



Are There Misconceptions in My Class? Misconception Analysis with T3-SF (Three Tier-Test on Static Fluid)

Devi Yulianty Surya Atmaja*

Physics Department, Universitas Pendidikan Indonesia, West Jawa, Indonesia.

Achmad Samsudin*

Physics Department, Universitas Pendidikan Indonesia, West Jawa, Indonesia.

*Correspondence author: deviyulianty.0715@upi.edu

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Abstract:

This study aims to identify the misconceptions of 20 students in class XI MIPA in one of the Senior High Schools in Sumedang Regency, Indonesia. The selection of research subjects used a random sampling technique. This research used a descriptive qualitative research design with a case study approach. The data collection technique in this study used T3-SF (Three Tier-Test on Static Fluid) to identify misconceptions in the submaterial of Hydrostatic Pressure, Pascal's Law and Archimedes' Law. Students did ten questions on Google Forms and processed them using Microsoft Excel. Based on this study, the majority of students, 88.5%, have misconceptions, 9% have understood the concept and 2.5% of students are in the category of not understanding the concept. It can be concluded that three concepts of static fluid, namely Hydrostatic Pressure, Pascal's Law and Archimedes' Law, are at a high level of misconception because more than 61%. Students of Pascal's Law material experience a high level of misconception (100%). Meanwhile, the lowest misconception from other question numbers is the question for Archimedes' Law material. The researcher also recommends that future studies further classify the misconception category into partial misconceptions, false negatives and false positives.

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Are There Misconceptions in My Class?

Introduction

Understanding is a way to integrate and connect different types of relevant information (Kaniawati et al., 2021). Conceptual understanding will allow students to connect ideas and show relationships and interrelationships between concepts (Aslan & Demircioğlu, 2014; Atmaja, 2021; Syukur, 2022). That understanding will be following scientific conceptions and can be said to be correct. However, if a person's conceptual view does not follow the scientific conception agreed upon by experts, then it becomes a misunderstanding or misconception (M. Ainiyah et al., 2018; Fratiwi et al., 2017; Kaniawati, 2021; Parwati & Suharta, 2020). Students can be said to understand a concept if they can understand and master it to be applied in solving existing problems (Putri & Hakim, 2022).

Based on interviews with Physics teachers at the school where this research took place, it was found that the understanding of Static Fluid material could have been better, and some of them needed to be corrected. As we know, during junior high school, students learn some Static Fluid sub-materials. However, the learning conditions at that time were during the Covid 19 pandemic. Where students and teachers must adapt quickly to learning and teaching remotely (Daniel, 2020) teachers must also innovate and implement alternative education and assessment strategies to accommodate students' needs (Dhawan, 2020; Pokhrel & Chhetri, 2021). However, not all teachers and students are ready for this change. Many challenges have been identified, such as the need for internet access and the need for more devices that support learning and educational policies (Murgatrottd, 2020).

The teaching and learning process could be more optimal, which results in student understanding. Based on this, misconceptions can occur due to various factors such as basic knowledge possessed by students (Rohmah et al., 2023), inappropriate level of knowledge development, and student's ability to understand, which is still low (Anisa et al., 2021; Putri, 2016), the method used by the teacher is not suitable (Muthma'innah, 2023) and interest in learning the concepts taught (Manurung, 2021; Sihombing, 2023; Tua, 2023). This has an impact on the quality of student learning outcomes (Irawati & Sofianto, 2019), especially if these misconceptions are used by students in solving problems that occur in everyday life (Muthma'innah, 2023). Therefore, teachers need to identify misconceptions experienced by students (Atchia & Gunowa, 2024) in order to obtain information about students' deficiencies in concepts and identify them (Inggit et al., 2021; Priyasmika, 2023).

