Assimilation: Indonesian Journal of Biology Education
ISSN 2621-7260 (Online)
Journal homepage: https://ejournal.upi.edu/index.php/asimilasi

The relationship between digital and scientific literacy with biology cognitive learning outcomes of high school students

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OPEN ACCESS

ARTICLE HISTORY
Received: 17 January 2022
First Revised: 25 February 2022
Accepted: 30 March 2022
First Available Online: 31 March 2022
Publication Date: 31 March 2022

KEYWORDS
Cognitive learning outcomes
Digital literacy
Scientific literacy

ABSTRACT

Digital literacy and scientific literacy are needed in the world of education as an effort to make students have 21st century competencies. This study aims to determine the relationship between digital literacy and scientific literacy together with cognitive biology learning outcomes of SMA N 16 Semarang students during the COVID-19 pandemic. This research is correlational quantitative research. The population of this study were students of class XI SMAN 16 Semarang with a total of 108 students. Sampling technique was using saturated sampling. Data collecting techniques were using questionnaires for digital literacy variables and tests for scientific literacy and cognitive biology learning outcomes. Hypothesis testing was using multiple correlation. The results showed that there was a positive and significant relationship between digital literacy and scientific literacy with cognitive biology learning outcomes, with a significance value of 0.00 < 0.05, a large correlation value of 0.474 (medium correlation), and a coefficient of determination of 20.4%. It is important for teachers and students to apply digital literacy and scientific literacy to improve cognitive learning outcomes.

INTRODUCTION

Increased connectivity, interaction, artificial intelligence, and the development of digital systems characterize the 21st century (Lase, 2019). There are various problems that cannot be separated from science and technology in this century (Adi et al., 2017). The challenge in the 21st century is to prepare human resources who have creative, critical, collaborative, and communicative skills (Pratiwi & Aminah, 2019). Skills such as information literacy, digital literacy, science literacy, and technology literacy are also needed (Mustofa & Budiwati et al., 2019). Difficulties also arose to prepare students for 21st century skills, such as trouble with understanding the technology or the activity, among the main concerns. That's why some adjustments are needed in the world of education to create superior human resources. The implementation of the 2013 Curriculum is one form of adjustment made in the world of education. The application of technology and science-based learning is the main feature of Curriculum 2013. Basically, there are six basic literacies developed in this curriculum including digital and science literacy. Understanding science and technology is important to prepare for life in the modern era. This encourages the need to implement digital literacy and science literacy movements (Vosniadou, 2019).

The development of technology, information, and communication currently requires students to be able to master digital literacy (Rahmadi & Hayati, 2020). Digital literacy leads to expertise in searching, scrutinizing, synthesizing, and disseminating information (Mustofa & Budiwati, 2019). Digital literacy involves various techniques including reading and writing various digital texts such as text, graphics, audio, video, visual displays in various forms of media. Digital literacy has three intellectual categories in its process, namely searching, consuming digital content, creating digital content, and communicating digital content (Spires et al., 2019).

The learning outcomes of doing digital literacy are a better understanding of the nature of science, revised attitudes towards science, increased science knowledge, and additional topic-specific knowledge as well as generic knowledge (Aristeidou & Herodotou, 2020). Elements of digital literacy include information literacy, digital science, learning skills, ICT, communication and collaboration, and media literacy (Desi, 2019). Digital literacy could improve students' logic asessment and improved their essential skills for the digital era (Greene et al., 2014). In the twenty-first century, digital literacy consists of a dynamic combination of skills that teachers need to understand before the students are taught the relevant digital literacy skills (Reddy et al., 2021). Digital literacy skills, self-control skills and course motivation significantly predicted the achievement of the fifth-grade students in the Science, Technology, and Society learning area. It was observed that these variables had a positive relationship with the students' achievement of the Science, Technology, and Society learning area. The components of digital literacy include: functional skills and beyond, creativity, collaboration, communication, the ability to find and selection information, critical thinking and evaluation, cultural and social understanding, e-safety (Greene et al., 2014).

