Identification of Students' Mastery Level of Physics Concepts in Static Fluid Material

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Abstract *- This study aims to identify the level of mastery of physics concepts on static fluid material. This research uses quantitative descriptive methods. The research subjects consisted of 23 MA students in Malang. The test instrument used was a four-point description question. The data collection process was carried out by distributing questions to students who were done for 60 minutes. The results showed that students' mastery of the concept of static fluid was in a very low category. The ability to remember (C1) students scored 51.1%, while the ability to understand (C2) reached 42.4%. The ability to apply (C3) was only 31.5%, and the ability to analyse (C4) reached 32.6%. The low mastery of this concept has an impact on the completion of tasks related to static fluid. Students experience various difficulties, such as assuming that the difference in hydrostatic pressure in a container depends on the shape of the container. Students also have difficulty in solving problems mathematically and assume that the longer the rope of the hanging object, the greater the buoyant force will be. Thus, the difference in buoyant force on an object suspended from a rope is considered to depend on the length of the rope. These findings emphasize the need to improve physics learning in the future, especially in improving the strengthening of the ability to master the concept of static fluid material.*

Keywords: *Physics Concept Mastery; Static Fluid Material.*

INTRODUCTION

Physics is one of the most important subjects for students to learn. Physics is based on the emphasis on mastery of concepts and application of knowledge through the process of discovery and mathematical presentation of data based on certain rules (Annisa, 2023). 21'st century skills require skills, one of which is concept mastery. In recent years, concept mastery has become the most important aspect compared to others (Sofna et al., 2024), (Yuliati et al., 2021).

In physics, the concepts tend to be abstract so that it is difficult to understand well. One of the physics materials that is in accordance with these characteristics is static fluid (Kurniawan et al., 2021), (Estianinur et al., 2020). The main topics in static fluid include several subtopics, consisting of hydrostatic pressure, Pascal's law, and Archimedes' principle. Static fluid material includes concepts that are often applied in everyday life (Irma et al., 2020), (Saputra et al., 2024). Therefore, it is very important to have good and correct concept mastery (Harizah et al., 2019). This has an effect on increasing students' curiosity and openness to new ideas.

Physics is not only limited to memorizing formulas and theories, but also includes various concepts that need to be understood deeply (Taufik & Sahidu, 2022). Concept mastery in physics is a major factor in determining the success of physics learning (Putri et al., 2024). Therefore, in the learning process at school, students need accurate concept mastery in every material taught.

Concept mastery is important that is inherent in students. The success of physics learning is highly dependent on students' concept mastery skills (Rais et al., 2020). Concept mastery provides a basis for students to adjust to various situations in everyday life (Azizah et al., 2020). Concept mastery refers to deep mastery and not just memorising information (K.A. Astiti et al., 2023). Thus, it requires the discovery of abstract ideas that make it possible to classify objects (Shidik, 2020).

Through the identification of concept mastery, students can know the level of mastery of the concept of static fluid material. In addition, areas that require more attention in the learning process can be identified. Identification of concept mastery in students can also help teachers to adjust teaching methods and presentation of material so that it is more in line with the needs and mastery level of students. Based on the explanation above, further identification needs to be done in order to test students' concept mastery. The purpose of this study is to identify the level of mastery of student concepts in static fluid.

Research on the identification of MA students' mastery of physics concepts in static fluid material has been carried out several times, but is still limited to the scope of the subtopics analyzed. Research (Hanidar et al., 2022) only focuses on student misconceptions related to hydrostatic pressure, while (Ajiij & Supriyatna, 2024)) research examines the mastery of the concept of static fluid only includes Archimedes' principle. In addition, the research conducted by (Sigi, 2022), took place during a pandemic, so it experienced problems in selecting respondents and was carried out randomly based on student availability. Therefore, this study aims to identify more comprehensively the misconceptions of MA students on the subtopic of static fluid which includes hydrostatic pressure, Pascal's law, and Archimedes' principle.

RESEARCH METHODS

This research uses a quantitative descriptive method. The research was conducted by giving open questions on static fluid material. The research subjects consisted of 23 MA students in one of the cities of Malang. The test instrument was in the form of 4 description questions. The data collection process was carried out by distributing questions to 23 students who were done for 60 minutes. Furthermore, the test results were analysed by referring to the Bloom's taxonomy concept mastery scoring rubric. Details of the description of indicators in Table 1.