There are many methods that teachers can use to identify them, such as two-tier tests, three-tier tests, four-tier tests, and five-tier tests. Each test has its advantages and disadvantages. Among these four tests, the three-tier test is a test that still needs to be used to identify misconceptions (Kirbulut & Geban, 2014). In addition, the three-tier test is a combination of the two-tier test concept with the Certainly Response Index (CRI) (Abidin et al., 2023). There are three levels in the three-tier test. The first level will ask for students' knowledge of the basic concepts of a phenomenon in the form of multiple choice. The second level will review student reasoning based on the results of choosing answers at the first level. Finally, the third level will ask about students' beliefs about the answers to the first and second levels (Caleon & Subramaniam, 2010; Nazura et al., 2021; Silviani et al., 2017). With current technological advances, the use

of the three-tier test is more efficient if done online because the results can be easily known, and the teacher can evaluate them to determine the next step (Putra, 2019).

This study introduces innovation by optimizing Microsoft Excel to process and analyze misconception data on Static Fluid material such as hydrostatic pressure, Pascal's Law and Archimedes' Law, especially for high school students in grade XI MIPA. So that when working on three-tier-test questions, students can be identified regarding misconceptions and materials that experience misconceptions. This can help teachers in preparing learning remediation strategies with targeted interventions. This is different from the research conducted by Kamilah, (2019) which classified more than three categories and experienced an error of 10.1%. This study only focused on using three categories based on research references from Laily Ika Fitriani, (2021) namely understanding the concept, misconceptions and not understanding the concept, and there were no errors in classifying. In addition, the subjects for this study were also different schools and regions.

Based on the explanation above, this research is expected to identify misconceptions about static fluid material using the three-tier test. Researchers will present the percentage of students who understand the concept and students who need clarification and help to understand it. Then, the percentage will be derived based on the material that is used as the reference in this study.

Research Method

This research uses a qualitative descriptive research design with a case study approach. The design of descriptive research is research that describes in real terms what happens in the field related to the condition of the subject under study. This research aims to describe a phenomenon, including what, why, and how it happens (Muhammad, 2021) and assess the relationship between one factor and another (Anisah, 2016). In addition, qualitative research will clearly describe the activities carried out and the impact of this (Ainiyah et al., 2023; Dahal, 2024; Denzin, N. K., & Lincoln, 1994). This research will be described as shown in Figure 1.

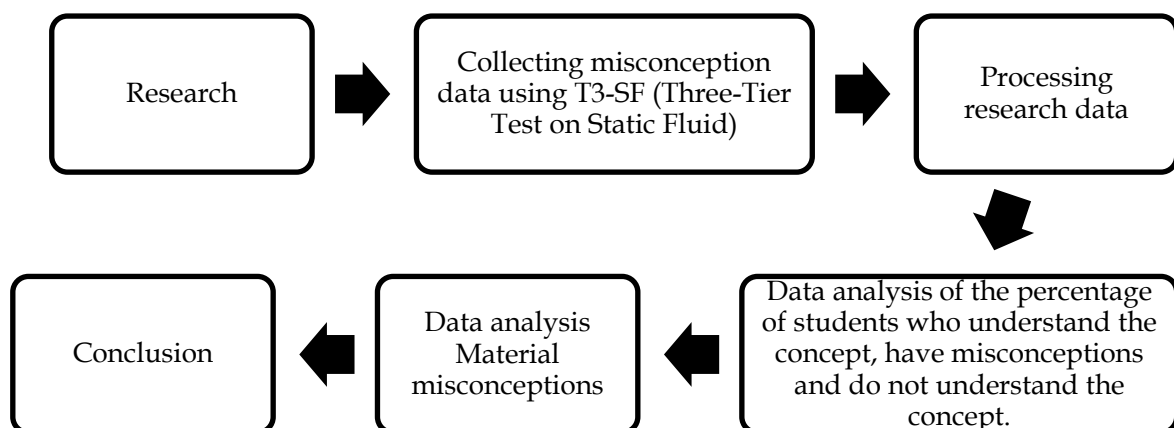


Figure 1. Research flow

Are There Misconceptions in My Class?

This study's subjects were 20 students from one of the Senior High Schools in Sumedang Regency, Indonesia. The research subjects were selected using a random sampling technique.

