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Digital age literacy profile of high school students and its implementation in biology learning

Anik Roslina Rosyadi*, Afandi, Eko Sri Wahyuni

Study Program Biology Education, Faculty of Teacher and Education, Universitas Tanjungpura, Prof. Dr. H. Hadari Nawawi Street, Pontianak, West Kalimantan, Indonesia

*Corresponding author: anik.roslina17@gmail.com



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ABSTRACT

This study aims to describe high school students' digital-age literacy skills. This study is a descriptive study with a quantitative approach. The sample of this study was 322 eleventh-graders of science at SMA Negeri in Pontianak City, which were determined using the cluster sampling technique. The instrument used is a questionnaire developed based on eight domains of digital-age literacy. The results showed that students' level of digital-age literacy was included in the medium category. Based on the domain, technological literacy, multicultural literacy, and global awareness were in the high category, while basic literacy, information literacy, scientific literacy, visual literacy, and economic literacy were in the medium category. The implementation of digital-age literacy in biology learning is expected to create more engaging and effective biology learning and improve students' digital-age literacy skills.



INTRODUCTION

One of the challenges that is the main focus in the 21st century is qualified and globally competitive human resources (Nuraini, 2017). According to the Asian Productivity Organization (APO), the readiness of the Indonesian workforce shows only about 4.3% of skilled workers out-off 1,000 Indonesian workers, lower than other countries in Asia such as the Philippines (8,3%), Malaysia (32,6%), and Singapore (34,7%) (Pramudyo, 2014). This is a whip for Indonesia to be able to prepare future generations to become qualified and competitive human resources as a form of meeting the challenges of the 21st century.

The twenty first century requires everyone to equip themselves with various supporting skills. These skills are essential for students' career readiness (Lavi et al., 2021). The lack of supporting skills possessed by students causes students to find it difficult to compete for jobs, because the skills required in the world of work will be increasingly diverse in line with technological developments and global market needs. Furthermore, the Caena & Redecker (2019) also clarifies that 21st century skills can be formed from aspects of knowledge supported by various skills, expertise and literacy both personally and professionally.

Literacy is a term that we often encounter, but the meaning of literacy changes along with technological developments (Tafazoli et al., 2017). According Kereluik et al. (2013), in the 21st century literacy has expanded meaning as a skill that not only allows people to read the world through words, but also involves the use of various forms of technology and communication that can help understand the world and express identity, ideas and culture. Definitions of literacy will continue to change. In other words, literacy is no longer defined as a single and simple skill but includes many skills (multiliteracy) (Pilgrim & Martinez, 2013).

The multiliteracy in question is digital-age literacy. Digital-age literacy is one of the 21st century skills based on the document set out in enGauge 21st Century Skills. The other twenty first century skills are inventive thinking, effective communication and high productivity. Digital-age literacy is a general term used to describe the various literacies, skills and competencies needed in the digital age (Tafazoli et al., 2017). Digital-age literacy includes eight domains, including: (1) basic literacy - the ability to speak (especially English) and do arithmetic at the level required in work and society to develop knowledge and potential in the digital age; (2) scientific literacy - knowledge and understanding of scientific concepts and processes required for decision-making; (3) economic literacy - the ability to identify economic issues and developments and adapt to global economic challenges; (4) technological literacy - knowledge of what technology is, how it works and how to use it effectively and efficiently; (5) visual literacy - the ability to use, interpret and create images and videos using conventional and modern media; (6) information literacy - the ability to search, synthesize and use information and evaluate information from various sources using technology and electronic resources effectively and efficiently; (7) multicultural literacy - the ability to understand and appreciate differences in the values, beliefs and cultures of others; (8) global awareness - the ability to recognize and understand problems at the global level (Afandi et al., 2019).

Digital-age literacy is an important 21st century skill to master and is one of the prerequisites for quality human resources who can utilize technological advances and information flows effectively and efficiently. Akour & Alenezi (2022) asserts that the technicalities of accessing technology now may change in the future, but digital age literacy shapes a person to be ready in the present and the future, whatever the form of technology in the future. Learners need to master science, technology and culture and understand information in various forms to succeed in the 21st century, where all these components are included in the domain digital-age literacy.

