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Utilising Natural Science Articles to Improve Critical Thinking in The Digital Era

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ABSTRACT

In the digital era, critical thinking has become an essential skill for secondary school students, particularly with the emergence of Artificial Intelligence (AI) and the digitalization of science learning that emphasizes media based on scientific articles. This research aims to explore the role of scientific articles in enhancing students' critical thinking skills through the analysis of two articles: slime transformation and the application of Archimedes' principle in hydraulic pumps for car wash machines. Employing a qualitative method with purposive sampling, data were collected through tests and analyzed using Two-Way ANOVA. The results demonstrate that the use of articles about Archimedes' principle in hydraulic pumps for car wash machines and changes in slime helps students connect physics concepts with their application in real-life problem analysis. Articles about slime proved easier to understand due to their concrete nature, whilst hydraulic pump articles required a deep understanding of pressure and buoyancy concepts. The difficulty level of texts significantly influenced students' critical thinking abilities. Integration of scientific literacy in science learning through critical reading activities and discussion can develop students' analytical, evaluative, and inferential skills. This research recommends the scientific article-based literacy approach as an effective strategy for enhancing critical thinking abilities in science education in the digital era.

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Introduction

Document Reading skills are fundamental in science education, not only as a primary source of information during school but also as an important skill to support learning. Critical reading in learning involves understanding, analyzing, and disseminating complex

information that often comes from scientific articles (Rahma et al., 2024; Niculescu & Dragomir, 2023; Archila et al., 2024). In the ever-growing digital era, critical thinking skills are essential skills that students must have, especially at the junior high school level. The presence of artificial intelligence (AI) and digitalization in learning Natural Sciences increasingly emphasizes the importance of learning media based on scientific articles. However, digital practices in schools and efforts to integrate literacy between home and school environments are still limited (Coiro 2021).

In science learning, using scientific articles allows students to develop the ability to verify information, identify evidence, and draw conclusions based on data. The use of articles also helps students understand the relevance of science to everyday life and current issues (Breakstone et al. 2021; Moreno Mosquera, & Mateus Ferro, 2018). Scientific articles have in addition to presenting the latest information, articles are effective tools for developing students' critical thinking skills, which include analyzing arguments, evaluating evidence, and drawing conclusions. Critical thinking skills are essential for understanding and making data-based decisions in science learning (Sihombing et al., 2024). The increasing flow of information also emphasizes the importance of junior high school student's ability to read critically and evaluate scientific information (Breakstone et al. 2021).

Previous research results show that digital science literacy needs to be developed among junior high school students. Song et al. (2021) highlight the need for further study on using scientific articles to improve critical thinking skills, especially in technology-based learning. Research by Kurniawaty et al. (2022) And Patigu et al. (2024) revealed that even though students are familiar with digital technology, they still need guidance to develop critical thinking skills when dealing with complex scientific information and not become argument followers. This aligns with the findings of Novianti et al. (2022), which revealed that developing interactive multimedia teaching materials based on scientific literacy can increase student participation in science learning. The findings show that using interesting and interactive teaching materials can make it easier for students to understand scientific concepts, especially in the era of science learning, which is increasingly dominated by digitalization and Artificial Intelligence (AI).

Research from the Programme for International Student Assessment (PISA), cited by Eryuni (2023), revealed that Indonesia is ranked 60th out of 65 participating countries with a score of 396 in the reading category. This assessment includes understanding, using, and reflecting on information in written form. The average international score set by PISA is 500. This achievement shows a decline compared to the results in 2009, where Indonesia was ranked 57th with a score of 402 out of 65 countries. This is supported by the research of Fatmawati et al. (2019), which shows that many students are still less active, and low category results in critical thinking. This can be seen from the lack of students asking questions, lack of self-confidence, and their unfamiliarity with problem-solving-based learning. This condition is caused by students' limited understanding of the material presented by the teacher. This study explores using scientific articles as an effective learning medium to improve junior high school students' critical thinking skills in science learning in the digital era.

Critical reading is an important skill in scientific literacy that involves a deep understanding of scientific texts. Critical reading encourages students to receive information passively and analyze and evaluate information to understand the context and meaning behind the text they read (Fauziah, 2024; Niculescu & Dragomir, 2023). Through this learning, students are invited to contextualize their acquired knowledge and develop the ability to analyze, interpret, and critically critique scientific texts (Juhji & Mansur, 2020). A study by Zamroni & Warsono (2020) shows a positive relationship between reading and

critical thinking abilities. Therefore, mastery of scientific literacy involving critical reading is crucial for students who can think critically, conduct scientific investigations, and develop perspectives based on in-depth and contextual analysis. Critical thinking skills can be improved through scientific literacy, which helps students conduct better scientific investigations. They can identify assumptions, evidence, and explanations of decision-making and make logical conclusions based on existing evidence (Karira & Sunarti, 2022).

