Jurnal Penelitian dan Pembelajaran Fisika Indonesia

Original Research Paper

Literature Review: Misconception Analysis of Static Fluid Material in High School Students

Lalu Azikri Amrullah[1], Handrianto[2], Ahmad Busyairi[3]
[1,2,3]Pendidikan Fisika, Universitas Mataram, Mataram, Indonesia.

Article history
Received: August 9th, 2024
Revised: September 9th, 2024
Accepted: October 10th, 2024

*Corresponding Author: Amrullah L.A., Pendidikan Fisika, Universitas Mataram, Mataram, Indonesia.
Email:azikrilalu2011@gmail.com

Abstract: This article presents a literature review on misconceptions of static fluid material in high school students, which is an important issue in physics learning. These misconceptions often stem from improper understanding of basic concepts, which can hinder students' academic achievement. Research shows that students often misunderstand key concepts such as hydrostatic pressure, Pascal's law and Archimedes' law, which negatively impacts their understanding of more complex physical phenomena. Through an in-depth analysis of 348 Google Scholar indexed publications from 2015 to 2024 with help from search tools such as Publish or Perish and Dimensions AI. This article identifies the causes of misconceptions and offers a constructivist approach as a solution to improve student understanding. By integrating findings from various studies, this review aims to provide a more comprehensive insight into the phenomenon of misconceptions and the strategies that can be applied to overcome them, so as to improve the effectiveness of physics learning at the high school level.

Keywords: Misconceptions; Physics Materials; Static Fluid; High School Students

Introduction

Physics as a branch of natural science, develops through observations and experiments on natural phenomena. Scientists research and analyze these phenomena to produce concepts and theories that underlie the universe (Busyairi & Zuhdi, 2020). Physics is essentially a science that explains natural phenomena based on facts, principles, and laws that have been scientifically tested. In its development, physics uses mathematics as a tool to understand and explain natural phenomena, with physicists building mathematical models as representations of these phenomena (Sarni, et.al., 2023).

Students' understanding of concepts in physics, especially in static fluid material, is often colored by misconceptions that have an impact on low learning achievement. Static fluid includes important concepts such as hydrostatic pressure, Pascal's law and Archimedes' law. However, various studies show that students often misunderstand these concepts, such as associating Archimedes' force with the mass of an object, or hydrostatic pressure with the volume of water and the shape of the container, even though these aspects are contrary to correct scientific principles (Sholahuddin et al, 2019; Cahyani et al, 2019). Therefore, in-depth analysis of these misconceptions is an important step to improve the effectiveness of physics learning at the high school level.

Misconceptions in physics often occur due to suboptimal learning processes, including teaching methods that do not emphasize conceptual understanding. Several studies have found that students tend to memorize formulas without understanding the concepts behind them, thus failing to apply concepts correctly in new contexts (Setiawan & Faoziyah, 2020). Recent research also shows that the application of diagnostic tests such as the four-tier diagnostic test can help identify the level of student misconceptions and provide insights for teachers to design more effective remediation strategies (Admoko, 2019).

The utilization of technology in learning can also be a solution to reduce misconceptions. Virtual laboratory-based simulations and computer-assisted learning have been shown to be able to reduce misconceptions in static fluid material. Through interactive approaches, students can observe and explore physics concepts visually and directly, thus improving their conceptual understanding (Diani et al., 2018; Sulastry, 2020). In addition, the use of PDEODE-based learning media (Predict, Discuss, Explain, Observe, Discuss, Explain) is also proven to be able to increase student understanding from

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DOI: 10.29303/jppfi.v6i2.629

14% to 50% in research conducted at the secondary school level (Saputra et al., 2019).

Furthermore, the factors that cause misconceptions can be analyzed through in-depth interviews and systematically designed diagnostic tests. Research shows that misconceptions are often rooted in basic concepts that students do not understand from the beginning, so they accumulate into more complex conceptual errors at higher education levels (Pramanda, 2024; Netta, 2021). Teachers can overcome this problem by applying a constructivist approach that allows students to develop their own concepts through discussion and direct experimentation (Pangestu, 2021).

Thus, it is important to conduct a comprehensive literature review to understand the causes and solutions to the misconceptions of static fluid material. This review is not only useful for the development of innovative learning strategies but also a reference for further research on the effectiveness of certain learning methods in overcoming student misconceptions. By integrating findings from various recent studies, this article aims to provide a more in-depth picture of the phenomenon of misconceptions and strategies to overcome them.