This research was conducted from May to June 2024. The data collection technique used was quantitative by processing the results of the Three Tier Test. The Three Tier Test will check students' concept understanding of static fluid material. Students work on questions on Google Forms in order to make it easier for researchers to download and process data in Microsoft Excel later. After the answers, reasons and belief levels of students are processed, then students will be classified into three categories, namely students who "Understand the Concept (Understand), Misconception (MK) and Do not Understand the Concept (TP)" as in Table 1.

Table 1. Student Answer Criteria

Level of Question	Answer	Reasoning	Confidence Level	Category	Code
Three Tier Test	True	True	Confidence	Understand Concept	Understand
	True	False	Confidence		
	False	False	Confidence	Misconception	MK
	False	True	Confidence		
	True	False	In confidence	Doesn't Understand Concept	TP
	False	True	In confidence		
	False	False	In confidence		
	True	True	In confidence		

Source : [Laily Ika Fitriani, \(2021\)](#)

The test instrument used is the Three Tier Test, which was developed by [Kamilah & Suwarna, \(2019\)](#). The number of questions used was only 10 out of 15 questions covering Hydrostatic Pressure, Pascal's Law and Archimedes' Law. The following is an example.

1a. Which point has the greatest hydrostatic pressure, among the points in the figure below?

- A. Only at point A
- B. Only at point B
- C. Only at point C
- D. At points A and B
- E. At all points

1b. Give your reasons!

- A. The smaller the cross-sectional area of the tube, the greater the pressure.
- B. The larger the cross-sectional area of the tube, the greater the pressure.
- C. The greater the volume of water above the height, the greater the pressure will be
- D. At the same depth as the water surface will have the same pressure
- E.

1c. Are you sure about your answer?

- A. Sure
- B. Not sure

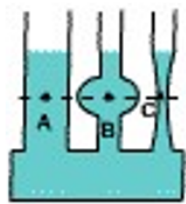


Figure 2. Examples of Questions Used

The following Microsoft Excel formula is used to calculate the percentage of students who "Understand the Concept (Understand), Misconception (MK), and Do not Understand the Concept (TP).

$$= (COUNTIFS(range; "criteria")/n)$$

For example this.

$$= (COUNTIFS(AJ2: AS2; "TP")/10)$$

Where:

- Range = Column of questions 1 to 10
- Criteria = Student answer criteria
 - Understand the concept (Understand)
 - Misconception (MK)
 - Do not understand the concept (TP)
- n = Number of questions

Average Percentage of Students Who Understand/MK/TP

To calculate the average of students who "Understand the Concept (Understand), Misconception (MK) and Do not Understand the Concept (TP)" using the following Microsoft Excel formula.

$$= AVERAGE(range)$$

For example this

$$= AVERAGE(AW2: AW21)$$

Where:

- Range = Column of questions 1 to 10
- Criteria = Student answer criteria
 - Understand the concept (Understand)
 - Misconception (MK)
 - Do not understand the concept (TP)
- n = Number of questions

Materials that Detected Misconceptions/Don't Understand the Concept in Students

If to calculate the most detected material "Misconception (MK) and Do not Understand the Concept (TP)" in students, it is calculated using the Microsoft Excel formula.

$$= (COUNTIFS(range; "criteria")/y)$$

For example this

$$= (COUNTIFS(AK6: AL6; "MK")/2)$$

Where:

- range = Column material
- criteria = Student answer criteria
 - Misconception (MK)
 - Do not understand the concept (TP)
- y = The number of columns of the material

Question Numbers that Detected Misconceptions/ Don't Understand the Concept in Students

The number of questions detected as "Misconception (MK) and Do not Understand the Concept (TP)" in students is calculated using the following Microsoft Excel formula.

Are There Misconceptions in My Class?

$$\text{For example this} = (\text{COUNTIFS}(\text{range}; \text{"criteria"})/\text{ns})$$

$$\text{Where:} = (\text{COUNTIFS}(\text{AJ2: AJ21}; \text{"MK"})/20)$$

- range* = Student column 1-20
- criteria* = Student answer criteria
Misconception (MK)
Do not understand the concept (TP)
- ns* = Number of students

Table 2. Percentage category of misconception level

Persentase	Category
0-30%	Low
31-60%	Medium
61-100%	High

Source: (Mulyani et al., 2020; Sheftyawan et al., 2018)

Results and Discussion

The researcher used ten questions from the Three Tier Test to detect misconceptions of senior high school students in class XI on Hydrostatic Pressure, Pascal's Law, and Archimedes' Law.

