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SCIENTIFIC REASONING ABILITY OF CLASS XI STUDENTS OF SMA NEGERI 1 SINDUE TOMBUSABORA ON DYNAMIC FLUID MATTER

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Abstract :
The purpose of this research is to determine the scientific reasoning abilities of students of state high school 1Sindue Tombusabora on dynamic fluid material. This type of research is qualitative research. The research respondents were 15 students out of 20 class XI Mathematics and Science 2 students at state high school 1 Sindue Tombusabora for the 2022/2023 academic year. The technique for taking respondents in this study used a purposive sampling area. The results of this study indicate that students' scientific reasoning on dynamic fluid material is still relatively low. This is evidenced by the category that students get the most in each scientific reasoning. In the pattern of correlation reasoning, students are in the No relationship (NR) category where most students are at (level 2) of the maximum (level 4) which means that students' correlation reasoning abilities to connect two problems or causation are still low. Then in the proportional reasoning pattern, most students are in the TM (no answer) category, where students do not answer questions, which means students empty answers (level 0). This means that the ability of students to provide answers to problems involving comparisons is still low.

Keywords: Abilities of Students, Fluid Dynamics, Student Scientific Reasoning

INTRODUCTION

Scientific reasoning is a very important aspect in the success of the problem solving process (Karuku, 2023; Romiyati et al., 2023). Students can use their argumentation skills or reasoning skills in answering problems well, tend to have a good understanding of the concepts of the material being studied so that if they are involved in a problem, they will make the right answer decision. Reasoning skills are important skills in learning, but the results of several studies show that students' reasoning skills are still in the unsatisfactory category (Supeno et al., 2017; Jama, 2023; Misastri et al., 2023).

The scientific reasoning ability of students is still relatively low. This is shown by the scientific thinking ability test. Overall the average score obtained by students is 50.28. While the average acquisition in the inquiry aspect is 47.72, the analysis aspect has an average score of 48.8, in the

inference aspect has an average score of 51.42, the argumentation aspect has an average score of 60.7 (Dermawan et al., 2018; Maria et al., 2023).

Students' scientific reasoning skills are still relatively low. This is shown in the scientific reasoning ability of students on the indicators of proportional reasoning 47.96%, correlation reasoning 66.33%, conservation reasoning 21.43%, probaliliti reasoning 24.43% (Nuraini et al., 2018; Suryonegoro & Hidayah, 2023; Karina et al., 2024), students' scientific reasoning ability is still low (Faiqoh et al., 2020; Novitasari et al., 2024; Musdahlipah et al., 2024). This is shown in the lack of scientific reasoning ability in the pattern of correlation reasoning presentation value of 20.53%.

The scientific reasoning ability of students is still relatively low, especially in the aspect of drawing conclusions inductively, the aspect of giving reasons, and the aspect of developing concepts (Himawan et al., 2020; Aningrum et al., 2024). Based on several studies that have been mentioned regarding scientific reasoning ability, that students' scientific reasoning ability is still very low. In this study, researchers examined the scientific reasoning ability of high school students, with correlation reasoning patterns and proportional reasoning patterns. Correlation reasoning pattern is the ability of students' reasoning to connect specific events or observations consisting of conjectures and proportional reasoning pattern is the ability of students to provide answers that involve comparison (Rimadani et al., 2017; Ridwan et al.,2024). From the results of preliminary observations conducted by researchers at State Senior High School 1 Sindue Tombusabora, researchers interviewed physics teachers. According to the teacher, in learning physics students are still partially able to solve problems correctly, especially in dynamic fluid material. This is because there are still many students who are not good at scientific reasoning so that in solving the problem is still not right. scientific reasoning ability is a provision for students to provide reasons for opinions, actions to draw conclusions, make decisions, and use appropriate language, in explaining every thought of reason or fact (Wagenif, 2002; Wulansari et al., 2023; Perdana et al., 2023).