According to Zamroni & Warsono (2020), critical thinking is an activity that requires various supporting skills, including reading and writing skills. Critical thinking is an active process that allows students to identify differences in information, collect data, analyze, evaluate, and finally draw conclusions (Yani, 2024; Facione, 2011). A person's ability to solve problems and gain knowledge through critical thinking is reflected in their ability to answer questions or find solutions to problems. Most teachers view critical thinking skills as important in training students to analyze by dividing tasks into components that make them up and evaluating them during the learning process. This aims to ensure students can be responsible and reflect on their decisions (Padmakrisya & Meiliasari., 2023).

This research focuses on evaluating critical thinking competencies according to the framework established by Paul Elder and Dewey, which includes: According to Paul and Elder, elements of critical thinking include: all reasoning is expressed and formed by concepts and ideas that have a purpose, all reasoning is done from several points of view based on assumptions, all reasoning is an attempt to answer a question, all reasoning is based on information, all reasoning contains inferences or interpretations, such as drawing conclusions and giving meaning to data (Oliveras, 2011).

Dewey describes general patterns of critical thinking, including there is a leap in more advanced thinking, and provides possible solutions, there is a process of confusion involving intellectual processes to solve problems or questions that must be sought, there is a sequential process from a main idea or hypothesis to initiate and guide observations or other operations in collecting factual materials, there is a mental elaboration of an idea or response as an idea or assumption (partial/not complete reasoning then making an inference), testing hypotheses with action or imagination (Rahardhian, 2022). From these two theories, researchers concluded that critical thinking indicators include: recognizing the ideas and objectives of the problem text, identifying assumptions from different points of view, formulating scientific questions, identifying data and evidence, conclude.

Previous studies have focused on scientific literacy and developing critical thinking skills through digital technology (Hasibuan et al., 2025), demonstrating that technological literacy can enhance students' critical thinking abilities. Bramastia & Rahayu (2023), in scoping review analysis, identified several issues such as the poor teaching of science regarding scientific literature, resulting in students being unable to identify problematic issues and scientific evidence due to a lack of practice in engaging with scientific literature. However, there are limited studies specifically on using scientific articles as learning media to improve critical thinking skills in the digital era. The novelty of this study is to integrate scientific articles as learning media in science learning to foster student's critical thinking. By analyzing the existing challenges and opportunities, this study has significance and is expected to provide new insights into the integration of scientific articles in science learning and its contribution to developing students' critical thinking skills in the digital era.

Method

This study uses a qualitative and direct test method for junior high school students in Ponorogo and Kedunggalar. This study involved grade VII students from two public junior high schools in Ponorogo and Kedunggalar, with 60 students. The sample was selected by

purposive sampling to ensure adequate representation. Data were collected through a critical thinking test based on scientific articles designed based on the theoretical framework of Paul & Elder (2019) and Dewey et al., (2008); the test consists of five indicators: recognizing main ideas, identifying assumptions, formulating scientific questions, analyzing evidence and concluding. Each indicator is assessed using a rubric with a scale of 1-4.

Data from students' answers were analyzed based on three phases of critical reading: pre-Reading phase: students identify the initial problem from the article, reading phase: students explore the article's content and relate it to elements of critical thinking, post-reading phase: students redefine the problem, look for supporting arguments, and conclude the results (Oliveras, 2011).

The analysis was conducted using Two-Way ANOVA to evaluate the effect of scientific articles on students' critical thinking scores and the interaction between the article and school variables. The analysis was conducted using SPSS software. The analysis results are presented as detailed descriptive narratives supplemented with direct quotes from student responses and average value diagrams to illustrate the development of students' critical thinking skills. This approach aims to explain how articles can influence students' critical thinking skills through a systematic theory-based study.