The average percentage of students who "Understand the Concept (Understand), Misconception (MK) and Do not Understand the Concept (TP)"

After processing each student's data, the researcher classified it into 3 columns: "Understand the Concept (Understand), Misconception (MK), and Do not Understand the Concept (TP)." The data was then presented in the categorisation table, as in Table 3 below.

Table 3. Average Percentage of Students who "Understand the Concept (Understand), Misconception (MK) and Do not Understand the Concept (TP)"

No.	Kategori					
	Understand	Number of students	MK	Number of students	TP	Number of students
1	15%	3	80%	16	5%	1
2	0%	0	100%	20	0%	0
3	5%	1	95%	19	0%	0
4	0%	0	100%	20	0%	0
5	5%	1	80%	16	15%	3
6	15%	3	85%	17	0%	0
7	15%	3	80%	16	5%	1
8	10%	2	90%	18	0%	0
9	0%	0	100%	20	0%	0
10	25%	5	75%	15	0%	0
Average	9%		88,5%		2,5%	

Description: Understand = Understand the Concept, MK = Misconception, TP = Do not Understand the Concept

Table 3 shows that the majority of students, or 88.5% of 20 students, experienced "Misconception." Only 9% of students already "Understand the Concept," and 2.5% of students do not understand the concept. If classified by material and question number, it can be seen in Table 4 below.

Table 4. Classification Based on Material and Question Number

Material	Concept	Number	Percentage (%)		
			Understand	MK	TP
Static Fluids	Hydrostatic Pressure	1	15%	80%	5%
	Pascal's Law	2,3	2,5%	97,5%	0%
	Archimedes' Law	4-10	10%	87%	3%

Description: Understand = Understand the Concept, MK = Misconception, TP = Do not Understand the Concept

Based on Table 4, it can be seen that students experience the largest "Misconception" on the concept of Pascal's Law at 97.5%. Then Archimedes' Law by 87% and Hydrostatic Pressure by 80%. Based on the misconception grouping conducted by [Sheftyan et al., \(2018\)](#), it can be concluded that three concepts of static fluid, namely Hydrostatic Pressure, Pascal's Law and Archimedes' Law, are at a high level of misconception because more than 61%. Students' misconceptions are caused by students' basic knowledge related to static fluid material, including low, as mentioned by [Putri, \(2016\)](#).

When comparing Table 3 and Table 4, it can be seen that 20 students answered incorrectly and fell into the category of high-level misconceptions (100%) in question numbers 2, 4 and 9. Where number 2 is Pascal's Law material. While numbers 4 and 9 are Archimedes' Law material. This 100% percentage shows that students' understanding is less related to the concept, which makes students build their understanding of the concept ([Natalia et al., 2016](#)). The questions with the lowest misconception value of other question numbers are question number 10 about Archimedes' Law, with as many as 15 students. Although based on the category, it is included in the high level of misconception. Furthermore, it will be discussed per concept and number as below.

Hydrostatic Pressure

In question number 1, students are shown a picture of a vessel consisting of 3 tubes with different shapes. There are 3 points (A-B-C) with the same height. Then, students are asked to determine the point with the greatest hydrostatic pressure. The data shows that 16 students had Misconceptions, and one student did not Understand the Concept. At the same time, only three students answered correctly and Understood the Concept. Seventeen students incorrectly answered when choosing the point with the greatest hydrostatic pressure. Students assume that hydrostatic pressure is influenced by the cross-sectional area of a building and the volume contained in it ([Simamora et al., 2023](#)). The same thing was also experienced by [Harniyati et al., \(2015\)](#), their students thought that the smaller or narrower the vessel, the greater the pressure. The hydrostatic pressure at all points is the same because the same depth from the air surface will have the same pressure. Moreover, only three students answered correctly and confidently. The same thing was also found in a study conducted by [Harmania et](#)

