# Digital Literacy and Scientific Literacy of Science Teachers and Student Learning Styles in Science Learning

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## Abstract

The study aimed to analyze the teachers' understanding of scientific literacy based on the PISA 2025 framework, teachers' digital skills, and student learning styles. The descriptive method used in this research. Data was collected by surveying and distributing questionnaires to 305 students and 20 science teachers at Bogor. The data was analyzed quantitatively through the provision of scores, and then the percentage was determined. The results showed that the average teacher's digital literacy was 73.5%, teachers' understanding of scientific literacy based on the PISA 2025 framework was 77.1%, and students had visual, auditory, read/writing, and kinesthetic learning styles. Thus, digital literacy and teachers' literacy understanding are in a good category. The study results are the basis for science teachers in compiling e-books for science learning by considering students' learning styles.

Keywords*:* Digital literacy, Scientific literacy, Learning styles, e-Books, Science learning

## INTRODUCTION

Education in the 21st century requires teachers to develop their professionalism constantly. This is necessary so that teachers have 21st-century skills to educate students well. One of these skills is basic literacy, including scientific and digital literacy. Efforts to develop teacher professionalism have been carried out through teacher training and coaching (Rerendo et al., 2021), teacher professional training programs (Maulana et al., 2023), classroom action research-based teaching (Meesuk et al., 2020), peer training (Afshar & Doosti, 2022), and teacher professionalism development based on scientific literacy (Rubini et al., 2017). A teacher also needs to have good scientific literacy to train and familiarize students with scientific literacy through the learning process and learning resources. This indicates that teachers with strong scientific literacy are better positioned to create relevant and effective learning resources that foster students' scientific literacy (Dewi et al.,2022; He et al., 2023). Just as teachers are expected to develop professionally, students must acquire essential 21st-century skills.

The 21st century also requires students to have various skills relevant to the development of technology and science. These skills need to be trained to students because life at school will be different from life in the world of work and society. Therefore, students must have the necessary skills to learn, communicate, collaborate, and solve problems in a digital environment (González-Salamanca et al., 2020). Another opinion states that the 21st century consists of three main components: competence, basic literacy, and personal and professional life (Trilling & Fadel, 2020). Scientific literacy and digital literacy are part of basic literacy. The 4Cs (communication, collaboration, critical thinking, and creativity) are included in the 21st-century competency component.

The 21st century is marked by the emergence of the Industrial Revolution 4.0 or the digitalization revolution (Haqqi & Wijayati, 2019). This century is a technological revolution phase that changes how humans act compared to previous life experiences (Supena et al., 2021). The development of information and communication technology (ICT) has led to digital transformation, including the world of education (Fukuda, 2020). Teachers need digital literacy to carry out 21st-century learning and improve their professionalism.

Digital literacy is the ability to obtain, understand, and use information from various sources in digital form. According to Siero, the indicators of digital literacy are basic ICT competencies; information skills, media awareness, and computational thinking (Siero, 2017). A teacher needs to possess digital literacy to develop teaching materials in a contextual, visual manner. Interesting and interactive (Rusydiyah et al., 2021). In addition to digital literacy, teachers also need to have scientific literacy. This is because the scientific literacy of Indonesian students, as a result of the PISA assessment, is still low. The results of PISA in 2022 show that 66% of Indonesian students are ranked 66 out of 80 participants with a score of 383 (OECD, 2022). These results indicate that most Indonesian students can still recognize scientific phenomena and use their knowledge to identify simple problems. One of the factors causing this is that the books used do not contain a scientific literacy component.

Writing science textbooks is very necessary to make it easier for teachers to carry out learning. Some of the teaching

books/modules that have been developed include: e-modules based on Socio Issues (Utami et al., 2023; Alfitriyani et al., 2021; Pursitasari et al., 2022), e-books based on STEM-AR (Nugraheni et al., 2022; Khoeriah et al., 2023), books on Critical Thinking and Ecoliteracy (Pursitasari et al., 2023), e-books on metacognition learning strategies (Susantini et al., 2021), and e-books based on multi-representation (Rasmawan et al., 2022). Based on the research, no one has developed a scientific literacy-based textbook.