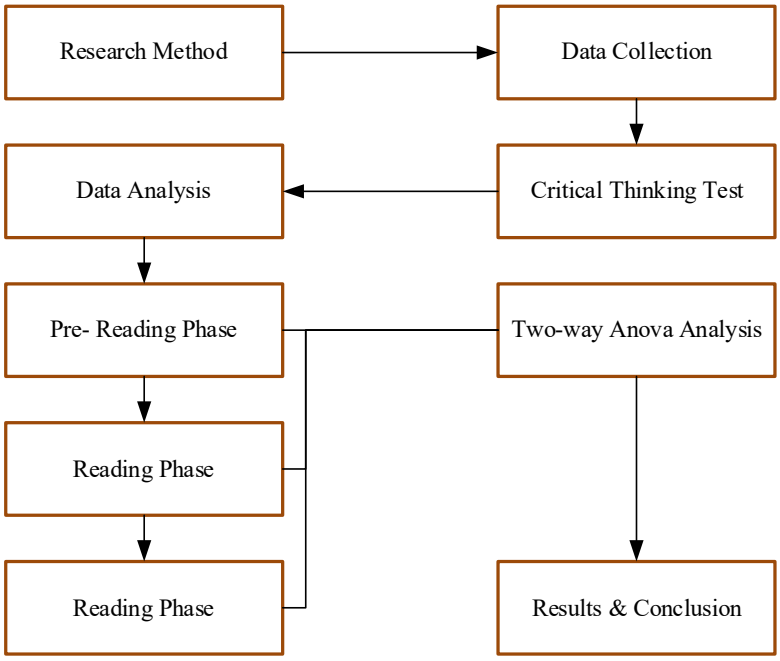

Figure 1. Research Flow

Results and Discussion

The study results showed variations in the students' understanding of articles about Slime and Archimedes' law of hydraulic pumps based on five indicators of critical thinking. The slime article was easier for students to understand than the article about hydraulic pumps, mainly because the observational nature of the change in the form of slime was more immediately visible. At the same time, the concept of Archimedes' law required a deeper understanding of pressure and lift in hydraulic systems.

Table 1. Statistical Retribution of Student Values Against Critical Thinking Indicators

Variables	Sig.
Article	.045
School	.501
Article*School	.205

The scores for each indicator were compared between the two articles, and different types of activities, including the interactions between them, were compared using a two-way analysis of variance. The statistical test was considered significant if the p-value was less than 0.05. From the results of the analysis using SPSS software, it showed that the article had a significant influence on the Critical Thinking Score. Utilising articles appropriate to the student's ability level can facilitate learning through gradual support until students achieve a deeper understanding. The average value of students also supports this.

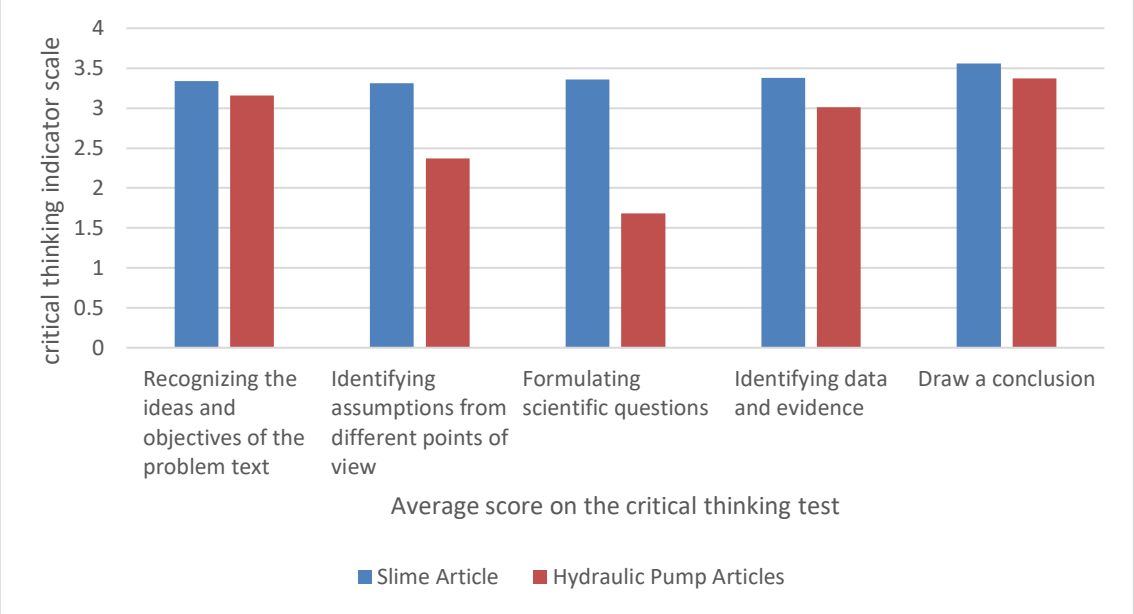

Figure 2. Distribution of Students' Average Scores Based on Critical Thinking Indicators

The mean score for the "identifying ideas" indicator shows that students find it easier to understand the main ideas in the slime article (mean score of 3.34) than in the hydraulic pump article (mean score of 3.16). This is because the slime article uses concrete and familiar examples for students, such as changes in the texture of slime, so it is easier to relate to everyday experiences. In contrast, the hydraulic pump article requires students to understand the principle of pressure more deeply. In the "analyzing data and evidence" indicator, students show a fairly good level of understanding for both articles (mean score of 3.38 for SlimeSlime and 3.01 for hydraulic pump). This shows that students can identify evidence that supports arguments. However, they need guidance in understanding the relationship between data and scientific theory, especially for more complex articles such as hydraulic pumps.