Based on the above explanation, the formation of a generation with adequate digital-age literacy is an essential thing to strive for today. To fulfill this, various efforts can be made, especially through the field of education. Thus, education must prepare students to be able to face new realities (Phuapan & Pimdee, 2016). The school questionnaire obtains data related to aspects of

the school, for example school quality human and material resources, decision-making processes, staffing work, context-based teaching (Stuckey et al., 2013). In accordance with the explanation of Afandi et al. (2019) that the education system is responsible for preparing learners to face the global challenges of the 21st century, not only with academic achievement but also 21st century skills needed in the work environment.

Saavedra & Opfer (2012) state that complex 21st century competencies and skills must be developed integrated with learning rather than with separate learning. Based on this statement, education through its learning process, including biology learning, is the foundation in striving for quality human resources and mastering various 21st century skills including digital-age literacy. Therefore, it is important for prospective biology teacher students to know the level of digital-age literacy of high school students and design biology learning as a means to implement and improve students' digital-age literacy skills.

METHODS

This research is a descriptive study with a quantitative approach that aims to determine the digital-age literacy profile of students of class XI IPA State High School in Pontianak City. The population of this study were all students of class XI IPA State High School in Pontianak city. The research sample was determined using cluster sampling technique and obtained 322 students. This study used an instrument in the form of a questionnaire developed from the eight domains of digital-age literacy in the enGauge 21st Century Skills document. This questionnaire is a closed questionnaire consisting of 37 statements and uses a Likert scale with five alternative answers. The questionnaire has met the validity eligibility criteria based on expert judgment with an Aikens V index of 0.96. The validity and reliability of the questionnaire were also analyzed using the Rasch Model with the help of the Winstep 3.73 application. Overall, the statement items were declared valid with an outfit MNSQ person and item value of 0.99 and an Outfit Z Standardized (ZSTD) value for person analysis worth -0.2 and item worth -0.3, and obtained a person reliability value of 0.68 (sufficient), item reliability worth 0.94 (excellent) and Cronbach alpha value of 0.72 (good). Data analysis in this study was carried out using descriptive statistical analysis, namely mean and standard deviation. The results of the analysis were then interpreted using the criteria in Table 1.

Table 1. Interpretation of average scores on a five-point Likert scale

Average	Criteria
1,00-2,49	Low
2,50-3,49	Medium
3,50-5,00	High

(Afandi et al., 2019)

RESULTS AND DISCUSSION

Learners' digital-age literacy level

Digital-age literacy is one of the skills that is important to master in order to face the demands of the 21st century,

Therefore, as an effort to continue to improve the quality of students, it is necessary to measure the digital-age literacy abilities of students. This measurement is based on the average score of all digital-age literacy domains presented in Table 2.

Table 2. Descriptive statistics of digital-age literacy

Gender	Sample Quantity	Mean	Standard Deviation	Category
Male	104	3,45	0,81	Medium
Female	2018	3,29	0,79	Medium
Total	322	3,41	0,80	Medium

The results showed that the level of digital-age literacy of students was generally included in the moderate category. Based on this data, it can be seen that overall the digital-age literacy ability of students in class XI IPA State High School in Pontianak City is quite good, but various efforts still need to be made to be able to continue to develop the digital-age literacy ability of students. Meanwhile, based on gender, the average score of male students is higher than female students. This is in line with the results of research by Arsad et al. (2012), namely there is an influence between gender and students' digital-age literacy skills.

Description of the level of digital-age literacy of high school learners based on the domain

The Digital-age Literacy assessment in this study consists of 8 domains spread over 37 statements. The results of the interpretation of students' abilities in each domain as a whole are presented in Figure 1.

Based on the domain, the level of digital-age literacy of high school students in the domains of technological literacy, multicultural literacy and global awareness is in the high category. Meanwhile, the other domains are classified as moderate, with the order from the lowest mean value being basic literacy, information literacy, science literacy, visual literacy, and economic literacy.