In addition to digital literacy, scientific literacy skills are also needed in the 21st century, given the low level of scientific literacy in Indonesia. Scientific literacy is still being identified and recognised as one of the main goals of science education. However, this concept has multiple interpretations and its definition often changes continuously depending on its social, cultural, and political contexts. Scientific literacy is part of the basic literacy developed in Curriculum 2013. The concept of scientific literacy in Curriculum 2013 is clearly seen with the use of a scientific approach or scientific approach in learning (Narut & Supardi, 2019). Scientific literacy is the ability to engage with science issues, science ideas, as reflective citizens (Greenhow et al., 2015). Science literacy involves scientific knowledge and skills to identify scientific arguments, conduct an effective literature search for facts, evaluate the use and misuse of scientific informations, and understand the elements of scientific research design (Adnan et al., 2021). Scientific literacy as a person's ability to distinguish science facts from various information, recognize and analyze using scientific

DOI: https://doi.org/10.17509/aijbe.v5i1.43322
e-ISSN 2621-7260

methods and be able to organize, analyze, and be able to interpret quantitative data and science information.

Scientific literacy skills are important to have because they offer fulfillment of the needs of a world that is faced with life questions that require scientific information and scientific attitudes to be able to make decisions in life problems (Huryah et al., 2017). There are several dimensions of scientific literacy including having an understanding of scientific matters, being able to apply scientific concepts, principles and theories in everyday life, being able to solve problems scientifically, being able to draw conclusions about existing natural phenomena, making science the basis for interaction, having an understanding of science and technology, having a broad view, having creativity about science and technology (Mun et al., 2015).

Scientific literacy according to Sutrisna (2021) is divided into four dimensions, namely science competence, science cotent, science context, and science attitude. Science competence consists of 3 aspects, namely explaining scientific phenomena, evaluating and designing scientific investigations, and interpreting scientific data and evidence. Science knowledge consists of content knowledge, procedural knowledge, and epistemic knowledge. The context of science application consists of health and disease, natural resources, environmental quality, hazards, and the latest developments in science and technology. Science attitudes refer to further development of science knowledge, pursuing a career in science, and using scientific concepts and methods in life.

Scientific literacy competencies consist of aspects of explaining scientific phenomena, evaluating and designing scientific investigations, and interpreting data and evidence scientifically (Mijaya et al., 2019). These competencies are needed to understand and engage in scientific discussions. These three competencies require knowledge including content knowledge, procedural knowledge, and epistemic knowledge (Setiawan et al., 2017). Scientific literacy is influenced by the way teachers teach in the classroom, the habits that occur in the classroom, and the approach that teachers use in the classroom using a scientific approach that is appropriate or not to the material being taught, especially to improve scientific literacy (Mijaya et al., 2019). Meanwhile, Hidayah et al. (2019) argue that factors that can affect students' scientific literacy include interest in science, learning motivation, teacher strategies in learning, and school facilities. Scientific literacy is important for students so that teachers need to implement scientific literacy-based learning to improve the ability to identify problems and knowledge, oral and written vocabulary needed to understand and communicate in science, and the relationship between science, technology, and society (Pertiwi et al., 2018).

Development of scientific literacy on students is linear with support qualitative learning and a wider understanding of the subject (Pelger & Nilsson, 2016). Mastery of digital literacy and scientific literacy can improve student learning outcomes, especially in this pandemic condition. Learning during the pandemic is carried out online and requires students to do more tasks. Students need to learn independently by utilizing digital media and learn with a scientific attitude so that learning outcomes improve. Learning outcomes are changes in behavior as a result of the learning process. Changes that occur in the form of knowledge, understanding, skills, and attitudes that include cognitive, affective, and psychomotor domains (Geitz et al., 2016). The cognitive domain is the domain that includes mental or brain activities. Cognitive domain assessment is carried out to determine student mastery related to factual, conceptual, procedural knowledge as well as low-level to high-level thinking skills (Cowan, 2014). Factors that influence learning outcomes include: activity, use and repetition, practice and success, association, learning readiness, interest and effort, physiological, and intelligence (Lin et al., 2016).