Most students achieved high scores on the "drawing conclusions" indicator for both articles, reflecting students' ability to integrate the information obtained with relevant scientific concepts. The selection of articles used in learning impacts increasing or decreasing critical thinking ability scores. This supports the development of analytical skills; research by Pratiwi (2023) shows that relevant articles that present reliable arguments and data can help improve students' critical thinking skills. Research supports Wahyudi & Purwanto (2024) articles with controversial topics or complex issues encourage students to think more deeply and critically. However, the lower average score on the "identifying assumptions" indicator indicates students' difficulty understanding the various perspectives underlying the arguments in the articles.

In the student answer sheet regarding the hydraulic pump for the car wash machine, most students concluded that the application of Archimedes' Law in the system was not fully conveyed correctly in the text. Although they initially doubted whether the hydraulic pump

system used Archimedes' Law or other fluid mechanics principles, after seeking additional information, they realized that hydraulic components rely more on the pressure and force generated than the lift in the fluid. Thus, they were able to evaluate the scientific basis of the reading. This is by indicator 4 in understanding critical thinking, namely analyzing data and evidence; this reflects that supporting students in discussion and seeking additional information can improve students' critical thinking skills.

Research by Widiastuti & Kania (2021) shows that discussion can improve critical thinking and problem-solving skills because, in discussion activities, students exchange information, opinions, and experience elements regularly. After examining the information from the article, there is an error in explaining the principle of pressure and lift in the hydraulic pump system of the car washer utilising fluid pressure to increase washing efficiency. However, the mechanism used differs from the concept of lift, which is usually associated with Archimedes' law for objects that sink in water. The hydraulic pump system uses pressure to move fluid through a hose, providing a greater thrust, which is different from the principle of buoyancy in Archimedes' law.

Students who do critical reading related to the application of Archimedes' law in the hydraulic pump of a car washing machine accept the information in the text at face value, even though they have found information on the internet that is more by scientific principles. However, some students prioritize the text's content, ignoring that the hydraulic pump's working principle relies more on Pascal's law, not Archimedes'. This is similar to when students study changes in SlimeSlime, where they focus more on direct observation without considering the in-depth scientific aspects of the physical and chemical changes that occur in SlimeSlime. In Changes in Slime, students tend to identify changes that occur as physical changes based on direct observation (such as changes in shape or viscosity) without delving into the scientific explanation of the chemical reactions that may be involved (such as the interaction between binders and thickeners). As with hydraulic pumps, a more critical understanding and use of valid information are essential to achieving a more accurate understanding of its scientific principles.

When asked to provide a critical view of the application of Archimedes' Law in the hydraulic pump of a car washing machine, some students failed to complete the task and instead provided an analysis based on whether they agreed with the working principle of the hydraulic pump or not. They had difficulty questioning the scientific basis of the explanations in the text. Most of them rewrote the existing information using their knowledge without realizing that the text prioritized Pascal's law in explaining how the hydraulic pump works, not Archimedes' Law. This is similar to how some students handled the material on changes in SlimeSlime. When asked to provide a critical analysis of the physical or chemical changes in SlimeSlime, they focused on whether they agreed with the changes without linking it to deeper scientific knowledge, such as the difference between physical and chemical changes in SlimeSlime. This shows their difficulty questioning and understanding the scientific basis behind the phenomenon.

The article has both positive and negative sides. Indeed, the application of Archimedes' Law in a car wash hydraulic pump explains the principle of lift in fluids. However, the explanation could be more accurate if the explanation prioritizes Pascal's law, which is more relevant to how a hydraulic pump works. In conclusion, the explanation of the physics principles in a hydraulic pump is correct, such as that the pump works based on pressure, but I do not completely agree with the use of Archimedes' Law to explain how it works. This is similar to how some students understand the changes in SlimeSlime. The changes in SlimeSlime can be seen as physical changes, but the explanation also considers the possibility of chemical reactions.