Scientific literacy is the ability to understand scientific concepts and processes, as well as being able to use scientific knowledge to solve problems. Various efforts have been made to improve students' scientific literacy, including: teaching materials containing marine contexts (Pursitasari et al., 2019), STEAM-based (Twiningsih et al., 2021), as well as learning in the context of socio-scientific issues (Ke et al., 2021), inquiry (Wen et al., 2021; Kang, 2020; Ma, 2023), AR-assisted STEM (Wahyu, et al., 2020), blended learning (Pursitasari et al., 2020), and discovery learning (Pursitasari et al., 2019). So far, there has been no effort to improve scientific literacy by writing science textbooks based on scientific literacy. In addition to scientific literacy, 21st-century learning also requires digital literacy.

Digital literacy is a skill that is needed to utilize digital media wisely, intelligently, and appropriately. Research to improve digital literacy has been conducted through: digital storytelling (Churchill, 2020; Çetin, 2021), the use of social media (Tsvetkova et al., 2021), self-regulated learning strategies (Anthonysamy et al., 2020), QR-Code-Based e-Modules (Pratiwi et al., 2022), and android-based learning modules (Wahyuni et al., 2021).

When preparing lesson plans and textbooks, paying attention to the student's learning styles is necessary. Each individual has a different learning style, and knowing one's learning style can help choose the right learning method and improve learning outcomes (Dariyanti et al., 2021; Farhan & Risdianti, 2021). Learning style is an individual's preference in processing information. According to Kolb's theory (1984), there are four types of learning styles: (1) convergent (using abstract knowledge to solve practical problems); (2) divergent (prioritizing observation and observation, developing ideas through reflection); (3) assimilation (prioritizing abstract and logical concepts, analytical thinking, and (4) accommodation (relying on intuition and trying new things). Another model states that there are four learning styles, namely Visual, Auditory, Reading/Writing, Kinesthetic, or abbreviated as VARK (Amaniyan et al., 2020; Espinoza-Poves et al., 2019; Husmann & O'Loughlin, 2019; Mozaffari et al., 2020). Each individual has different learning style tendencies, and understanding this can help teachers design effective learning strategies.

According to the VARK model (Flemming, 2021), students are identified as having learning style preferences such as Visual, Auditory, Read/Write, and Kinesthetic learning styles. Visual learners love maps, charts, graphs, diagrams, colors, photos, and spatial layouts. In contrast to visual learners, Auditory learners prefer to explain new ideas to others, discuss problems with other students and teachers, record lectures, and participate in discussion groups that use humor. Reading/writing learners prefer essays, reports, textbooks, web pages, and note-taking. The owners of the kinesthetic style like field visits,

laboratory practicums, solving challenging problems, and simulations (Mirza & Khurshid, 2020; Taheri et al., 2021).

Based on the background that has been presented, the purpose of the research is to analyze digital literacy, teachers' understanding of science literacy, and student learning styles. These three variables need to be analyzed as materials in writing textbooks that can improve students' science literacy.

## METHOD

The research was conducted on 305 junior high school students in grades VII and VIII, comprising 154 males and 151 females, and 20 teachers, 15 female teachers and five male teachers from the Science Teacher Working Group in Bogor Regency. Data was collected by using a questionnaire on teachers' understanding of the PISA 2025 framework, scientific literacy, a digital literacy questionnaire, and a student learning style questionnaire. Data collection was carried out using a Google form.

The teacher's understanding of the PISA 2025 framework scientific literacy instrument is in the form of multiple-choice questions consisting of 20 valid questions related to the understanding of science knowledge and 10 valid questions including the teacher's understanding of the science identity contained in the PISA 2025 Science Framework, with a reliability coefficient of 0.82. The digital literacy questionnaire consists of four parts, namely (1) knowledge and use of digital tools; (2) information search and management; (3) digital publications and promotions; and (4) legal and ethical aspects, with a reliability of 0.86. The learning style questionnaire comprised 16 statements with two answer choices: Agree and Disagree. This is done to simplify and further ensure the choice of answers. The collected data is then analyzed in a quantitative descriptive manner by giving scores and determining the percentage. In addition, qualitative descriptive data analysis was also carried out.