The application of digital literacy and scientific literacy can improve learning outcomes. The teachers that were interviewed stated that their student's motivation and interest are higher when they teach by applying digital and scientific literacy (Al-Rsa'i & Salameh, 2013). In addition, scientific literacy also affects student learning outcomes. In line with research conducted by Fortus et al. (2022), based on the data obtained, it is known that scientific literacy affects student learning

DOI: https://doi.org/10.17509/aijbe.v5i1.43322
e-ISSN 2621-7260

outcomes. Scientific literacy can also make the class active because of classroom discussions (Fortus et al., 2022). One of the schools that implement digital literacy and scientific literacy-based learning is SMA N 16 Semarang. This research focused on digital literacy and scientific literacy as well as students' cognitive learning outcomes in Biology class XI MIPA semester 2 from KD 3.8 to 3.14. Based on the review of research that has been done, there is no research that examines the relationship between digital literacy and science with Biology learning outcomes. Based on this description, it is necessary to conduct research about the relationship between literacy digital and scientific with cognitive learning outcomes of biology of High School Students. The purpose of this study was to determine how the relationship between digital literacy and scientific literacy together with the cognitive learning outcomes of Biology students in class X1 SMA N 16 Semarang during the COVID-19 pandemic.

METHODS

The method used in this research is quantitative correlation that examines the relationship between digital literacy and science literacy together with cognitive learning outcomes. The population of this study were all students of class XI MIPA SMA N 16 Semarang. The sampling technique of this research is saturated sample, so the sample of this research is all students of class XI MIPA SMA N 16 Semarang which amounted to 108 students.

This research instrument consists of a digital literacy questionnaire and science lieration test questions and cognitive learning outcomes. The digital literacy questionnaire was adopted from Nasionalita & Nugroho (2020) which consists of 20 questions using a Likert scale. The questionnaire in this study consists of 8 dimensions including functional skills and beyond, collaboration, creativity, the ability to find and slection information, communication, cultural and social understanding, critical thinking and evaluation, e-safety. The science literacy instrument was adopted from Fives et al. (2014) with a total of 15 multiple choice questions. Science literacy consists of 8 indicators, namely being able to identify valid scientific opinions, being able to search for effective literature, understanding the components in research design, solving problems with quantitative skills, making graphs appropriately, understanding and being able to interpret basic statistics, being able to evaluate useful and useless science information, and being able to make predictions, inferences, and draw conclusions based on data. The cognitive learning outcome instrument consists of 25 questions. The questions consist of semester 2 class IX material from K.D 3.8 to K.D 3.14.

The first research stage is the instrument validity test, for digital literacy and science literacy instruments, an internal validity test is carried out. The cognitive learning outcomes instrument was tested, out of 40 questions tested 25 questions were valid and reliable. The next stage of research is data collection which was carried out in August-September 2021. Data analysis uses the help of the SPSS 16 for windows program, before hypothesis testing, prerequisite tests are carried out in the form of normality, linearity and multicollinearity tests. Hypothesis testing uses multiple correlation analysis with the condition that if $n < 0.05$ then Ho is rejected and Ha is accepted. If the value of $n < 0.05$ then Ha is rejected and Ho is accepted.

RESULTS AND DISCUSSION

Prerequisite tests carried out before hypothesis testing include normality test, linearity test, and multicollinearity test. The normality prerequisite test shows that the data is normally distributed, this can be seen from the significance value of the data analysis conducted (0.698> 0.05). The linearity prerequisite test shows a significance value of 0.571 > 0.05 so it can be concluded that between the three variables namely digital literacy, science literacy, and cognitive learning

DOI: https://doi.org/10.17509/aijbe.v5i1.43322
e-ISSN 2621-7260

outcomes have a linear relationship. Multicollinearity test shows the result that there is no multicollinearity between independent variables with a VIF value of 1.021 < 10.0 show in Table 1.

