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Preliminary Analysis of Scientific Literacy in Fluids at SHS 6 Padang

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Abstract: One of the 21st-century skills that students must master is scientific literacy. A good mastery of scientific literacy helps solve real-world problems. However, the results of PISA 2018 inform that Indonesian students' scientific literacy is relatively low. This study aims to analyze students' physics scientific literacy on fluid materials. Quantitative descriptive methods using fluid material scientific literacy test instruments were used to collect data. The research sample consisted of 36 students at SHS 6 Padang. The use of students' scientific literacy in the context aspect was 35.5% in the low category, the content was 35.7% in the low category, and the competency category was 35.3% in the low category. So, students' mastery of scientific literacy on fluid materials is in a low category.

Keywords: Fluids; Preliminary analysis; Scientific literacy

Introduction

The development of innovative technology encourages students to have 21st-century skills. One of the demands of the 21st century is mastering communication skills, critical thinking, creativity, collaboration, technology, and scientific literacy (González-Pérez & Ramírez-Montoya, 2022; Kennedy & Sundberg, 2020; Van Laar et al., 2017). Scientific literacy helps students form knowledge, competencies, and attitudes toward science and technology in everyday life (Cansiz & Cansiz, 2019; Fanata et al., 2017). Good scientific literacy encourages mastery of problem-solving.

Scientific literacy refers to understanding problems through analyzing, identifying, conducting investigations, and making conclusions (Sinaga et al., 2017). This capability aims to build a strong scientific foundation for discussing global issues (Cansiz & Cansiz, 2019; Dewi et al., 2019; Tienken, 2017). Mastery of good understanding is needed in solving real-world problems. Scientific literacy is an important part of improving mastery of the material in learning.

Physics is part of science that is closely related to the problems of everyday life. Various forms of natural phenomena and real-world contexts are discussed in material physics. Thus, scientific literacy in physics is needed to increase understanding and be implemented in everyday life.

A good understanding of concepts and procedures about the real world indicates good mastery of scientific literacy for students. According to PISA, students can be considered to have good scientific literacy competence if they can evaluate and plan scientific research, explain phenomena using science, and interpret data or evidence using science (PISA, 2019). Conversely, if students experience misconceptions, it impacts students low mastery of concepts (Mufit et al., 2022; Mufit & Fauzan, 2023).

The average science score of Indonesian students, 389, is much lower than the OECD's 489 in PISA 2018 (Kemendikbud, 2019). The results of previous studies revealed low understanding of students' concepts in

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science learning. Student understanding in solving problems related to fluid material is also still relatively low (Dhanil & Mufit, 2021a; Puspitasari et al., 2021). One of the recommendations from the Indonesian government for overcoming these problems is technology optimization. Because technology has an important role to increase student literacy (Kunina-Habenicht & Goldhammer, 2020). Therefore, appropriate media and teaching materials are needed to support students' scientific literacy. In addition, selecting learning models that emphasize investigation is part of efforts to support the mastery of scientific literacy.

Learning models in 21st-century education must accommodate changing times and student needs by utilizing technology, collaboration, and other 21st-century skills to prepare students to become competent and highly competitive individuals in the global era. Learning models and approaches that are contextual and emphasize inquiry are part of efforts to support students' mastery of scientific literacy (Asrizal et al., 2018).

In addition, ICT media can be an effective teaching material and media in supporting students' scientific literacy. In today's digital era, ICT media such as videos, animations, simulations, and interactive games can make it easier for students to understand science concepts visually and interactively and motivate students to learn science in a more fun way (Mufit et al., 2023). ICT media also allows students to access more accurate information and expand their understanding of scientific phenomena in everyday life.

Research on students' mastery of science literacy needs to be investigated because technological advances should have a positive impact in supporting literacy mastery if it has been applied properly. Because, science literacy is a basic skill in explaining, investigating, and interpreting data from information in life. This ability becomes an important part of 21st century skills and soft skills that help in solving everyday problems through scientific knowledge acquired during learning. Preliminary analysis is needed to determine students' mastery of scientific literacy. Through this preliminary analysis, we can explore additional information that will help improve the quality of education and appropriate solutions to solve the problem. Therefore, the research aims to analyze students' physics scientific literacy on fluid materials.

Method

The type of research conducted is a survey with a quantitative descriptive approach. This study aims to analyze students' initial knowledge about students' scientific literacy and the implementation of learning in supporting the improvement of students' scientific literacy at SHS 6 Padang on fluid material. The stages in this study are presented in Figure 1.