## RESULT AND DISCUSSION

Scientific literacy is one of the basic literacy skills individuals need to face challenges in the 21st century. However, the scientific literacy of Indonesian students, based on the results of the Program for International Student Assessment (PISA) assessment, is still below the average scientific literacy score in the world. PISA test scores are often the main research focus (Aditomo & Klieme, 2020; König et al., 2021; Radišić et al., 2021). This needs the attention and efforts of all parties so that there will be an increase in the scientific literacy of Indonesian students in the future. One of the efforts that can be made includes writing learning resources or books by teachers. Books are a window to science. Therefore, a teacher should also write books both in print and digitally that can be used to support the science learning process and improve students' scientific literacy. For the book he writes to train and familiarize students to learn science holistically and apply it in daily life, it is necessary to prepare a textbook based on scientific literacy. Therefore, a collection and analysis of teachers' understanding of the PISA 2025 framework scientific literacy has been carried out, with the results contained in Figure 1.

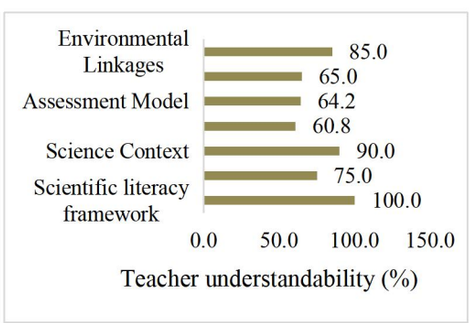

Figure 1. Teachers' Understanding of PISA 2025 Framework Scientific Literacy Content

Figure 1 shows that all teachers understand the definition of scientific literacy with the PISA 2025 framework. This is because the explanation of scientific literacy in the PISA 2025 framework is easy to understand. This is reinforced by the results of research by Deta et al. (2024), which concluded that the language in the PISA 2025 Framework is simpler and more coherent by emphasizing the main ideas of science. The PISA 2025 framework develops scientific literacy and the function of scientific information. Procedural and epistemic knowledge is expanded and clarified.

The science context aspect also obtained excellent grades. This is because, in the PISA 2025 framework, scientific literacy is easy to understand. The context of science in the PISA 2025 framework for scientific literacy is similar to the PISA 2018 framework for scientific literacy, which consists of personal, local, and global contexts (OECD, 2019; OECD, 2023). The lowest score is the teacher's understanding of science competence. This is because there is a slight change in science competencies in the PISA 2025 and PISA 2018 Framework scientific literacy. In the PISA 2025 framework, decision-making has emerged as one of the skills needed in the 21st century. The 21st-century proficiency includes communication, collaboration, critical thinking and problem-solving, and creativity and innovation, abbreviated as the 4Cs (Thornhill-Miller et al., 2023). Therefore, teachers need to design learning by providing reading resources to prepare students with decision-making and problem-solving skills (Binkley et al., 2012). A comparison of the science competencies of the PISA Framework 2018 and 2025 is found in Table 1.

Table 1. Comparison of science competencies of the PISA Framework 2018 and 2025

| No. | Science competencies | |
|---|---|---|
| | Framework PISA 2018 | Framework PISA 2025 |
| 1. | Explain phenomena scientifically | Explain phenomena scientifically |
| 2. | Evaluating and designing scientific inquiry. | Construct and evaluate design for scientific inquiry and critically interpret scientific data and evidence. |
| 3. | Interpreting data and evidence scientifically. | Research, evaluate, and use scientific information for decision-making and action |

OECD, 2019; OECD, 2023

In addition to understanding the scientific literacy content of the PISA 2025 Framework, information on teachers' understanding of science identity with an average of 99% (very good) was also obtained, as shown in Table 2. Almost all indicators scored 100% except those that understand the importance of supporting students' curiosity and critical attitude towards science, as well as explaining the scientific process and how scientific knowledge progressed along with new discoveries, with an average of 95%. Students' curiosity, critical attitude towards science, scientific processes, and knowledge about the development of science and technology need to continue to be built, trained, and habituated through the learning process and digital books. Therefore, teachers also need to have good digital literacy.