Table 1. Hypothesis test results

Variable	Regression Coefficient	t Count	t Table	sig.
Constant	4,435	271		
X1 (Digital Literacy)	0,327	1,994	1,992	0,046
X2 (Scientific Literacy)	0,499	4,187	42,04	0,000
		Sig. F Change = 0,000		
		R = 0,474		
		R^2 = 0,204		

The results of data analysis show that digital literacy and science literacy together have a relationship with students' cognitive learning outcomes. The sig value F change value of 0.00 <0.05 so it can be concluded that it is correlated. The degree of relationship between digital literacy and science literacy with learning outcomes can be seen from the large R value of 0.474. Referring to the guidelines for the degree of relationship, the number 0.474 is in the range of 0.40 to 0.599 which is in the moderate correlation category. The coefficient of determination can be seen in the R2 value of 0.204. This can be interpreted that the digital literacy and science literacy variables together can explain the cognitive learning outcomes of Biology by 20.4%, and the rest is influenced by other factors by 79.6%. From the results of the calculated output, the regression equation is obtained as follows:

$$Y = 4.435 + 0{,}327X_1 + 0{,}499X_2$$

The regression coefficient value of digital literacy is 0.327. When digital literacy increases by 1 unit, the average cognitive learning outcomes increase by 0.327. The scientific literacy regression coefficient value is 0.499, if scientific literacy increases by 1 unit, the average cognitive learning outcomes increase by 0.499.

Literacy is fundamental to the learning process. Literacy can make insights grow and improve mastery of material in learning. Digital literacy and scientific literacy are two of the six literacies developed in Curriculum 2013. The application of this literacy is considering the low level of literacy in Indonesia. This literacy is also applied to face the challenges of changing times, the development of technology and science that is growing so rapidly. The integration of these two literacies also needs to be applied so that students can choose, sort information appropriately and carefully in the digital era by being guided by the scientific method and thinking scientifically.

Digital literacy needs to be promoted in the digitalization era, especially during the pandemic, where learning during this pandemic uses a lot of digital media and the internet. The use of the internet in the digital era can have a positive impact in the field of education. Research conducted by Norra (2020) shows that the use of the internet and digital media for high school students is often used. The existence of the internet opens up blockages to information sources. Digital literacy is a solution when some students currently have low self-control, resulting in high media errors (Purnama et al., 2021). Digital literacy plays an important role in the digital era, considering that students' low knowledge of fake news or hoaxes needs attention. Digital literacy plays an important role in preventing hoaxes. Students have been actively searching for information on the internet, but the information available is not necessarily tested for truth. Students also often absorb information without a verification process and result in distorted understanding of concepts (Surya, 2019).

Digital literacy is one of the skills used to solve various problems in the digital era that have emerged due to the proliferation of media and technology in life (Ati, 2019). Digital literacy is part

DOI: https://doi.org/10.17509/aijbe.v5i1.43322
e-ISSN 2621-7260

of self-control to prevent and stop fake news from recurring and spreading (Sabrina, 2019). The application of digital literacy makes the teacher a facilitator in the classroom. Teachers in the classroom can use various learning resources such as scientific articles, online news, and other digital media, so that learning resources are not only sourced from books. The use of rich learning resources will provide knowledge that is in accordance with the times and current conditions.

The application of digital literacy in learning will make students always be able to get the latest information and can keep up with technological developments. Digital literacy allows students to get a variety of information in depth so that it can help students complete assignments and increase insight and can find information in digital content accurately, precisely and efficiently. The application of digital literacy is very suitable for all subjects at school, especially in the conditions of the COVID-19 pandemic. This is in line with research conducted by Akhyar et al. (2021) which states that learning by applying digital literacy during the COVID-19 pandemic has a positive and significant impact on student learning outcomes.

Digital literacy is a solution during this COVID-19 disruption era. Digital literacy can improve learning outcomes during this COVID-19 pandemic. Trust in digital technology has been proven in the field, the ability of technology to change learning. The use of technology in learning is highly recommended even after the pandemic is over (Basir et al., 2021). Digital literacy is important for students because it can support students to be confident and competent in the use of technology and develop knowledge by encouraging curiosity, creativity, critical thinking, thus enabling them to use technology intelligently from the increasing number of digital resources available. The development of digital literacy in learning can support students to be effective, competent and critical in these subjects in the digital era (Johnston, 2020).