Figure 1. Research flowchart

The first stage in this study is to collect data on mastery of science literacy using instruments in the form of science literacy tests about fluid materials. The science literacy test instrument consists of 20 complex multiple-choice questions that contain aspects of context, content and competence. There were 36 students who had learned fluid material and were tested using science literacy instruments to see their mastery of abilities.

The second stage, the test result data is data tabulation and data analysis. In quantitative data analysis, the data taken includes test results. The purpose of processing test result data is to understand students' scientific literacy abilities. The results of student mastery are calculated the number of true and false from each question item answered. The scores obtained by students are calculated based on percentage techniques such as Equation 1.

$$Score = \frac{Correct\ answer\ of\ each\ category}{Number\ of\ students} x\ 100\% \quad (1)$$

After all the data is processed, and analyzed aspects of content, context, and competence. The next step is to group the results of students' mastery of science literacy and conclude based on predetermined criteria. The criteria for students' scientific literacy scores are presented in Table 1.

Table 1. Scientific Literacy Score Criteria (Jufrida et al., 2019)

Score	Category
81-100	Very high
61-80	High
41-60	Medium
21-40	Low
0-20	Very low

Result and Discussion

This test has 20 complex multiple-choice questions with contexts relevant to real problems. These problems are presented in the form of readings or texts supplemented with questions that must be answered based on the understanding of the text. According to the

OECD (2018), scientific literacy has three interrelated aspects of the assessment framework: context, knowledge, and competence (PISA, 2019).

The context aspect leads students to recognize life situations related to global or national issues involving science and technology. Students are expected to understand that science has important value for individuals and society in improving the quality of life and developing public policies. The results of context aspects in scientific literacy tests are shown in Table 2.

Table 2. Context Aspects in Scientific Literacy Problems

Context	Question Number	Percentage (%)
Environment	11, 12, 17, 13	31
Science and technology	5, 6, 9, 10, 14, 15, 16, 18	36
Global issues and dangers	1,2,3,4	39
Health and disease	7, 8	35
Natural resources	19, 20	36
Average		35.40

Based on the data in Table 2 informs that students' skills in studying physics phenomena in the environment are in a low category. Mastery of science and technology in life is in the low category. In addition, the context of real-world problems related to global hazards, health, and natural resources is in the low category. Overall, the average percentage of students' scientific literacy ability in the context indicator was 35.4%. This score belongs to the low category.

The knowledge aspect leads students to understand nature based on scientific knowledge, including knowledge of nature and science. The knowledge aspect refers to the content of the material discussed in a particular field. The results of content aspects in scientific literacy tests are shown in Table 3.

Table 3. Content Aspect

Content	Question Number	Percentage (%)
Hydrostatic pressure	1, 2, 4	31.40
Pascal's principle	5, 6	35.10
Archimedes principle	3, 7, 8	34.70
Surface tension	11	38.8
Capillarity	9, 10	38.8
Viscosity	12	36
Debit	13	36
Continuity equation	14	36
Bernaulli's law (Leaky tanks, venturi meters, pitot tubes, and aircraft)	15, 16, 17, 18, 19, 20	35
Average		35.70

Based on the data in Table 3 informs that there are 8 fluid material contents in the scientific literacy test. The results of mastery of students' scientific literacy in the content aspect have an average score of 35.7%. This score falls into the low category on all fluid materials.

In the problem, three scientific processes are tested: explaining phenomena with a scientific approach, evaluating and designing scientific investigations, and interpreting data and evidence scientifically. The results of students' mastery of scientific literacy on aspects of competence in the test are shown in Table 4.

Table 4. Competency Aspects

Competency indicators	Question Number	Percentage (%)
Explain phenomena scientifically	3, 4, 5, 7, 11, 12, 16, 18	35
Evaluate and design scientific investigations	9, 10, 13	33
Interpret data and evidence scientifically	1, 2, 6, 8, 14, 15, 17, 19, 20	38
Average		35.30

Based on Table 4 informs that students have not been able to explain scientific phenomena scientifically. In evaluating and drafting scientific investigations are still relatively low. In addition, students have not been able to interpret scientific data and evidence well. Overall, the average percentage of students' scientific literacy ability in the competency indicator was 35.3%. This score belongs to the low category. Overall, aspects of mastery of students' scientific literacy are shown in Figure 2.