Technological literacy obtained the highest average score compared to other domains, namely 4.08. The high level of technological literacy of students is the impact of technological advances in this digital era. High school students belong to the digital native generation, which is a generation born and raised in an environment that uses digital technology, computers and various applications in everyday life (Akçayır et al., 2016). This has resulted in this generation more quickly accepting, adapting, and actively utilizing internet technology that has been introduced since childhood (Fitriarti, 2019).

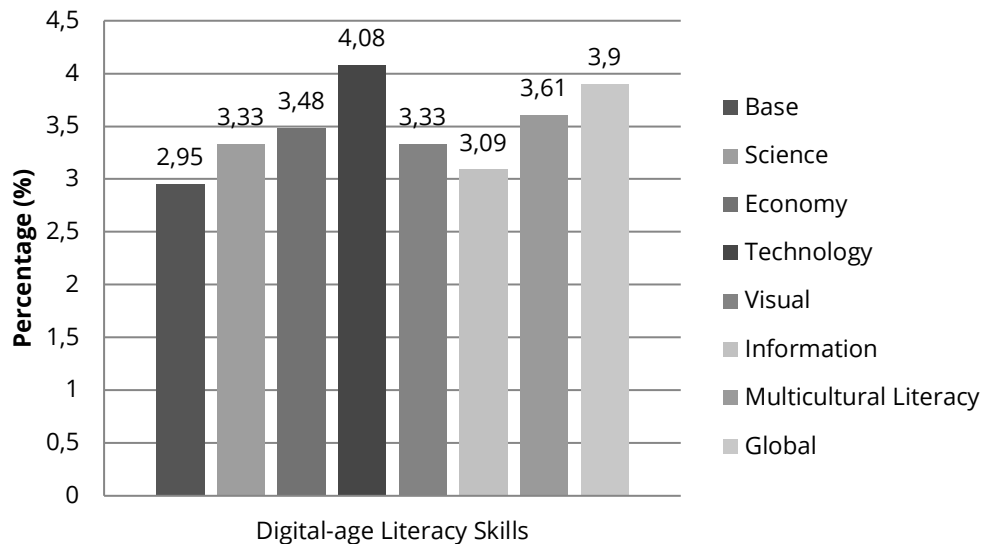


Figure 1: Digital-age literacy skills by domain

The level of global awareness of learners is included in the high category with an average score of 3.9. The score shows that learners already have good knowledge and understanding of global issues that occur today. Learners high level of technological literacy and daily life that is always connected to the internet allows learners to be exposed to various news, global information and communicate with people from other countries. Learners have begun to understand and realize that they are not only part of a particular nation but also part of the global community. Learners who have global competence are able to reflect on how much capacity they have to complete the tasks given and look for opportunities to collaborate with others.

The third domain included in the high category is multicultural literacy with an average score of 3.61. Technological advances in the 21st century allow learners to interact with other people in various regions both regionally and internationally. Indonesia itself is a country with diverse ethnicities, religions, cultures, languages, customs and races. The heterogeneity of society is both a wealth and a challenge for a nation. Therefore, it is very important for each individual to have good multicultural literacy, so that they can accept differences and open themselves to learning new things and can work well together in their work and social environment. In addition, a positive attitude towards multiculturalism will reduce ethnocentrism, and is expected to reduce intercultural and intergroup conflicts (Luthfia, 2014). Not only needed in the context of a heterogeneous society, multicultural literacy is also needed in the face of social change due to the influence of globalization and the rapid development of information technology (Mustaqim, 2020).

The domain that obtained the lowest average score compared to the other domains was basic literacy at 2.95. Basic literacy includes language skills (especially English) and numeracy. Language skills include the ability to read, write, listen and speak in English. The numeracy skills include the ability to apply, formulate and interpret mathematics in everyday life (Fiad et al., 2017). Low English proficiency can be caused by the lack of use of English in everyday life, especially in schools (Rahmat et al., 2020). The lack of encouragement and opportunities for students can have a negative impact on students' vocabulary, grammar and English pronunciation. Meanwhile, factors that can affect the level of mathematical literacy or numeracy of students are learning provided by teachers, classroom environment, family environment support, and readiness to take tests (Khoirudin et al., 2017).