The application of scientific literacy also needs to be done in education. The concept of scientific literacy is seen in Curriculum 2013 by using a scientific approach in learning. Learning with a scientific approach consists of observing, questioning, exploring, associating and communicating (Hugerat, 2016). Learning by applying concepts like this can affect student learning outcomes. Moreover, Biology learning emphasizes the process of inquiry and providing direct experience to students (Ritonga et al., 2020). Krathwohl in Juhji & Mansur (2020) stated that scientific literacy affects students' cognitive abilities which include the ability to understand, apply, remember, analyze, and create, and evaluate. Mastery of scientific literacy is needed to master the concepts of subjects such as Biology, with scientific literacy making students stimulated to be more active in reading and examining scientific phenomena in order to solve existing problems. This will improve students' cognitive abilities.

Scientific literacy abilities that are needed and must be mastered by students are scientific attitudes, knowledge, and skills (Fakhriyah et al., 2017). The characteristics of scientific literacy are to encouraged students to use science in everyday life, developing values/attitudes/scientific temper, having basic science knowledge, and reading and writing (Sarkar & Corrigan, 2014). Scientific literacy is important for students to master because it will make students able to view the environment, health, economy, and the problems of modern society that have dependence on science and technology. Scientific literacy is used to prepare students to enter society, as well as to solve problems scientifically and responsibly. Scientific literacy gives students the ability to be wiser in making decisions and addressing problems (Ristina et al., 2019).

The application of scientific literacy in learning has an impact on improving learning outcomes. This is in line with research conducted by Nufus et al. (2021) scientific literacy has a significant effect on learning outcomes. Scientific literacy is the main need for students in the 21st century, scientific literacy affects the way of thinking, acting, and working. The same thing was also stated by Saraswati et al. (2021) which states that scientific literacy has a positive effect on students' cognitive learning outcomes. Learning in schools should be directed to support students to grow and develop into scientifically literate humans through the scientific process.

Education in Indonesia in its application only focuses on science and mathematics subjects, while subjects such as technology and engineering are only minor or even absent from it (Sartika,

DOI: https://doi.org/10.17509/aijbe.v5i1.43322
e-ISSN 2621-7260

2019). It is necessary to develop education especially during a pandemic like this in order to achieve effective education. One of the developments that teachers can do during this pandemic is the application of digital and science literacy in learning given the importance of these two literacies.

Mastery of science and technology is important to overcome current problems. The application of scientific literacy and digital literacy together needs to be done to face education 4.0. The utilization of digital technology in the teaching and learning process is a distinctive feature of education 4.0. Scientific and digital literacy skills need to be improved to improve the quality of education and student abilities. 21st century abilities include critical thinking, creative, innovative, communicative, and able to solve problems.

The application of digital literacy and science in learning makes students active. Active learning is suitable for science subjects such as Biology. Active learning will result in students having new experiences and understandings that have an impact on learning outcomes (Khoiri et al., 2020). With active learning students can investigate. Inquiry-based learning seeks to instill the basis of scientific thinking so that students are more independent in learning, solving problems, and being creative.

CONCLUSION

The relationship between digital literacy and scientific literacy with cognitive learning outcomes of SMA Negeri 16 Semarang students during the COVID-19 pandemic is significant and positive with a significance value of 0.00, and a moderate correlation (0.474), and contributes 20.4%.

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DOI: https://doi.org/10.17509/aijbe.v5i1.43322
e-ISSN 2621-7260

Acknowledgment

Researcher would like to thank the university which funded this research and the participants who were involved in this research.

Authors' Note

The authors declare that there is no conflict of interest regarding the publication of this article. Authors confirmed that the paper was free of plagiarism.

How to Cite this Article

Yusuf, A. M., Hidayatullah, S., & Tauhidah, D. (2022). The relationship between digital and scientific literacy with biology cognitive learning outcomes of high school students. *Assimilation: Indonesian Journal of Biology Education*, *5*(1), 9-18.

DOI: https://doi.org/10.17509/aijbe.v5i1.43322
e-ISSN 2621-7260