Methode

This research uses a systematic literature review approach, which is carried out by collecting and analyzing various scientific articles. The articles that became the data source came from national journals available in Indonesia, so the focus of the study was limited to the scope of the national database. These articles were obtained through the use of search engines such as Publish or Perish and Dimensions AI. These two tools were chosen because of their flexibility, wide coverage of information, and ability to provide personalized and reliable search results. These tools have been widely used by researchers to collect academic references. Dimensions AI provides access to millions of national and international scholarly articles, while Publish or Perish is known for its ability to analyze citations and literature relevance.

Data searches were conducted using keywords relevant to the Literature Review "Analysis of Misconceptions of Static Fluid Material in High School Students". The analysis covered 348 documents indexed by Google Scholar during the period 2015 to 2024. Google Scholar was chosen as the primary source because it has consistent document selection standards and offers a wider range of documents than other databases. This allows the research to gain a more comprehensive insight into the development of studies in this field.

Result and Discussion

Research data on misconceptions of Static Fluid material in high school students with a total of 348 were obtained from the Overview section of Dimensions AI. The data shows the number of publications on related titles from 2015-2024. In 2015, research began with the publication of 2 studies until finally in 2024 the publication reached 348 publications. More details in Figure 1 are presented data on the development of related research trends in the form of graphs to facilitate reading of the results.

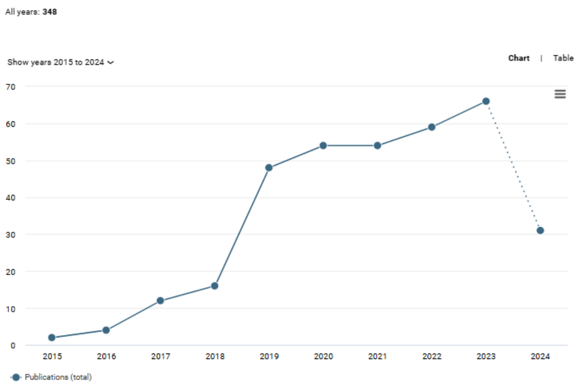

Figure 1. Development of Misconception Research Trends in Static Fluid Materials

Based on Figure 1, we can see that research on misconceptions in static fluid material is still warm in research studies, from 2015 to 2023 this research consistently increased until finally in 2024 it decreased slightly. This shows that misconceptions in static fluid material are still a concern for researchers so that a lot of analysis is still being done. In addition to the trend development in Figure 1, we can also see the type of publication related to the misconceptions of Static Fluid material in high school students in the Publication Type section. For more details, see table 1 below.

Tabel 1. Publication Type of Misconception Research on Static Fluid Materials

Publication type	Publication
Article	326
Proceeding	18
Edited Book	2
Chapter	1
Preprint	1

Based on Table 1 above, the most publication type data is obtained in the type of Articles as many as 326 publications, then Proceedings as many as 18 publications, edited books as many as 2 publications and Chapters and Preprints each 1 publication. Then in addition to the type of publication we can also see the researchers who most often examine the problem of misconceptions in static fluid material in the Researchers section. Take a look at table 2 below.

Tabel 2. Top 5 Researchers of Misconception Research on Static Fluid Material from 2015-2024

Name	Publications	Citations	Citation mean
Lia Yuliati	9	21	2.33
Putri Dwi Sundari	6	2	0.33
Abdul Halim	5	15	3.00
Sutopo	5	19	3.80
Fauzi Bakri	5	34	6.80

Based on table 2, it is obtained that Lia Yuliati is the researcher who has done the most studies on misconceptions in this static fluid material as many as 9 publications, 21 citations and 2.33 average citations per year. Then there is Putri Dwi Sundari with 6 publications, 2 citations and 0.33 average citations per year. Then Abdul Halim, Sutopo and Fauzi Bakri are the same as 5 publications. besides the 5 researchers there are many more researchers who have conducted research related to this title. Finally, after analyzing 348 related publications, we took the top 15 publications as the main source of analysis in this research on misconceptions in static fluid material. The results of the analysis are shown in table 3 below.