Are There Misconceptions in My Class?

al., (2020), students experienced misconceptions related to two things, namely first, that the larger the cross-sectional area of the vessel, the greater the hydrostatic pressure received, and vice versa. The cross-sectional area does not affect the magnitude of the hydrostatic pressure. Second, the greater the volume of liquid in a container, the higher the hydrostatic pressure produced. This statement is not entirely true because the hydrostatic pressure in a container will be affected by depth, gravitational acceleration, and fluid density. Therefore, the higher the liquid in the container, the greater the hydrostatic pressure.

Pascal's Law

In question number 2, students are shown a picture of an air pump with a piston container whose cross-sectional area is known. A stone is placed in the container, and students are asked to determine the conditions after the air pump is given force. The data shows that 20 students (100%) answered the problem incorrectly, and according to (Sheftyawan et al., 2018), number 2 needs to be corrected. Students should have answered that the piston would drop slightly because the force given was the same as the object's weight. After all, the pressure was the same. This does not mean that the piston is not moving because if the piston does not move, it means that the force given is less than the weight of the load.

In question number 3, students are shown a picture of a hydraulic lifter. Students are asked to determine the picture that has the most significant force. The data shows that 19 students answered incorrectly and needed clarification; only 1 understood the concept. Students should have answered the picture that shows that the larger the cross-sectional area, the greater the force produced. Most likely, students are fooled by the shape of the picture rather than the value of the picture.

As in the study conducted by Nisa' et al., (2022), where students assume that the position of an object influences the pressure of a liquid in a closed space and that the pressure will be more significant if the piston cross-section used is large. In Pascal's Law, the pressure in a liquid in a closed space is the same at all points and does not depend on the position of the object in it. The pressure on a liquid depends on the depth, density, and force applied to it. Likewise, with the cross-section of the piston, the broader the cross-section, the smaller the pressure on the resulting liquid.

Archimedes' Law

In question number 4, students are shown two pictures of containers inserted by marbles (A) with different mass ratios. Students are asked to determine the comparison of the lifting force. The data shows that 20 students (100%) answered incorrectly, and according to Sheftyawan et al., (2018) number 4 is included in the high level of misconception. Students should answer (C) that the ratio of lifting force is 1:6 because (D) the more significant the volume of the immersed object, the greater the lifting force. This is based on the mathematical equation $F_a = \rho \cdot g \cdot V$.

For question number 5, students are given two pictures of buckets in which objects with different volumes, densities, and masses are inserted. Then, students were asked to compare the lifting forces. The processed data showed that 16 students had misconceptions, three did not understand the concept, and only one needed help

understanding the concept. Students should have answered (C) 1:4 where (D) the more significant the volume of the immersed object, the greater the lifting force. This is based on the mathematical equation $F_a = \rho \cdot g \cdot V$, where the lifting force is not influenced by the object's mass or volume but by the density of the object and the volume of the immersed object.

In question number 6, students are given a table and five pictures of glasses with different contents. Then, students are asked to determine the glass's condition if two objects are put into the fluid. According to the processing results, 17 students experienced misconceptions, and three understood the concept. Students assume that if ice and oil are mixed, the ice will float or sink while the oil floats. The correct answer is (C) number 3, where the position of ice will be below the oil but still float because (C) the more significant the density, the more it will sink. So, according to the position, the most basic order is water, then ice, and finally oil.

Meanwhile, in question number 7, students are given a picture of a ship with a depth indicator in the form of numbers on the ship's hull. Students are asked to determine the number limit if the ship moves from the sea to the river. This is related to the density of the fluid. Based on recorded data, 16 students experienced misconceptions, one person needed help understanding the concept, and three students understood the concept. Most students think that the air height will decrease when a ship moves from the sea to a river, making the ship look more buoyant. Students should answer that the number limit would be (A) greater than two because the number limit is recorded as two at sea. This is because (A) river water's density is more minor than seawater's.