Table 1. Scoring of Concept Mastery Indicators C1-C4

Indicator	Description	Score
Remembering (C1)	No Answer	0
	Recalled a concept less precisely	1
	Recalled a concept slightly correctly	2
	Recalls a concept correctly but incompletely	3
	Recalling a concept correctly and completely	4
Understanding (C2)	No answer	0
	Understands the concept less precisely	1
	Understands the concept slightly correctly	2
	Understand the concept precisely but incompletely	3
	Understanding the concept correctly and completely	4
Apply (C3)	No answer	0
	Apply the concept in solving the problem inaccurately	1
	Applying the concept in solving the problem is slightly correct	2
	Applying the concept in solving the problem is correct but incomplete	3
	Applying the concept in solving the problem is precise and complete	4
Analyse (C4)	No answer	0
	Analysing problem solving according to the concept is less precise	1
	Analysing problem solving in accordance with the concept is slightly correct	2

Indicator	Description	Score
	Analysing problem solving according to the right concept but incomplete	3
	Analysing problem solving according to the right concept and complete	4

The scores were converted into a percentage score calculated by equation 1 as follows:

$$Percentage\ Value = \frac{gain\ score}{maximum\ score} x100\% \ (1)$$

The criteria obtained from the percentage score of students' concept mastery of static fluid material are qualified based on the following Table 2.

Table 2. Interpretation of Concept Mastery Categories

Category	Interpretation
81,25 < X < 100	Very High
71,50 < X < 81,25	High
62,50 < X < 71,50	Medium
43,75 < X < 62,50	Low
0 < X < 43, 75	Very Low

The test instruments used were first tested for validity and reliability. The validity test of the test instrument is calculated through SPSS software with Pearson Correlation questions are said to be valid if the significance value < 0.05 (Arikunto, 2013). The trial was conducted on 50 students, with the results showing that as many as 4 questions of concept mastery had a P value < 0.05 which means valid. The results of the empirical validity test of concept mastery questions are shown in Table 3.

Table 3. Empirical Validity Test Results of Concept Mastery

Question Code	Sig.Person Correlation	Significance Tolerance	Description
C1	0,00		Valid
C2	0,03	0,05	Valid
C3	0,00		Valid
C4	0,00		Valid

Furthermore, the reliability test of the question instrument was analyzed using Cronbach alpha. If the Cronbach alpha value > 0.6 means that the question being tested is reliable, and the Cronbach alpha value < 0.6 means that the question being tested is not reliable (Arikunto, 2013). Based on the Cronbach alpha value of 0.86, the Croncbach alpha value > 0.06. So that the decision making in the reliability test for concept mastery is reliable.

Table 4. Reliability Score of Concept Mastery Measurement Instrument

Reliability Statistics

	Cronbach's Alpha	N of Items
Concept Mastery	.86	5

RESULT AND DISCUSSION

Results

This research produces values of concept mastery ability on static fluid material. These values were obtained from the results of the students' concept mastery test completion, which are detailed in Table 5.

Table 5. Descriptive Statistics of Students' Concept Mastery Ability

Statistical Element	Score
Total	23
Mean	39,40
Maximum	47,00
Minimum	29,00
Standard Deviation	8,46

Table 5 shows that the average score of students' concept mastery score is 39.40. Based on table 2, students' concept mastery is at a very low category level. More specific details about the achievement of C1-C4 concept mastery indicators are shown in Figure 1.