Students' understanding of Archimedes' law in the hydraulic pump of a car washing machine: Some students can form opinions based on the information they read and provide scientific arguments about why the principle of pressure in a hydraulic pump allows the pump to work more efficiently in improving the performance of the car washing machine. They relate the theory to how the hydraulic system works. However, some students still have difficulty distinguishing between Archimedes' Law and Pascal's, which are more relevant to the hydraulic pump system. This is similar to how students understand changes in SlimeSlime. Based on their observations, most students can explain the physical changes in slime, such as changes in viscosity or shape. However, they tend to ignore the possibility of chemical changes, such as reactions between binders and thickeners in SlimeSlime. Both cases show the importance of student's ability to relate scientific theories to the phenomena they observe. However, sometimes, they must be more critical in choosing the right scientific principles to explain the phenomenon.

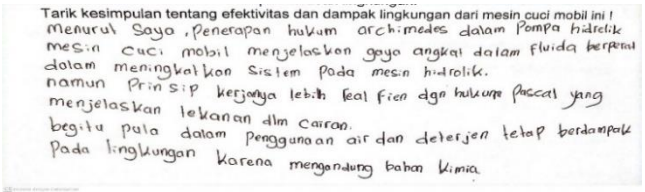
Tarik kesimpulan tentang efektivitas dan dampak lingkungan dari mesin cuci mobil ini !
Menurut Saya, Penerapan hukum archimedes dalam Pompa hidrolik mesin cuci mobil menjelaskan gaya angkat dalam fluida berperan dalam meningkatkan Sistem Pada mesin hidrolik.
namun Prinsip kerjanya lebih kuat fisika dgn hukum Pascal yang menjelaskan tekanan dlm cairan.
begitu pula dalam Penggunaan air dan deterjen tetap berdampak Pada lingkungan karena mengandung bahan kimia

Figure 3. Student Test Answers of Inference the Concept from Phenomena

The answer shows if the working principle of the hydraulic washing machine is more relevant to Pascal's law. This is similar to changing the slime.

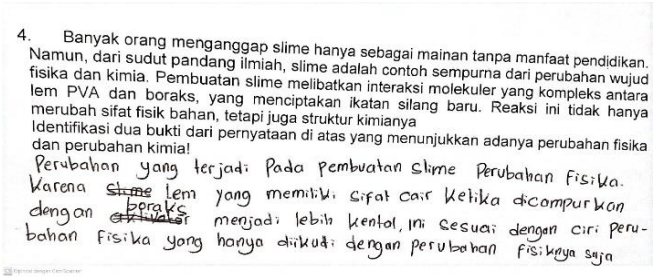
4. Banyak orang menganggap slime hanya sebagai mainan tanpa manfaat pendidikan. Namun, dari sudut pandang ilmiah, slime adalah contoh sempurna dari perubahan wujud fisika dan kimia. Pembuatan slime melibatkan interaksi molekuler yang kompleks antara lem PVA dan boraks, yang menciptakan ikatan silang baru. Reaksi ini tidak hanya merubah sifat fisik bahan, tetapi juga struktur kimianya
Identifikasi dua bukti dari pernyataan di atas yang menunjukkan adanya perubahan fisika dan perubahan kimia!
Perubahan yang terjadi Pada pembuatan slime Perubahan Fisika.
Karena ~~slime~~ lem yang memiliki sifat cair ketika dicampurkan dengan ~~efektivitas~~ boraks menjadi lebih kental, ini sesuai dengan ciri perubahan Fisika yang hanya diikuti dengan perubahan fisiknya saja

Figure 4. Student Test Answers Pertaining Physics Concept

Many students consider physical changes in slime, such as changes in shape or viscosity, as changes that are only influenced by physical factors, and they often ignore the possibility of chemical reactions in the process. Similarly, a deeper understanding of the exact principles is essential for a more accurate explanation of the hydraulic pump system.

Although some know that Archimedes' Law has certain properties and characteristics in explaining the car wash machine hydraulic pump, they conclude that it does not significantly improve its efficiency. They justify the working principle of the hydraulic pump with arguments such as pressure in the fluid, engine power, and good system design. Some students even mention other factors, such as the material used in making the pump, as reasons for improving the machine's efficiency. They do not consider the application of Archimedes' Law mentioned in the article an important factor.

This is similar to how students understand changes in Slime. Although they recognize that physical changes, such as changes in the viscosity or shape of the Slime, occur, they ultimately conclude that factors such as temperature and time are more important in determining these changes. They do not pay much attention to the chemical reactions that may occur in the slime, which could explain the deeper changes in its physical properties. Both cases demonstrate how students can ignore or not fully understand the relevant scientific theories in explaining these phenomena.