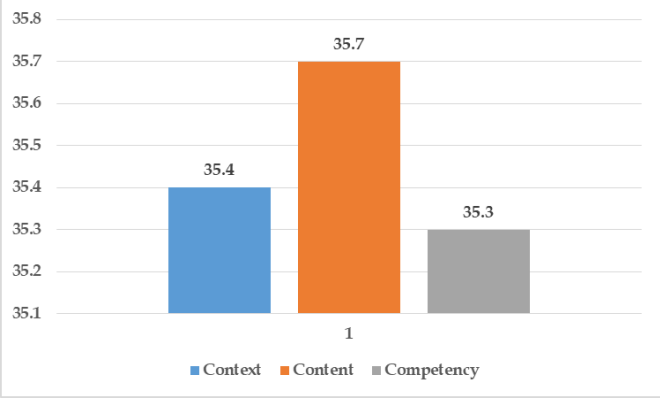

Figure 2. Aspects of scientific literacy

Figure 2 presents overall student literacy outcomes. Based on the results of the scientific literacy test, which contains 3 aspects of the assessment framework in the form of complex multiple-choice questions, are in a low category in aspects of context, concepts, and competencies. The results of this study are supported by previous studies that obtained similar results. The assessment of students' scientific literacy includes aspects of context, content, processes, and attitudes in students that are relatively low in analyzing information related to real-world problems (Fakhriyah et al., 2017;

Jamaluddin et al., 2019). Learning focusing on rote memorization impacts students' mastery of scientific literacy on physics material (Purwani et al., 2018).

Scientific knowledge is part of scientific literacy. Good mastery of scientific knowledge helps solve problems (Drummond & Fischhoff, 2017). The complete presentation of material based on real-world concepts helps improve students' scientific literacy (Henukh et al., 2021; Maxwell et al., 2017). The implementation of the learning process that emphasizes the context of daily life problems is the cause of students' low scientific literacy (Bellová et al., 2018). The presentation of physics learning materials based on aspects of scientific literacy is still rarely applied in learning (Effendi et al., 2021).

The low level of scientific literacy is caused by a lack of understanding of science learning, where teachers do not fully understand students' lack of scientific literacy. In terms of content, the low level of scientific literacy is caused by the science learning approach that is still focused on memorization, so students only memorize without really understanding the material they are learning (Jufri et al., 2016). This scientific literacy problem is a focus for teachers in aspects of the learning process (Sjöström & Eilks, 2018). Students only listen to explanations from teachers and learn science as a product that must be remembered, regardless of the process, attitude, and application. In addition, contextual aspects also affect the low literacy of science, where teachers do not fully relate the material to the student's environment (Alvina et al., 2022).

Scientific literacy requires not only an understanding of science concepts and theories, but also knowledge of general procedures and practices associated with scientific inquiry, as well as how these contribute to the advancement of science. In addition, the use of ICT in learning is needed in presenting more contextual learning more easily (Dhanil & Mufit, 2021b; Mufit et al., 2022; Rosidah et al., 2021). The use of ICT in learning can encourage improving students' scientific literacy (Hu et al., 2018). scientific literacy emphasizes mastery of understanding concepts and not just rote memorization (Amala et al., 2023). Learning that emphasizes inquiry can increase students' understanding of concepts in learning (Dirman & Mufit, 2022). Therefore, selecting strategies, models, approaches, media and the use of ICT in learning is needed to improve students' scientific literacy in presenting aspects of context, content and better competition.

Conclusion

Based on the results of the analysis of scientific literacy, students in the context aspect have an average score of 35.5%, in the content aspect have an average score of 35.7% with a low category, in the competency aspect have a value of 35.3% with a low category. Overall, the average scientific literacy of students at SHS 6 Padang on fluid material is in a low category.

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The author's contributions include: Muhammad Dhanil in collecting data, analyzing data, writing original drafts, and so on; Fatni Mufit in conceptualizing research, focusing on methodology, and reviewing writings.

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Conflicts of Interest
The authors declare no conflict of interest.

References

Alvina, S., Mellyzar, M., Zahara, S. R., Masrina, M., & Afrianti, S. (2022). The Influence of POGIL and MFI Models on Science Literacy and Science Process Skills for Junior High School. *Jurnal Penelitian Pendidikan IPA*, *8*(4), 1907–1915. https://doi.org/10.29303/jppipa.v8i4.2121

Amala, I. A., Sutarto, S., Putra, P. D. A., & Indrawati, I. (2023). Analysis of Scientific Literacy Ability Junior High School Students in Science Learning on Environmental Pollution. *Jurnal Penelitian Pendidikan IPA*, *9*(3), 1001–1005. https://doi.org/10.29303/jppipa.v9i3.1816