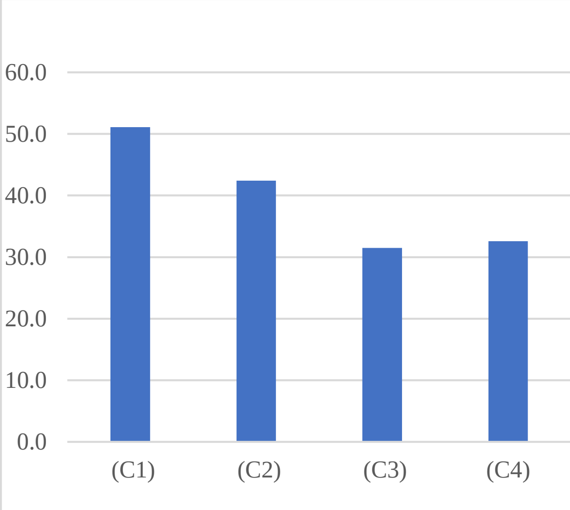
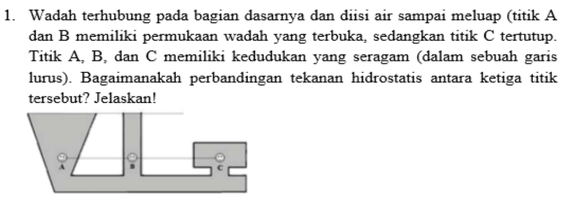
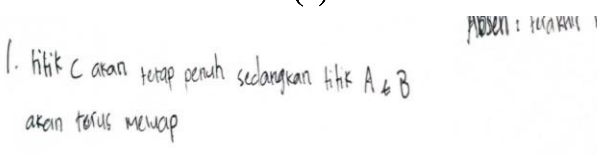


Figure 1. Graph of Student Concept Mastery Indicators

Details of the concept mastery indicators of ability (remembering (C1), showing that students obtained a score of 51.1%, while the ability to understand (C2) obtained 42.4%, then the ability to apply (C3) obtained 31.5% and the ability to analyse (C4) obtained 32.6%. A more detailed explanation is based on the students' answers as follows.



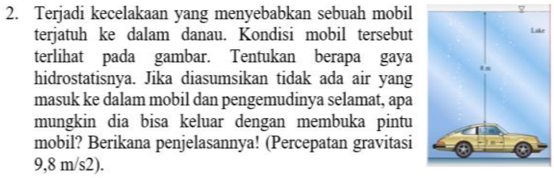
(a)



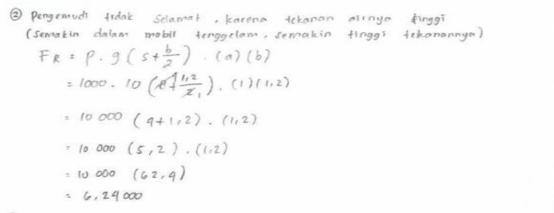
(b)

Figure 2. (a) Question 1 (b) Student Answer

Students can remember the concept of the material by describing how hydrostatic pressure is at the three points. However, students' ability to analyze the comparison of the three hydrostatic pressures is still relatively low.



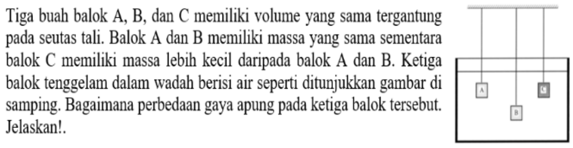
(a)



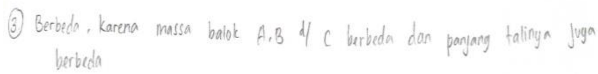
(b)

Figure 3. (a) Question 2 (b) Student Answer

Students can remember the concept of the material by describing how hydrostatic pressure is when the car sinks. However, students' ability to determine the amount of static fluid force is still relatively low.



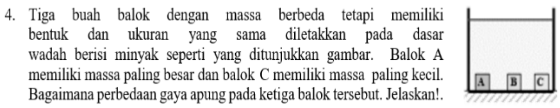
(a)



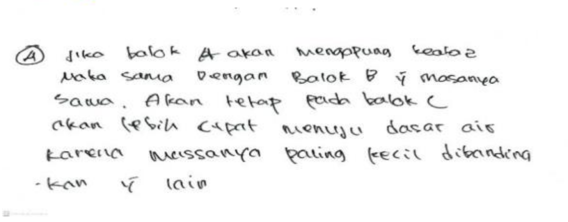
(b)

Figure 4. (a) Question 3 (b) Student Answer

Students can remember the concept of the material by describing how the buoyant force on the three dependent beams. However, students' ability to analyze the differences in the three buoyancy forces is still low so that they do not produce correct and complete answers.