The principle of Archimedes' Law does help us understand the concept of lift in fluids. However, it does not directly improve the performance of hydraulic pumps because Pascal's principle of fluid pressure is more relevant and plays a role in the effectiveness of hydraulic pumps, not Archimedes' Law. In both articles, students focus only on the visible aspects without realizing the more precise scientific concepts that underlie the phenomenon. The use of critical reading activities in learning about Archimedes' law in car wash hydraulic pumps can improve students' understanding of the scientific concepts that underlie the technology; it is not enough to just read texts that explain the principle of Archimedes' law and its application to hydraulic systems. Students must also be guided to critically assess and evaluate the text critic discussions to help facilitate deeper analysis and reflection on this topic.

Meanwhile, in the article on slime changes, students also benefit from critical reading activities related to physical and chemical changes in SlimeSlime. In this case, students read texts about changes in slime texture and have to analyze and absorb the scientific explanations that underlie the phenomenon. Many studies have shown that students can learn more effectively when actively involved in activities, such as group discussions and interactions, which allow them to understand better how changing conditions (such as temperature or pressure) affect the properties of slime (Simatupang et al., 2024).

The students' answers show it is difficult to apply critical thinking when analyzing texts discussing Archimedes' law in car washing machine hydraulic pumps. According to Inggriyani & Fazriyah (2018) and Oktafiani & Irawan (2021), many students have difficulty expressing their opinions in writing, accepting the information in the text, and implicitly trusting the author. Some aspects of critical thinking make it difficult for students, namely identifying the author's purpose and finding supporting evidence in the text. However, students can develop these skills and learn to read more carefully by working on various critical reading activities with texts from various sources (such as books, scientific articles, and other related sources).

The ability to read science critically is reflected in indicator 5, concluding. At this stage, students demonstrate their ability to identify arguments in the text, compare them with relevant theories and evidence that may be obtained from reliable sources of information, and conduct a critical analysis of the contents of the text. This is what distinguishes between critical reading and critical science reading because although students can identify important ideas, scientific evidence or arguments, and the author's intent in the text that indicates a good understanding, their ability cannot be categorized as critical science reading if they have not compared scientific arguments in the text with the appropriate theoretical model.

In Archimedes' law article, students may have difficulty distinguishing between scientific facts, theories, and evidence that underlie the application of the law in hydraulic systems. For example, some students may not be able to distinguish between experimental data on the efficiency of a hydraulic pump and the opinions that may be expressed in the article. Therefore, it is essential that before reading these scientific texts, students learn the differences between data, opinions, scientific arguments, and evidence and understand how each is derived (Marwati, 2021). Differentiating these concepts will help students be more thorough in reading and analyzing scientific information more critically and accurately.

In comparison, in the article on changes in SlimeSlime, some students may take the explanation of changes in the texture of the SlimeSlime at face value without really understanding the difference between experimental data showing how temperature or pressure affects the properties of SlimeSlime and the opinions expressed in the text. Therefore, teaching students to distinguish scientific evidence from opinion and critically

analyze information will help them better understand scientific experiments, both in the context of Archimedes' law and changes in SlimeSlime.

This research encourages students' critical thinking skills using a literacy approach with scientific articles on applying Archimedes' law in hydraulic pumps on car wash machines and changes in form in Slime. Research by Putri et al. (2024) shows that literacy significantly improves students' critical thinking skills (Rohman, 2022). Emphasizes that literacy is very important in improving students' critical thinking skills. With literacy, students can process and understand information closely related to critical thinking skills to analyze better and solve problems (Annas et al., 2024). Stated that good literacy skills are closely related to children's ability to analyze information and make decisions. Literacy includes reading, writing, and the ability to communicate effectively and understand the world around them, all of which support the development of critical thinking. It is also important for teachers to provide guidance and space for students to discuss collaboratively, especially in terms of theories such as changes in the physical properties of slime due to changes in temperature or pressure. Suppose teachers do not encourage discussion or involve students in critically analyzing data. In that case, students may not be able to relate the results of their analysis to the underlying theory. This aligns with research by Alamsyah et al. (2023), which emphasizes that teachers play an important role in facilitating discussions by providing guidance and relevant questions. The discussion method allows students to speak and listen to other people's opinions, which can significantly improve their critical thinking and analytical skills. Teachers must prepare materials, form groups, and ensure that each student actively participates in the discussion. Research by Putri et al. (2021) emphasizes the importance of the teacher's role in guiding students to explore deeper understanding through scientific literacy. Therefore, in Archimedes' law in car wash hydraulic pumps and slime changes, facilitating class discussions is important to develop students' critical thinking skills.