Asrizal, A., Amran, A., Ananda, A., Festiyed, F., & Sumarmin, R. (2018). The development of integrated science instructional materials to improve student digital literacy in scientific approach. *Jurnal Pendidikan IPA Indonesia*, *7*(4), 442–450. https://doi.org/10.15294/jpii.v7i4.13613

Bellová, R., Melicherčíková, D., & Tomčík, P. (2018). Possible reasons for low scientific literacy of Slovak students in some natural science subjects. *Research in Science & Technological Education*, *36*(2), 226–242. https://doi.org/10.1080/02635143.2017.1367656

Cansiz, N., & Cansiz, M. (2019). Evaluating Turkish science curriculum with PISA scientific literacy framework. *Turkish Journal of Education*, *8*(3), 217–236. https://doi.org/10.19128/turje.545798

Dewi, C. A., Khery, Y., & Erna, M. (2019). An ethnoscience study in chemistry learning to develop scientific literacy. *Jurnal Pendidikan IPA Indonesia*, *8*(2), 279–287. https://doi.org/10.15294/jpii.v8i2.19261

Dhanil, M., & Mufit, F. (2021a). Design and Validity of Interactive Multimedia Based on Cognitive Conflict on Static Fluid Using Adobe Animate CC 2019. *Jurnal Penelitian & Pengembangan Pendidikan Fisika*, *7*(2), 177–190. https://doi.org/10.21009/1.07210

Dhanil, M., & Mufit, F. (2021b). Design and Validity of Interactive Multimedia Based on Cognitive Conflict on Static Fluid Using Adobe Animate CC 2019. *Jurnal Penelitian & Pengembangan Pendidikan Fisika*, *7*(2), 177–190. https://doi.org/10.21009/1.07210

Dirman, H. M., & Mufit, F. (2022). Disain dan Validitas E-Instrument Five Tier-Multiple Choice Test Menggunakan iSpring Quiz Maker Sebagai Asesmen Literasi Sains Siswa Pada Pembelajaran Abad-21. *Jurnal Penelitian Pendidikan IPA*, *8*(6), 3170–3179. https://doi.org/10.29303/jppipa.v8i6.2300

Drummond, C., & Fischhoff, B. (2017). Individuals with greater science literacy and education have more polarized beliefs on controversial science topics. *Proceedings of the National Academy of Sciences*, *114*(36), 9587–9592. https://doi.org/10.1073/pnas.1704882114

Effendi, D. N., Anggraini, W., Jatmiko, A., Rahmayanti, H., Ichsan, I. Z., & Rahman, M. M. (2021). Bibliometric analysis of scientific literacy using VOS viewer: Analysis of science education. *Journal of Physics: Conference Series*, *1796*(1), 12096. https://doi.org/10.1088/1742-6596/1796/1/012096

Fakhriyah, F., Masfuah, S., Roysa, M., Rusilowati, A., & Rahayu, E. S. (2017). Student's science literacy in the aspect of content science? *Jurnal Pendidikan IPA Indonesia*, *6*(1). https://doi.org/10.15294/jpii.v6i1.7245

Fanata, M. R. (2017). *Materi Pendukung Literasi Sains, Gerakan Literasi Nasional*. Kementrian Pendidikan dan kebudaya.

González-Pérez, L. I., & Ramírez-Montoya, M. S. (2022). Components of Education 4.0 in 21st century skills frameworks: systematic review. *Sustainability*, *14*(3), 1493. https://doi.org/10.3390/su14031493

Henukh, A., Simbolon, M., Astra, I. M., & Rosdianto, H. (2021). Analysis of Students' Science Literacy Ability on Heat Concept. *JIPF (Jurnal Ilmu Pendidikan Fisika)*, *6*(2), 178–184. https://doi.org/10.26737/jipf.v6i2.2077

Hu, X., Gong, Y., Lai, C., & Leung, F. K. S. (2018). The relationship between ICT and student literacy in mathematics, reading, and science across 44 countries: A multilevel analysis. *Computers & Education*, *125*, 1–13. https://doi.org/10.1016/j.compedu.2018.05.021

Jamaluddin, J., Jufri, A. W., Ramdani, A., & Azizah, A. (2019). Profil literasi sains dan keterampilan berpikir kritis pendidik IPA SMP. *Jurnal Penelitian Pendidikan IPA*, *5*(1). https://doi.org/10.29303/jppipa.v5i1.185

Jufri, A. W., Setiadi, S., & Sripatmi, D. (2016). Scientific Reasoning Ability Of Prospective Student Teacher in The Excellence Program of Mathematics and Science Teacher Education in University of Mataram. *Jurnal Pendidikan IPA Indonesia*, *5*(1), 69–74. https://doi.org/10.1007/s10857-023-09570-x