Table 2. Teachers' Understanding of the Science Identity of the PISA 2025 Framework

| No. | Indicator | Value (%) |
|---|---|---|
| 1 | Understand the importance of supporting students' curiosity and critical attitude towards science. | 95 |
| 2 | Understand the importance of providing real expectations and examples of action to students regarding environmental issues. | 100 |
| 3 | Understand the importance of teaching media literacy and critical evaluation skills to students. | 100 |
| 4 | Understand the importance of explaining scientific processes and how scientific knowledge develops along with discoveries. | 95 |
| 5 | Demonstrate an understanding of the importance of supporting student resilience and an experience that failure is part of the scientific process. | 100 |
| 6 | Demonstrate an understanding of the importance of creating a learning environment that supports openness and inquiry from students. | 100 |
| 7 | Demonstrate an understanding of the importance of relating science material to students' interests and daily lives to increase engagement | 100 |
| 8 | Demonstrate an understanding of the importance of critically evaluating the impact of technology and making informed decisions | 100 |
| 9 | Demonstrate an understanding of the importance of demonstrating the relevance of science in everyday life and various fields of work | 100 |
| 10 | Demonstrate an understanding of the importance of supporting student initiatives in environmental issues and extracurricular activities. | 100 |
| | **Average** | 99 |

**Teachers' Digital Literacy**

The preparation of textbooks digitally requires the ability of teachers to understand and use computer technology. The results of digital literacy of science teachers are descriptively contained in Table 3.

Table 3. Digital Literacy of Science Teachers

| No. | Description | Value (%) |
|---|---|---|
| 1 | Highest score | 91.8 |
| 2 | Lowest score | 61.6 |
| 3 | Average | 75.3 |
| 4 | Mode | 71.2 |
| 5 | Median | 71.2 |
| 6 | Standard deviation | 7.89 |

Table 3 shows the average digital literacy of science teachers of 75.3 (good category). Good digital literacy will make it easier for science teachers to compile digital textbooks. In today's digitalization era, the need for textbooks is getting bigger. This is not only because books are easy to read but also more interesting, can be read without space and time limitations, and can support a better learning process. The results of research by Sari et al. (2017) and Joebagıo and Akhyar (2018) show that using digital-based teaching materials can support the teaching and learning process as a whole. Demirkan (2019) stated that digital teaching materials are more interesting, make lessons fun, create diverse, original, and effective content; allow for participatory and student activities; learning is easier to implement; student motivation will increase; effective communication will allow; technology will be involved in the process; student success will increase.

Digital literacy is the skill of using technology and accessing, understanding, assessing, and communicating information obtained in the digital space safely (UNESCO, 2018). Another opinion states that digital literacy is an individual's skill in the use of digital devices to search, sort information, think critically and creatively, and communicate effectively through the digital landscape (Bawden, 2008; Julien, 2019). 'The results of the digital literacy of science teachers needed to create digital textbooks based on each component of digital literacy are presented in Figure 2.

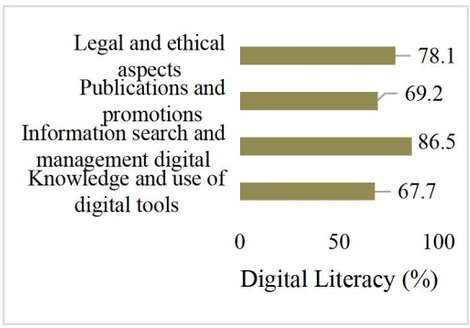


Figure 2. Digital Literacy of Science Teachers

Based on Figure 2, the highest level of digital literacy is obtained in terms of the ability to search for information and manage digital data. The results are very good and necessary for science teachers writing textbooks. According to Kanori et al., 2018, the ability to search for information is influenced by the effective use of electronic resources in education. The lowest results were obtained for the reference management indicator. This is because 50% of science teachers have never managed references digitally. Teachers who manage references using Mendeley are 40% and End Notes are 10%. Reference management is beneficial for storing, managing, and sharing source material more efficiently (Proske et al. 2023). References indicate scientific sources by providing a standard set of information (i.e. citation information) that allows readers to easily identify, search, and retrieve sources (Bapte, 2022)

The lowest digital literacy is in knowledge and use of digital tools, with an acquisition of 67.7%. This result is because not many teachers use online applications or platforms to help with the book writing process (for example, Grammarly, Hemingway Editor, and ProWritingAid).