Tabel 3. Main Analysis Source of Misconception on Static Fluid Material

No	Author Name	Year	Title of Publication
1	Alberto Yonathan Tangke Allo dkk.	2015	Pengembangan Perangkat Pembelajaran Fisika Model Guided Discovery Learning Menggunakan Alat Sederhana Untuk Mereduksi Miskonsepsi Siswa Sma Pada Materi Fluida Statis.
2	Hanifah Cahyani dkk.	2019	Identifikasi Miskonsepsi Fluida Statis Pada Siswa SMA Menggunakan Four-Tier Diagnostic Test.
3	Kana Dhiean Zukhruf dkk.	2016	Remediasi Miskonsepsi Dengan Menggunakan Media Pembelajaran Interaktif Pada Materi Fluida Statis.
4	Vicki Dian Prastiwi dkk.	2018	Identifikasi Pemahaman Konsep Dan Penalaran Ilmiah Siswa SMA Pada Materi Fluida Statis.
5	Mantari Harniyati dkk.	2015	Remediasi Miskonsepsi Siswa Pada Fluida Statis Menggunakan Pembelajaran Predict, Observe, Dan Explain Di SMA.
6	Rini Simamora	2023	Kemampuan Pemecahan Masalah Peserta Didik Dan Hubungannya Dengan Miskonsepsi Pada Materi Fluida Statis.
7	Syarifah Sulastry	2020	Identifikasi Miskonsepsi Siswa Dalam Materi Fluida Statis Di SMA Negeri 1 Arongan Lambalek.
8	Sri Wahyuni dkk.	2018	Integrasi Remediasi Miskonsepsi Siswa Menggunakan Model Problem Based Learning Dalam Pembelajaran Fluida Statis Di SMA.
9	Shofyan Sholahuddin dkk.	2019	Profil Miskonsepsi Siswa Berdasarkan Hasil Tes Diagnostik Four Tier Test Pada Materi Fluida Statis.
10	Oka Saputra dkk.	2019	Miskonsepsi Siswa SMA Pada Topik Fluida.
11	Ruth Novi Kornalia Mellu	2023	Profil Miskonsepsi Peserta Didik Pada Materi Kinematika Gerak Dan Fluida Statis.
12	Yohanis Taruly dkk.	2022	Analisis Miskonsepsi Siswa Dalam Menjawab Soal-Soal Pada Materi Fluida Statis.
13	Tika Anggraeni	2019	Identifikasi Miskonsepsi Siswa Kelas XII MIA Di SMA Negeri 8 Kota Jambi Pada Materi Fluida Statis.
14	Luh Sukariasih dkk.	2024	Identifikasi Miskonsepsi Siswa Kelas XI Pada Konsep Fluida Statis Dengan Menggunakan Four-Tier Diagnostic Test Di SMA Negeri 2 Kendari.
15	Kana Dhiean Zukhruf	2018	Mengidentifikasi Miskonsepsi Fluida Statis Pada Mahasiswa Calon Guru Fisika Universitas Samudra.

DOI: 10.29303/jppfi.v6i2.629

Based on table 3 above, we conducted a literature review to analyze the theme of misconception themes related to static fluid material. We found a number of main misconception profiles that can be grouped into certain aspects. These themes reflect various misconceptions that are common among students in understanding basic concepts related to static fluid. For more details, see table 4 below.