Jufrida, J., Basuki, F. R., Kurniawan, W., Pangestu, M. D., & Fitaloka, O. (2019). Scientific Literacy and Science Learning Achievement at Junior High School. *International Journal of Evaluation and Research in Education*, *8*(4), 630–636. https://doi.org/10.11591/ijere.v8i4.20312

Kemendikbud. (2019). *Hasil PISA Indonesia 2018: Akses Makin Meluas, Saatnya Tingkatkan Kualitas*. Retrieved from https://www.kemdikbud.go.id/main/blog/2019/12/hasil-pisa-indonesia-2018-akses-makin-meluas-saatnya-tingkatkan-kualitas

Kennedy, T. J., & Sundberg, C. W. (2020). 21st century skills. In *Springer International Publishing*. Springer. https://doi.org/10.1007/978-3-030-43620-9_32

Kunina-Habenicht, O., & Goldhammer, F. (2020). ICT engagement: A new construct and its assessment in PISA 2015. *Large-Scale Assessments in Education*, *8*(1), 1–21. https://doi.org/10.1186/s40536-020-00084-z

Maxwell, S., Reynolds, K. J., Lee, E., Subasic, E., & Bromhead, D. (2017). The impact of school climate and school identification on academic achievement: Multilevel modeling with student and teacher data. *Frontiers in Psychology*, *8*, 2069. https://doi.org/10.3389/fpsyg.2017.02069

Mufit, F., Asrizal, A., Puspitasari, R., & Annisa, A. (2022). Cognitive Conflict-Based E-Book with Real Experiment Video Analysis Integration to Enhance Conceptual Understanding of Motion Kinematics. *Jurnal Pendidikan IPA Indonesia*, *11*(4). https://doi.org/10.15294/jpii.v11i4.39333

Mufit, F., & Fauzan, A. (2023). The effect of cognitive Conflict-Based Learning (CCBL) Model on remediation of misconceptions. *Journal of Turkish Science Education*, *20*(1). https://doi.org/10.36681/tused.2023.003

Mufit, F., Hendriyani, Y., & Dhanil, M. (2023). *Augmented Reality dan Virtual Reality Berbasis Konflik Kognitif Sebagai Media Pembelajaran Sbad ke-21 [Augmented Reality and Virtual Reality Based on Cognitive Conflict as a 21st Century Learning Medium]*. Rajawali Press.

PISA, O. (2019). *PISA 2018: Assessment and Analytical*

Framework. PISA, OECD Publishing Paris. Retrieved from https://www.oecd.org/education/pisa-2018-assessment-and-analytical-framework-b25efab8-en.htm

Purwani, L. D., Sudargo, F., & Surakusumah, W. (2018). Analysis of student's scientific literacy skills through socioscientific issue's test on biodiversity topics. *Journal of Physics: Conference Series*, *1013*(1), 12019. https://doi.org/10.1088/1742-6596/1013/1/012019

Puspitasari, R., Mufit, F., & Asrizal. (2021). Conditions of learning physics and students' understanding of the concept of motion during the covid-19 pandemic. *Journal of Physics: Conference Series*, *1876*(1). https://doi.org/10.1088/1742-6596/1876/1/012045

Rosidah, U. A., Marwoto, P., & Subali, B. (2021). Analysis of the Need for Android Based Mobile Learning Development to Improve Student Science Literations. *Jurnal Penelitian Pendidikan IPA*, *7*(4), 601–606. https://doi.org/10.29303/jppipa.v7i4.805

Sinaga, P., Kaniawati, I., & Setiawan, A. (2017). Improving secondary school students' scientific literacy ability through the design of better science textbooks. *Journal of Turkish Science Education*, *14*(4), 92–107. https://doi.org/10.47939/es.v2i12.22

Sjöström, J., & Eilks, I. (2018). Reconsidering different visions of scientific literacy and science education based on the concept of Bildung. *Cognition, Metacognition, and Culture in STEM Education: Learning, Teaching and Assessment*, 65–88. https://doi.org/10.1007/978-3-319-66659-4_16

Tienken, C. H. (2017). Understanding PISA results. *Kappa Delta Pi Record*, *53*(1), 6–8. https://doi.org/10.1080/00228958.2017.1264806

Van Laar, E., Van Deursen, A. J. A. M., Van Dijk, J. A. G. M., & De Haan, J. (2017). The relation between 21st-century skills and digital skills: A systematic literature review. *Computers in Human Behavior*, *72*, 577–588. https://doi.org/10.1016/j.chb.2017.03.010