In question number 8, students are given two air-filled containers and different wood blocks. Suppose one of the blocks has a greater mass than the other block. Students are asked to determine the condition of the block when it is placed in the air. Based on the data, 18 students experienced misconceptions, and 2 understood the concept. Students assume that the lifting force of a block is influenced by mass. [Suparno, \(2013\)](#) also explained this in his book entitled "Misconceptions & Concept Changes in Physics Education." Students assume that objects sink in air because the object is heavier than air and thick fluids have a large density. Students should choose (A) position one, where the two blocks both float in the same position because (C) the density of the two pieces of wood is the same. This is based on the mathematical equation $F_a = \rho \cdot g \cdot V$, where the lifting force is not influenced by the object's mass but by its density.

For question number 9, students were shown three measuring glasses, the first filled only with water, the second with object A, and the third with object B. Students were asked to measure the increase in water when object B was inserted. Based on the data, 20 students (100%) answered incorrectly and fell into the high misconception category. Students answered that the increase in water would be higher than 1 unit, even though the correct answer was (C) the water would decrease compared to the measuring cup containing object A. This was because (A) the volume of the dipped can be the same because the fluid lifting force is influenced by volume and density, not the object's mass.

Are There Misconceptions in My Class?

Next is question number 10. Students are shown a picture of a wooden block lifted using a spring balance. If the weight of the block in air is known, students are asked to determine the weight of the block in water. According to data processing results, as many as 75% of students answered incorrectly and fell into the high misconception category. This value is the smallest compared to the other questions. Students assume that the weight of the block in water is greater than that of the block in air. However, the correct answer is (A), which means the weight of the block in water is lighter than that of the block in air. This is because (C) there is a lifting force that affects the weight of the block in the water. The researcher also recommends that further research use a four-tier test with five categories: understanding the concept, not understanding the concept, partial misconception, damaging misconception, and positive misconception.

As in the study conducted by Simamora et al., (2023), students assume that buoyancy is influenced by an object's mass and total volume without looking at whether the object is completely submerged. Buoyancy is influenced by the volume of the object submerged in the fluid. In addition, students often view that objects do not experience buoyancy when they are in the fluid, and the buoyancy is the same as the weight of the object in the water and the condition of an object when the shape and weight of the object influence floating and sinking. This is incorrect because objects will experience buoyancy, whether they object to float, sink, or float. The buoyancy is the same as the weight of the fluid displaced by the volume of the submerged/immersed object.

Based on the explanation above, most students experience misconceptions based on their perceptions (Astuti et al., 2016; Simamora et al., 2023). Therefore, researchers recommend that teachers use the Conceptual Change (CC) model with a cognitive conflict approach to carry out remediation in the classroom. The cognitive conflict strategy begins by providing counterpoints, analogies, demonstrations, and experiments to improve students' understanding (Rachmawati, 2021). This strategy focuses on students' misconceptions, considers the interactions between various concepts by actively involving students in learning, helps students interpret concepts correctly, and ensures that this understanding is accurate and can last a long time (Wartono et al., 2018). In addition, researchers propose other studies with additional classifications for misconception categories such as partial misconceptions, false negatives, and false positives so that the identification of misconceptions becomes more detailed in order to be able to compile effective learning remediation.

Conclusion

Based on this research, it can be concluded that in testing Static Fluid concepts such as hydrostatic pressure, Pascal's Law, and Archimedes' Law in class XI MIA students using the three tests, the majority of students, 88.5% of 20 students experienced "misconceptions." Only 9% of students have 'understood the concept' while 2.5% fall into the category who do not understand the concept of Static Fluid material. From this percentage, the most significant 'misconception' experienced by students on the concept of Pascal's Law reached 97.5%.

The misconceptions experienced by students are so great that up to 88.5%, researchers recommend that teachers use the Conceptual Change (CC) model with a cognitive conflict approach to carry out remediation in the classroom. In addition, there needs to be a more detailed classification related to this, such as classifying the categories of misconceptions into partial misconceptions, false negatives, and false positives so that the identification of misconceptions becomes more detailed in order to be able to compile effective learning remediation.

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Are There Misconceptions in My Class?

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