Ufondu et al. (2024) emphasized the importance of digital literacy, technological tools in 21st century skill development, and recommendations for integrating digital literacy into the educational curriculum. This is important because digital literacy is the ability to navigate and utilize digital technology effectively, and it is an important skill in the modern world of work (Thompson & Lee, 2012; Tobin, 2014). The questionnaire results also showed that the software most often used by science teachers was Microsoft Word 90% and Google Docs 10%. In addition to word processing software, some software teachers use in writing books include note-taking software, Canva, Flikbook, e-book Creator, and Spreadsheet. However, two teachers have never used software other than Microsoft Word.

Teachers' digital literacy in promoting the books they write shows an achievement of 69.2 (Figure 2). This is because only 30% of teachers publish books on digital platforms. The platforms that teachers use to publish their books include Amazon Kindle Direct Publishing (KDP), Google Play Books, and Apple Books. The questionnaire results also revealed that teachers plan to promote their books online through social media such as Facebook, Twitter, Instagram, and Goodreads). According to Hoechsmann and Poyntz (2012), developing teachers' digital competencies is very important in facing the challenges of 21st century education, including promoting teachers' work online. In addition, using digital technology such as e-books can increase the effectiveness of information dissemination and access to teachers' works, improving students' digital literacy (Guggemos & Seufert, 2021).

**Student Learning Style**

Each student has a different and unique learning style. Some students have only one learning style, but some students have a combination of two, three, or four learning styles. This can be seen from a survey of 305

junior high school students in grades VII and VIII (Figure 3).

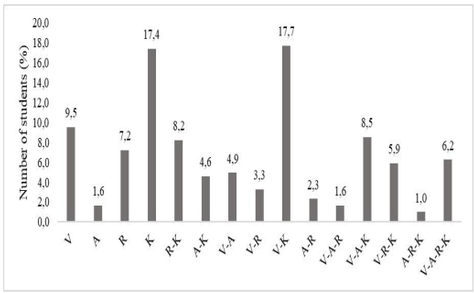


Figure 3. Learning styles of junior high school students

Figure 3 shows the variation of students' learning styles with learning style categories V (Visual), A (Auditory), R (Reading/Writing), and K (Kinesthetic), as well as a combination of these styles. The dominance was seen in the "V-K" (Visual-Kinesthetic) combination learning style, which had the highest number of students (17.7%) and Kinesthetics (17.4%). The results show that students understand the material more easily through visual representations and practical activities. Therefore, in preparing textbooks, it is necessary to use illustrations, diagrams, infographics, experimental activities, and projects involving physical activities. This aligns with research that shows the effectiveness of visualization-based learning and hands-on activities in improving students' understanding of science concepts (Chiu et al., 2015; Jessee, 2012). In addition, multimedia technology such as videos, animations, and interactive simulations can increase the effectiveness of books in conveying complex science concepts. Integrating multimedia elements in science teaching materials can significantly improve student motivation and learning outcomes (Lee et al., 2016).

Other learning styles with a relatively large number are Visual (9.5%), Visual-Auditory-Kinesthetic (8.5%), and Read (7.2%). The learning style with the least number of students is a combination of the Auditory-Reading/Writing-Kinesthetic learning style of 1.0%. Although the Auditory-Reading/Writing-Kinesthetic learning style has the lowest percentage (1.0%), it is important to consider this group in preparing books. The Universal Design for Learning (UDL) approach recommended by CAST (2018) emphasizes the importance of providing various ways of representing information to accommodate the diversity of students' learning styles.

## CONCLUSION

The study results concluded that teachers' understanding of scientific literacy with the PISA 2025 framework was in the good category with an average of 77.1%, while teachers' digital literacy obtained an average of 75.3% in the good category. Students' learning styles tend to have more than one type of learning, with the largest number of students having a combination of Visual-Kinesthetic learning styles. In contrast, the combination of Audio-Read/Writing-Kinesthetic learning styles is only owned by 1.0% of students. The acquisition of scientific literacy results and teachers' digital literacy, as well as these learning styles, are beneficial for developing teacher professionalism by writing scientific literacy-based digital science textbooks.

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