Conclusion

Using the article on Archimedes' law in the hydraulic pump of a car washer and the changes in SlimeSlime conducted in class helps to connect the physics concepts learned and apply them to the analysis of real-life problems. However, to state that the objectives related to understanding Archimedes' law in the hydraulic pump of a car washer cannot be achieved in just one critical reading. Instead, these concepts must be taught and applied regularly throughout the student's learning journey. Like the article on changes in slime, where students learn to identify physical and chemical changes in various contexts, the understanding of Archimedes' law must be reinforced through various experimental activities, discussions, and practical applications. Thus, these objectives can be achieved gradually and deeply, and build their critical thinking and scientific skills continuously.

References

Alamsyah, A., Fridayasha, N., & Angelina, R. (2023). Implementasi penerapan metode pembelajaran diskusi pada guru pendidikan agama islam dengan jumlah peserta didik yang sedikit di SDN 107411 Lau Rempak. *Jurnal Bilqolam Pendidikan Islam*, *4*(1), 1-13.

Annas, A. N., Baguna, I., Kobandaha, F., Salasa, S. A., Ilomata, Y., & Abdul, M. N. H. (2024). Urgensi literasi terhadap kemampuan berpikir kritis anak. *Jurnal Ilmiah Multidisiplin Keilmuan Mandira Cendikia*, *2*(14), 1–6.

Archila, P. A., Ortiz, B. T., & Truscott de Mejía, A. M. (2024). Beyond the passive absorption of information: Engaging students in the critical reading of scientific articles. *Science & Education*, 1-35.

Bramastia, B., & Rahayu, S. (2023). Study of science learning based on scientific literacy in improving critical thinking: A scoping review. *Jurnal Penelitian Pendidikan IPA*, *9*(8), 499-510.

Breakstone, J., Smith, M., Wineburg, S., Rapaport, A., Carle, J., Garland, M., & Saavedra, A. (2021). Students' civic online reasoning: A national portrait. *Educational Researcher*, *50*(8), 505-515.

Coiro, J. (2021). Toward a multifaceted heuristic of digital reading to inform assessment, research, practice, and policy. *Reading Research Quarterly*, 56(1), 9–31.

Dewey, J., Corita, S. M., & Eddington, A. S. (2008). Critical thinking. *A Primer on Natural Resource Science*, 65.

Eryuni, E. R. (2023). Pentingnya literasi dalam menumbuhkan nilai-nilai karakter di era digital. *Jurnal Kependidikan*, *7*(2), 67-73.

Facione, P. A. (2011). Critical thinking: What it is and why it counts. *Insight Assessment*, *1*(1), 1-23.

Fatmawati, A., Zubaidah, S., & Mahanal, S. (2019). Critical thinking, creative thinking, and learning achievement: How they are related. In *Journal of Physics: Conference Series* (Vol. 1417, No. 1, p. 012070). IOP Publishing.

Fauziah, A. (2024). Pentingnya kemampuan membaca kritis di era informasi digital. *Jurnal Citra Pendidikan*, *4*(2), 1685-1689.

Hasibuan, M. S., Lubis, M. J., & Hutagalung, S. M. (2025). Utilization of technological literacy to improve students' critical thinking skills in writing text. *International Journal of Multidisciplinary Approach Research and Science*, *3*(01), 50–58.

Inggriyani, F., & Fazriyah, N. (2018). Analisis kemampuan berpikir kritis siswa dalam pembelajaran menulis narasi di sekolah dasar. *Jurnal Pendidikan Dasar UNJ*, *9*(2), 30-41.

Juhji, J., & Mansur, M. (2020). Pengaruh literasi sains dan keterampilan berpikir kritis terhadap penguasaan konsep dasar biologi. *Edusains*, *12*(1), 113-122.

Karira, N. F., & Sunarti, T. (2022). Analisis keterkaitan kemampuan literasi sains dan keterampilan berpikir kritis. In *Proceedings of the Universitas Negeri Surabaya Physics Seminar*, *6*, 26-31.

Kurniawaty, I., Hadian, V. A., & Faiz, A. (2022). Membangun nalar kritis di era digital. *Edukatif : Jurnal ilmu pendidikan*, *4*(3), 3683–3690.

Marwati, H., & Waskitaningtyas, K. (2021). *Cerdas cergas berbahasa dan bersastra Indonesia untuk SMA/SMK Kelas XI*. Pusat Kurikulum dan Perbukuan.

Moreno Mosquera, E., & Mateus Ferro, G. E. (2018). La lectura de textos científicos en el marco de la literacidad disciplinar. *Enunciación*, *23*(1), 16–33.

Niculescu, B.-O., & Dragomir, I. (2023). Critical reading - A fundamental skill for building 21st-century literacy. *International Conference Knowledge-Based Organization*, *29*, 215–220.

Novianti, N. M. D., Parmiti, D. P., Renda, N. T., & Renda, N. T. (2022). Bahan ajar interaktif multimedia berbasis literasi sains pada muatan IPA kelas V sekolah dasar. *Mimbar Ilmu*, *27*(3), 399–408.