(a)



(b)

Figure 5. (a) Question 4 (b) Student Answer

Students can answer by remembering the concept of buoyancy force that has been learned. However, students' ability to analyze the differences between the three buoyancy forces is still low.

Discussion

Based on the results of the study, it was found that the ability of students' concept mastery level was very low. In practice, students' ability to remember concepts is low, so that it contributes to the increasing difficulty of understanding, applying, and analysing concepts in solving tasks. Students find it difficult to identify hydrostatic pressure in vertical and horizontal directions. In this context, many students believe that the vertical or horizontal direction does not affect the difference or equation of hydrostatic pressure in a container. Students assume that hydrostatic pressure is affected by the shape of different containers regardless of the vertical and horizontal directions. The results obtained add information related to concepts that need to be improved by students. Other research by (Setyawan & Wahyuni, 2019), (ANDARINI, 2023) which shows that this material is indeed difficult for students to understand. According to (Saputra et al., 2019), students often have difficulty distinguishing between density and pressure, so they assume that the pressure in a liquid is the same in all parts.

Another common error is determining the static fluid force. Students remember the mathematical equation. However, students find it difficult to solve problems with mathematical calculations. As for research by (Kurniawati & Ermawati, 2020) and (Rizal Wicaksono et al., 2019) one of the common mistakes students make is to assume that the smaller the cross-sectional area, the higher the fluid rise. Students who hold this belief argue that a wider container, despite having the same depth, can support a greater load (Dahl et al., 2020), (Gao et al., 2020). These types of difficulties affect students' ability to master basic concepts.

Then students often have difficulty when solving buoyant force problems (on floating, levitating, sinking objects). Understanding why objects float and sink is one of the most challenging topics in concept change for students. Although floating and sinking are phenomena that are often encountered in everyday life, students find it difficult to solve problems in this context. Students have difficulty in understanding the concept when an object is hung on a rope which is then immersed in a container. Most students believe that objects that float, sink are influenced by the length of the rope from which the object is hung. The longer the rope of the hanging object, the higher the buoyant force produced. So the difference in buoyant force on objects that depend on the rope depends on the length of the rope.

The results obtained agree with research conducted by (Kurniawan et al., 2021) that students have not mastered the concept of Archimedes' law and its application in everyday life. Students do not understand that buoyant force is not affected by the mass of the submerged object. There are still many students who do not understand that the buoyant force is equal to the mass of water spilled due to the immersion of an object.

Students' difficulties in mastering concepts are influenced by various factors. Some of them are lack of focus while learning, weak basic understanding of fundamental concepts, and teacher-centered teaching methods, making it difficult to identify the obstacles faced by students. In addition, differences in students' learning styles that are not aligned with teaching methods also cause difficulties in understanding the material.

In the data collection process, the weaknesses found during the research were poor environmental conditions. Therefore, the data collection time was less than optimal. In addition, the less conducive classroom conditions also had an adverse effect on thinking to complete the task. Furthermore, in this study, only the category of students' concept mastery ability was obtained. For the future, research can be developed that discusses efforts to improve students' concept mastery.

CONCLUSION

Students' mastery of the concept of static fluid is in a very low category. understanding of the concept of ability (remembering (C1), shows that students get a score of 51.1%, while the ability to understand (C2) is 42.4%, then the ability to apply (C3) is 31.5% and the ability to analyse (C4) is 32.6%. This low concept understanding affects the completion of static fluid assignments. Various difficulties experienced by students, assuming that the difference in hydrostatic pressure on a container depends on the shape of the container. Then students have difficulty in solving tasks mathematically. And students assume that the longer the rope of the hanging object, the higher the buoyant force produced. So, the difference in buoyant force on objects that depend on the rope depends on the length of the rope. As for the implementation of this research, it was carried out with poor conditions, classroom conditions that were not conducive. Therefore, it is necessary to choose the optimal time in its implementation.

The suggestions that can be given to further research can apply learning methods that encourage student activeness and create more meaningful learning experiences to improve concept mastery. The learning that is applied should be based on a constructivistic approach so that students can master concepts better. Some suggested learning models include STEAM-integrated project-based learning and STEAM-integrated problem-based learning.

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