According to the advantage of students' scientific reasoning ability is that students are able to explain a concept well, students are able to make an argument to help students develop a strong understanding of knowledge (Han, 2013). To find out the scientific reasoning ability of students, research needs to be done. This is because if the scientific reasoning ability of students is known, it needs to be followed up. Scientific reasoning ability is important to know because it represents a collection of skills and abilities needed to solve problems in the process of science investigation (Zohar and Nemet, 2002; Rahmawati et al., 2023; Pamungkas et al., 2023).

This study offers novelty in exploring students' scientific reasoning ability in the context of specific fluid dynamics material. Most previous studies have focused more on basic physics material or more general concepts, while this study explores in depth how students apply scientific reasoning in understanding complex fluid dynamics phenomena. By focusing on state senior high school 1 Sindue Tombusabora, this study also provides new insights into students' challenges and strengths in a local context that may differ from other areas. The findings of this study are expected to provide new insights for designing more effective educational interventions in improving students' scientific reasoning ability, especially in materials that require in-depth understanding and application of advanced physics concepts.

RESEARCH METHOD

Type of Research

The type of research used in this research is qualitative research. Qualitative research is intended to describe and describe existing phenomena, both natural and human-made, which pay more attention to the characteristics, quality and interrelationships between activities (Syaodih, 2011; Sari & Mwakifuna, 2023; Setiyani et al., 2023). This research is qualitative research, aims to explain a phenomenon in depth and is done by collecting data as deeply as possible.

Research Subject

This research was conducted at state senior high school 1 Sindue Tombusabora, 2022/2023 school year. The subjects in this study were students of class XI mathematics and science 2 totalling 20 people. In this study, 15 respondents were selected. The technique of taking respondents in this study

using purposive sampling area, by grouping students' answers according to the type of reasoning adapted to the patterns of reasoning.

Data Collection Technique

By giving essay tests on scientific reasoning and conducted with interviews conducted to clarify the answers to the tests given (Yohanie et al., 2023; Wardani et al., 2023; Tulyani, 2024). At the stage of reducing data, researchers used a scientific reasoning rubric based on the assessment category of two scientific reasoning patterns. The outline of the interview instrument used in this study can be seen in the following table:

Table 1. Interview Grid

No.	Grid
1.	Connecting the plane taking off with Bernoulli's law
2.	The relationship between the continuity principle and the rate of water flow when one end of the hose is pressed
3.	Comparing the speed of v1 and v2
4.	Pressure difference in the two pipes

Data Analysis Techniques

The stages of data analysis activities in this study followed the qualitative data analysis of Miles and Huberman (Sugiono, 2017; Ningsih, 2024; Fauziyah et al., 2023). Data reduction is carried out by reducing the data obtained from student answers. The data reduction process begins by analysing the data, classifying the data into each problem through description, discarding statements that are not related to the purpose and direction of the research, and organising the data to get data that becomes a reference in drawing conclusions.

Data presentation is an arranged set of information that gives the possibility of drawing data conclusions taking action. The next step is to present the data results, scientific reasoning tests and interviews in the form of transcripts and interviews. The transcripts in question are presented in narrative form which shows the ability of the concept. So that it makes it easier for researchers to draw conclusions.

Vertification is part of an activity from a complete configuration so that it can answer research questions and research objectives. Vertification is the final step carried out by comparing the results of student work and interview results so that conclusions can be drawn about the location and causes of errors. Vertification of the data can be presented in the form of a short and clear sentence statement. The percentage formula for calculating scientific reasoning (Arikunto, 2003):

$$P = \frac{f}{n} \times 100\%$$

Description:

P : Percentage value of student answers

F : Frequency of student answers

n : Number of students

Table 2. Verification category interval

Presentase	Category
81% - 100%	Very good
61% - 80%	Good
41% - 60%	Fair
21% - 40%	Not good
0% - 20%	Not very good

RESULTS AND DISCUSSION

The results discussed are based on the objectives of this study, namely to determine the scientific reasoning ability of public senior high school 1 Sindue Tombusabora students on dynamic fluid material. In the study, a 4-number scientific reasoning essay test was given with dynamic fluid material on each item which is an item with different reasoning patterns.

