furthermore, the category of mathematical problem solving ability of students based on heuristic strategies of the Krulik & Rudnick types in terms of majors at the previous education level can be seen in the table below:

Table 5. Categories of Mathematical Problem Solving Abilities Based on KR Types Heuristic Strategies Reviewed from Majors at the Previous Education Level

Category	**Department**			
	IPA	IPS	Religion	Vocational
High	3	1	0	1
Medium	2	1	0	1
Low	**4**	**3**	**1**	**3**
Sum	**9**	**5**	**1**	**5**

Table 5 above shows the category of mathematical problem solving ability of students based on heuristic strategies of the Krulik & Rudnick types in terms of majors at the previous level of education with high category results obtained by students majoring in science as many as 3 people, social studies and vocational 1 person each. The medium category is also obtained by students majoring in science as many as 2 people, social studies and vocational 1 person each, and the low category is obtained by students majoring in science as many as 4 people, social studies and vocational 3 people, and religion only 1 person. Based on table 5 above, it also shows the science department as the most majors occupying each high, medium, and low category with 9 people or 45%, the rest are occupied by social studies and vocational majors of 5 people each or 25%, and religion majors are only 1 person or 5%.

Then the category of mathematical problem solving ability of students based on heuristic strategies of the Krulik & Rudnick types is reviewed from the value of mathematics at the previous level of education. The mathematical value is obtained from the value of the diploma at the previous level of education with the following details:

Table 6. Descriptive statistics of mathematical scores at previous levels of education

	N	Minimum	Maximum	Mean	Std. Deviation
High School Math Scores	20	75,00	94,00	84,0090	4,68871
Valid N (listwise)	20				

Table 6 above describes the mathematics scores of 20 students at the previous level of education with a minimum score of 75 and a maximum score of 94, with an average score of 84. The description of such mathematical values can be illustrated in the following graph:

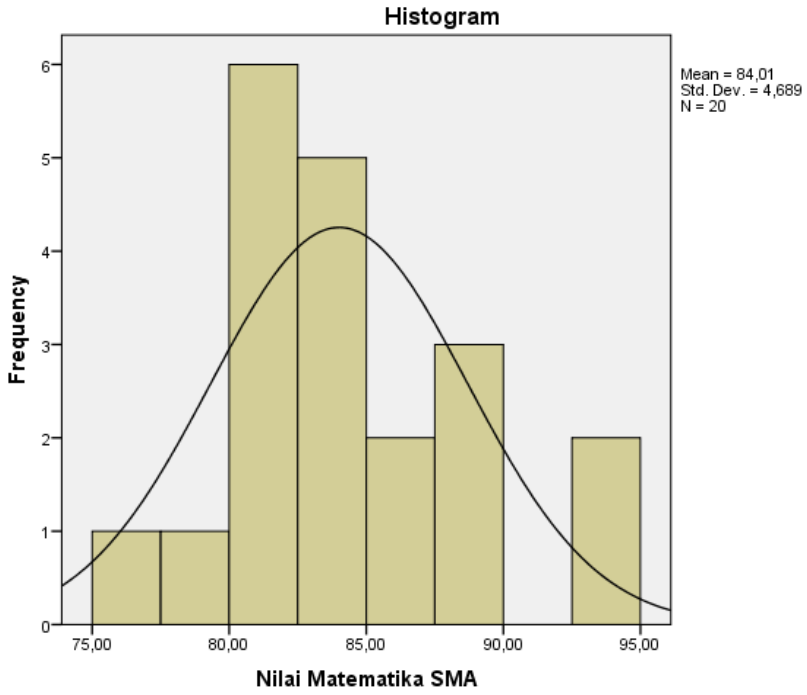

Figure 1. Participant's Mathematical Scores at Previous Levels of Education

Furthermore, the results of students' mathematical problem solving abilities based on heuristic strategies of Krulik & Rudnick types in terms of mathematics scores at the previous education level can be categorized in the table below:

Table 7. Category of Mathematical Problem Solving Ability Based on Heuristic Strategy of KR Types Judging from Mathematics Scores at the Previous Education Level

Category	**Math Scores**		
	Very Good (80 – 100)	Good (60 – 79)	Medium/Sufficient < 60
High	5	0	0
Medium	4	0	0
Low	9	2	0
Sum	**18**	**2**	**0**

Table 7 above shows the category of mathematical problem solving ability of students based on heuristic strategies of the Krulik &Rudnick types in terms of mathematical scores at the previous level of education. There were 18 students or 90% whose mathematics scores at the previous education level were very good with a range of grades between 80 to 100, and the remaining 2 students or 10% whose mathematics scores at the previous education level were good with a range of grades between 60 to 79.