Tabel 4. Misconceptions on the Concept of Static Fluid

Concept Aspect	Misconception Description
Archimedes' Law	Learners often experience misconceptions in understanding Archimedes' Law, such as assuming that the lifting force only works on floating objects, while objects that sink completely do not experience lifting force. Then, students also assume that the lift force depends on the weight of the object, not the volume of fluid being moved, so objects that are heavier than the fluid are considered to always sink, regardless of the density of the object and fluid. In addition, some students mistakenly think that the lift force increases if the object is placed deeper in the fluid, even though the lift force is only affected by the volume of the submerged object. Other misconceptions include the assumption that small objects always experience a smaller lift force without understanding the relationship between the volume of the submerged object and the lift force, as well as the misunderstanding that hollow or porous objects do not experience lift force because the fluid enters them. This misunderstanding often makes it difficult for students to apply Archimedes' Law appropriately.
Hydrostatic Pressure	Learners often have misconceptions in understanding hydrostatic pressure, such as assuming that pressure depends only on the volume of the fluid, not on the depth or density of the fluid. Many misunderstand that the pressure at a point in the fluid can change depending on the shape or size of the container, so a fluid in a larger container is thought to produce more pressure. In addition, learners often think that the pressure at the bottom of the container increases if the surface area of the fluid increases, without understanding that pressure only depends on the height of the fluid column. Some students also assume that the fluid pressure is the same at all points, regardless of the difference in depth. Others misunderstand that the heavier the fluid, the greater the pressure, without considering the height of the fluid column. These misconceptions are often exacerbated by the erroneous understanding that hydrostatic pressure only applies to liquid fluids and not to gaseous fluids. These errors demonstrate the importance of emphasizing the relationship between depth, fluid density and gravity in determining hydrostatic pressure.
Pascal's law	Learners often have misconceptions in understanding Pascal's Law, such as assuming that pressure exerted on a fluid in a confined space only spreads in the direction the pressure is applied, rather than in all directions equally. They also often misunderstand that this law only applies to liquid fluids and does not apply to gases. Some students assume that the transmitted pressure is affected by the shape or size of the container, so a fluid in a small container is considered to transmit pressure weaker than a large container. In addition, there is a misconception that the fluid must flow for pressure to be transmitted, even though this law applies to stationary fluids. Some learners also mistakenly believe that pressure can only be transferred in fluids with high density, so light fluids such as air are considered ineffective in transmitting pressure. These misconceptions indicate the need to emphasize the concept of pressure as a scalar quantity that spreads evenly in a closed fluid according to Pascal's principle.
Viscosity	Learners often experience misconceptions in understanding viscosity, such as assuming that fluids with high viscosity always flow slower, regardless of the influence of external forces or pressure applied. Many mistakenly think that viscosity is not affected by temperature, so the fluid remains viscous even if it is heated, or vice versa, a dilute fluid will not change even if the temperature is lowered. In addition, some students misunderstand that viscosity only applies to liquids, not gases, even though gases also have viscosity that affects their flow. There is also the assumption that viscous fluids always produce a greater frictional force, without considering the relative velocity between the fluid layers. Another misconception is to think of viscosity as an unchanging property, regardless of environmental conditions such as pressure or temperature, making it difficult for students to understand the effect of viscosity in fluid dynamics

Based on table 4 above, it shows the various misconceptions that students often experience in learning static fluids. These misconceptions include various misunderstood basic concepts, such as the relationship between hydrostatic pressure, Archimedes' law and Pascal's principle, as well as the difference between surface tension and fluid viscosity. In addition, students also often struggle to understand how fluids behave under the influence of forces, as well as how to measure pressure or viscosity with the right tools.

The main cause of these misconceptions is a lack of understanding of how these concepts are interconnected. Students often do not correctly understand how hydrostatic pressure relates to the depth and density of the fluid, or how lift works according to Archimedes' law. Lack of practical experience in testing and observing fluid behavior directly, such as in experiments with fluid pressure or flow, also contributes to these misconceptions.

To address this issue, it is important for teaching to focus more on basic concepts using more interactive and practice-based methods. For example, through hands-on experiments, discussions, or the use of simulations, students can more easily understand these concepts and overcome their confusion. With the right approach, it is expected that students can correct their misconceptions and understand the static fluid material better.

Conclusion

Physics is a science that develops through the integration of experiments and theoretical explanations of natural phenomena. In learning physics, especially at the high school level, it is important to hone students' cognitive, psychomotor and affective abilities. However, misunderstandings or misconceptions of basic concepts such as in static fluid material are a big challenge that can hinder the learning process and reduce student motivation. These misconceptions often occur due to a lack of basic understanding and lack of practical experience in learning the material. Examples of misconceptions include misinterpretations of Archimedes' law, hydrostatic pressure, Pascal's law and fluid viscosity. As a result, students have difficulty bridging theoretical concepts with their application in real life, which negatively impacts their learning outcomes.

Research shows that overcoming misconceptions requires a more participatory learning approach, such as through hands-on experiments, simulations and group discussions. This approach is able to improve students' understanding as well as train critical thinking skills that are indispensable in solving problems related to static fluids. The available scientific articles are an important reference for understanding students' misconception patterns as well as developing more effective teaching strategies. By utilizing these findings, teachers can design more suitable learning methods, deepen students' understanding of static fluid concepts, and minimize the risk of misconceptions in the future.

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