The scientific reasoning patterns used in this study are correlation reasoning patterns used in item numbers 1 and 2 and proportional reasoning patterns used in items 3 and 4 given to class XI mathematics and science 2 students totalling 20 people and then from the 20 students grouped in each category in the correlation reasoning pattern and proportional reasoning pattern. Then interviews were conducted on representatives of each level in each category to clarify the answers to the tests given. In the results of this scientific reasoning essay test, the results of each category of scientific reasoning were obtained as shown in Table 3 below.

Table 3. Correlated reasoning pattern test results

No Item	Reasoning pattern				Number of students
	TM	*NR*	*OC*	*C*	
1	8	7	2	3	20
2	-	10	4	6	20

TM = Not answered, *I = Intuitive, NR = No relationship, OC = One cell,C = Correlation.*

Table 4. Propositional reasoning pattern results

No Item	Reasoning pattern				Number of students
	TM	*I*	*TR*	*R*	
3	9	4	3	4	20
4	13	5	-	2	20

TM = Not answered, *I = Intuitive, A = Aditive, TR = Transitional, R = Ratio*

Based on these categories, students representing each category in each scientific reasoning pattern were selected and willing to be interviewed. The data of students interviewed are presented in the form of Table 4.3.

Table 5. Student data based on category

Pattern of reasoning	No Item	Code of respondent	category
Correlational reasoning	1	R-1	TM
		R-3	*NR*
		R-5	*OC*
		R-7	*C*
	2	R-2	*NR*
		R-4	*OC*
		R-6	*C*
Proportional reasoning	3	R-9	TM
		R-11	*I*
		R-13	*TR*
		R-14	*R*
	4	R-8	TM
		R-10	*I*
		R-12	*R*

Table 6. Percentage of Scientific Reasoning Test Results

Pattern of reasoning	No Item	category	Percentage
	1	TM	40%

		I	0
Correlation reasoning pattern		NR	35%
		OC	10%
		C	15%
		TM	0
	2	I	0
		NR	50%
		OC	20%
		C	30%
		TM	45%
Proportional reasoning pattern	3	I	20%
		A	0
		TR	15%
		R	20%
		TM	65%
	4	I	25%
		A	0
		TR	0
		R	10%

Based on the results of the research that has been done, the results obtained in the first item are questions connecting the aircraft taking off with bernoulli's law. Based on the correlation reasoning question, most students are still in the TM (No answer) category as much as 40%. This is due to the lack of students‘ correlation reasoning skills so that students cannot relate the aircraft taking off with Bernoulli's law. correlation reasoning is the ability of students’ reasoning to connect specific events or observations consisting of conjectures (Rimadani et all., 2017; Anggraeni et al., 2023). Only 15% of students are in category C (Correlation) where students provide appropriate reasons and explanations for all problems by explaining their relationship.

The second item is a question about the relationship of the principle of continuity on the occurrence of water flow rate when one end of the hose is pressed. Where the question is a correlation reasoning pattern question. Based on the correlation reasoning question, most students are still in the NR (No relationship) category as much as 50%. Students in this category are still weak in connecting the cause and effect of the problem. Due to the lack of development of students' scientific reasoning skills in learning so that they have a lack of understanding of the issues raised in the problem.

Scientific reasoning skills that help the younger generation face real-world problems for real thinking and reasoning (Lai & Viering, 2012; Maymunah et al., 2023; Essenzi, 2024). Only 30% of students are in category C (Correlation) where students provide appropriate reasons and explanations for all problems by explaining their interrelationships.