Oktafiani, E. N., & Irawan, D. (2021). Analisis kesulitan siswa dalam menemukan informasi penting dari sebuah bacaan paragraf. *Jurnal Muara Pendidikan*, *6*(2), 190-196.

Oliveras, B., Márquez, C., & Sanmartí, N. (2011). The use of newspaper articles as a tool to develop critical thinking in science classes. *International Journal of Science Education*, *35*(6), 885–905.

Padmakrisya, M. R., & Meiliasari, M. (2023). Studi literatur: Keterampilan berpikir kritis dalam matematika. *Jurnal Basicedu*, *7*(6), 3702–3710.

Patigu, Y. P. W., Rahmah, N., & Zulnuraini, Z. (2024). Literasi sains dan digital dalam pembelajaran IPA. *Journal of Education Research*, *5*(3), 3103–3110.

Paul, R., & Elder, L. (2019). *The miniature guide to critical thinking concepts and tools*. Rowman & Littlefield.

Pratiwi, R. T., Hadiyanti, N., Setiawan, I., & Nuryatin, A. (2023). Meningkatkan kemampuan berpikir kritis siswa pada mata pelajaran ekonomi. *Equilibrium: Jurnal Penelitian Pendidikan dan Ekonomi*, *20*(01), 29–36.

Putri, D. T., Setiono, S., & Ramdhan, B. (2021). Profil keterampilan proses sains peserta didik menggunakan model pembelajaran 9e learning cyccle at home melalui pembelajaran daring. *Biodik*, *7*(3), 164-175.

Putri, I. T. A. (2024). Literasi dalam meningkatkan kemampuan berpikir kritis peserta didik sekolah dasar era digital. In *Social, Humanities, and Educational Studies (SHES): Conference Series* (Vol. 7, No. 3). Universitas Sebelas Maret.

Rahardhian, A. (2022). Kajian kemampuan berpikir kritis (critical thinking skill) dari sudut pandang filsafat. *Jurnal Filsafat Indonesia*, *5*(2), 87-94.

Rahma, S. N., Deyanti, F., & Fitriyah, M. (2024). Peran membaca dalam meningkatkan kemampuan berpikir kritis di kalangan mahasiswa. *Dharma Acariya Nusantara: Jurnal Pendidikan, Bahasa dan Budaya*, *2*(1), 100–108.

Rohman, A. (2022). Literasi dalam meningkatkan kemampuan berpikir kritis di era disrupsi. *EUNOIA (Jurnal Pendidikan Bahasa Indonesia)*, *2*(1), 40-47.

Sihombing, M. S. S., Hidayat, W., & Ramadhanic, M. (2024). Pengaruh model pembelajaran cooperative learningterhadap kemampuan berpikir kritis siswa padatema 1 sub tema 3 di kelas V SDN 107416 Sugiharjo. *Jurnal Teknologi Pendidikan Dan Pembelajaran*, *2*(1), 416-427.

Simatupang, S. A., Situmorang, E. R. V., Simbolon, I. C., & Umar, A. T. (2024). Analisis penerapan metode pembelajaran diskusi kelompok terhadap pemahaman siswa pada pembelajaran di SMA negeri 21 Medan. *Jurnal Nakula: Pusat Ilmu Pendidikan, Bahasa Dan Ilmu Sosial*, *2*(4), 201–210.

Song, J., Chun, J., & Na, J. (2021). Why do people trust something other than science? *Science & Education*, *30*, 1387–1419.

Wahyudi, A., & Purwanto, H. (2024). Menganalisis aspek peningkatan kemampuan berpikir kritis siswa dalam pembelajaran IPA. *Edukasi Elita: Jurnal Inovasi Pendidikan*, *1*(4), 162-178.

Widiastuti, W., & Kania, W. (2021). Penerapan metode diskusi untuk meningkatkan kemampuan berfikir kritis dan pemecahan masalah. *Jurnal Pendidikan Ekonomi Indonesia*, *3*(2), 259-264.

Yani, M. (2024). Peran literasi membaca dalam mengembangkan kemampuan berpikir kritis mahasiswa STKIP taman siswa bima. *Jurnal Pendidikan dan Pembelajaran Indonesia (JPPI)*, *4*(2), 715-720.

Zamroni, M., & Warsono, W. (2020). Hubungan antara kemampuan berpikir kritis dengan kemampuan membaca (studi kasus budaya literasi mahasiswa PPKN Universitas Negeri Surabaya). *Kajian Moral dan Kewarganegaraan*, *8*(2), 687-701.