Discussion

Participants by gender in this study consisted of 4 men and 16 women. Based on the category of results of students' mathematical problem solving abilities in terms of gender, the high category is dominated by female participants (female students) as many as 5 people, while male participants (students) who only number 4 people are in the medium and low categories. This is because students in solving economic problems do not write down the steps of solving problems based on heuristic strategies, especially in the first step, namely read and think or read and think by writing down what is known from the given problem. Likewise, in the fifth step, namely reflect and extend or review the answers that have been given by writing a conclusion sentence on the answers that have been obtained based on the economic mathematics problems given. But not much different, female students also do the same thing done by students in solving given economic mathematics problems. This is also in accordance with research findings which revealed that no significant differences were found in relation to gender and mathematical problem-solving abilities of learners (Dawngliani, MS and Ralte, Lalruatfeli and Fanai, 2019).

While the category of mathematical problem solving ability of students based on heuristic strategies of the Krulik & Rudnick types in terms of majors and mathematics scores at the previous education level showed the results of 5 female students included in the high category with details of 3 female students from the science department, 1 female student from the social studies department, and 1 female student from the vocational department with mathematics scores at the previous education level classified as very good. This shows that mathematics scores at the previous level of education provide an overview of the results of the appropriate mathematical problem-solving ability of female students. The 5 female students solved the given economic math problems correctly and systematically, fulfilling the steps of working on heuristic strategy of the Krulik & Rudnick types. Based on the results of the interview, the high-category students stated that they solved the problems given according to what the lecturer taught when explaining the material. The lecturer also stated that the 5 female students when participating in learning always ask questions if there are discussions that are not understood, even the lecturer always reminds students to actively ask if there is explanatory material that is not understood, so that the lecturer can re-explain until students can understand well.

Then, the mathematical problem solving ability of students in the medium category amounted to 4 people with a distribution of 1 student and 1 female student from the science department, 1 female student from the social studies department, and 1 female student from the vocational department with excellent mathematics scores at the previous education level. However, when solving economic mathematical problems, it was found that there were steps that were not systematic or incompatible with the steps of solving based on heuristic strategies of the Krulik & Rudnick types. Students only wrote down four of the five steps. The step that is not written is the fifth step, namely reflect and extend or review the solution to the problem that has been given in the form of a conclusion sentence to the results of the answers obtained. Participants who belong to the medium category are students who are active in learning, it's just that they are not careful or even forget to write down the fifth step. This is in accordance with the results of the interview that they forgot to write the fifth step because they were not used to writing conclusion sentences and did not even know what the conclusion sentence should be made. Even though the lecturer has explained the steps for solving problems based on heuristic

strategy of the Krulik &Rudnick types, it's just that students are not careful or even forget to write it down.

Furthermore, students who are included in the low category are 11 people with details of 3 students and 8 female students from science, social studies, religion, and vocational majors with mathematics scores classified as very good and good at the previous education level. Students who belong to this low category solve economic math problems do not meet the steps of solving based on heuristic strategies of the Krulik & Rudnick types. This can be seen when solving the problem students only write the third, fourth and fifth steps, namely select a strategy or choose a solving strategy using a mathematical formula that is in accordance with the given problem, find and answer or find and answer the problem according to the mathematical formula that has been determined in the previous step, and reflect and extend or review the answers that have been given by writing a conclusion sentence. However, there are also students in the low category who do not write the fifth step, only enough in the third and fourth steps. After further interviews, students in the low category had difficulty understanding the problems in the given economic math problems so they did not write down what was known and asked. So that it directly solves the economic mathematics problem given by writing down the answer directly without writing down what is known and asked.

CONCLUSION

Based on the description above, it was obtained that the results of students' mathematical problem solving abilities based on heuristic strategies of Krulik & Rudnick types in terms of gender, majors and mathematics scores at the previous education level were divided into three categories, namely the high category obtained by 5 female students (3 female students majoring in science, 1 female student majoring in social studies, and 1 female student majoring in vocational) with mathematics scores obtained at the previous education level classified as Very good with a range of values between 80 to 100. The category is being obtained by 1 student majoring in science and 3 female students (1 female student majoring in science, 1 female student majoring in social studies, and 1 female student majoring in vocational) with mathematics scores obtained at the previous education level classified as very good with a range of scores between 80 to 100. While the low category was obtained by 3 students (1 student majoring in social studies, 1 student majoring in Religion, and 1 student majoring in vocational and 8 female students (4 female students majoring in science, 2 students majoring in social studies, and 2 female students majoring in vocational) with mathematics scores obtained at the previous education level classified as very good with a range of values of 80 to 100 and classified as good with a range of values of 60 to 79.

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