The third item is a question comparing the speed of v1 and v2, and the fourth item is a question of the difference in pressure in the two pipes, where the question is a proportional reasoning pattern question. From these questions, it was found that most students were still in the TM (No answer) category as much as 45% in question number 3, and as much as 65% in question number 4. This is because in physics learning, students are not given practice questions about comparison so that students' proportional reasoning skills are very lacking. According to Rimandani et all. (2017) that proportional reasoning ability is the ability of students to provide answers that involve comparison. Only 20% in question number 3 and as many as 65% in question number 4 students are in the R (Ratio) category where students can apply arguments and determine values appropriately.

From the overall research of scientific reasoning ability of State Senior High School 1Sindue Tombusabora students, it can be concluded that the level of scientific reasoning ability of students is still relatively low. This is because only 15% of students are in the correlation category of the first question, 20% in the second, and in proportional reasoning only 20% in the third question, 10% in the fourth question. This is in accordance with the results of research conducted by Rimadani (2017) that students' scientific reasoning skills are still classified as low in the category in each scientific reasoning pattern used in the question items. The results show that students' reasoning skills in correlational

reasoning are mostly in the NR (No Relationship) category by 44.3%, in proportional reasoning most students are in the AD (Additive) category by 24.7% and in probabilistic reasoning most students are in the AP (Approximate) category by 62.8%. Based on the results of research by Putri Okta Wardani, Supeno, Subiki (2018). Her research entitled 'identification of scientific reasoning abilities of vocational high school students about electrical circuits in physics learning' concluded that students' scientific reasoning in simple electrical circuit material is still relatively low. This is evidenced by the category that most students get in each pattern of scientific reasoning. Based on previous research, researchers can conclude that the results of this research fund previous research have the same results that the ability to reason students is still low.

Previous research conducted by Anggraeni, (2018) regarding scientific reasoning abilities. There are significant differences between the current study and previous studies. The current study focuses on the scientific reasoning ability of high school students in the context of fluid dynamics material, which is more specific and contextual at the secondary education level. Meanwhile, previous studies examined the scientific reasoning ability of students in engineering chemistry courses, which cover higher education levels with more complex and applicable materials. These differences indicate a gap in the understanding and application of scientific reasoning concepts between different education levels, as well as the need to explore how these concepts are translated and taught at different education levels to improve scientific understanding as a whole.

This study offers novelty by examining high school students' scientific reasoning skills in the context of specific fluid dynamics material. While many previous studies have focused on scientific reasoning skills at the tertiary level or on more general topics, this study provides new insights into how high school students develop and apply their scientific reasoning skills in understanding complex physics concepts. In addition, this study contributes to the understanding of how contextual and curricular factors influence students' mastery of the material, as well as providing relevant empirical data for the development of more effective teaching strategies at the secondary level.

This study has important implications for curriculum development and teaching strategies at the secondary education level. The findings of this study can provide insight into how well students understand and apply scientific reasoning principles in the context of fluid dynamics, as well as identify areas where students may experience difficulties. The results of this study can be used to design more effective interventions, such as the development of more appropriate teaching materials or innovative learning methods, to improve students' scientific reasoning abilities. In addition, this study can help teachers formulate more appropriate approaches to teaching complex scientific concepts, thereby improving the quality of education and students' readiness for future academic and professional challenges.

CONCLUSION

Based on the explanation of the results and discussion that has been described by the researcher, it can be concluded that students' scientific reasoning on dynamic fluid material is still relatively low. This is evidenced by the category that most students get in each scientific reasoning. In the correlation reasoning pattern, students are categorised as No relationship (NR) where most students are at (level 2) from the maximum (level 4) which means that students' correlation reasoning ability to connect two problems or cause and effect is still low. Then in the proportional reasoning pattern, most students are categorised as TM (no answer), where students do not answer the question which means students leave the answer blank (level 0). This means that students' ability to provide answers to problems involving comparison is still low.

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