The information literacy domain obtained the second lowest average score of 3.09 and was included in the moderate category. These results indicate that although students have good technological literacy skills and are familiar with the use of the internet which is the starting point of the electronic information explosion, students still do not have a qualified ability to identify,

access and process and evaluate this information. This is inseparable from the characteristics of digital natives who are opportunistic and omnivorous, they are accustomed to an all online environment so they like something instant, want to get information quickly, and access randomly (hypertext) (Gaith, 2010).

Twenty first century education is oriented to help learners become lifelong learners (Arsad et al., 2012). The foundations needed in lifelong learning to be able to learn various other skills in the 21st century is basic literacy (Subandiyah, 2017) and information literacy (Sujana & Rachmatin, 2019). The two literacies are interconnected, if students' reading skills are low, it can be said that the development of students' information literacy skills is also low. In line with the above statement Afandi et al. (2019) explained that the lack of proficiency in English and math causes difficulties in reading, understanding, and translating the information they need. So, the level of basic literacy and information literacy can affect the success of learners to master other literacy skills or domains.

Science literacy of students in class XI IPA State High School in Pontianak City is included in the medium category. The factors causing the lack of science literacy skills of students in Indonesia put forward by researchers include the selection of learning resources that rely more on textbooks than direct learning (non-contextual learning), misconceptions, especially in science learning, low reading skills, and a non-conducive learning environment and climate (Fuadi et al., 2020).

Visual literacy of high school students is included in the medium category with an average score of 3.33. This indicates that students already have sufficient ability in understanding and interpreting visual media, and can create various visual media to support the communication process. However, it still needs to be developed optimally to continue to improve students' visual literacy, given the importance of visual literacy for students as stated by Nurannisaa (2017) namely a good understanding of visual literacy can improve processes, decision making, communication, and learning.

Economic literacy is a life skill that must be possessed by anyone to make economic decisions appropriately (Melina & Wulandari, 2013). The higher the economic literacy, the more rational the consumptive behavior of students (Solihati & Arnasik, 2018). In line with this statement, Sina (2012) added that the impact of a poor understanding of economic literacy can result in a person experiencing errors when making spending decisions and other matters. The economic literacy of public high school participants is included in the moderate category with an average score of 3.48. This shows that students' understanding of economic issues is good enough, but still needs to be improved so that students can consider the benefits and risks in every action related to finance and resources properly.

Implementation of digital-age literacy in biology learning

The implementation of digital-age literacy in 21st century education is multidisciplinary, meaning that all materials can refer to the framework (Afandi et al., 2019). Biology is a subject that strongly supports the improvement and balance between soft skills and hard skills of students (Zhang et al., 2020). Biology learning can play a role in empowering students to have 21st century skills. One of them is through integrating various related disciplines or domains so that it can help students not only achieve learning objectives but also in developing 21st century skills, especially digital-age literacy. This shows that learning biology is one of the important elements in efforts to improve the digital-age literacy of future generations. Therefore, teachers must be ready and able to implement aspects of 21st century skills in biology teaching and learning activities.

From the results of the study, it is known that students are more interested and are used to applying technology well, which is indicated by the high technological literacy domain. Therefore, it is expected that teachers can integrate technology in learning biology, so as to create a more effective and interesting teaching and learning process, biology that increases students' activeness and makes it easier for them to understand the material and achieve learning objectives well.

Starting from using learning strategies that support technology integration such as Technological Pedagogical Content Knowledge (TPACK) and the Science, Technology, Engineering and Mathematic (STEM) approach. Digital learning resources are now widely available in various forms and can be accessed easily, so it is expected to increase students' interest in learning and understanding. Digital learning media can also be the right choice to match the characteristics of students in this era. Kasutto et al. (2021) identifies alternative digital technology media that can be utilized in learning, including interactive multimedia, digital video and animation, podcasts, augmented reality (AR), virtual reality (VR), game-based learning, and gamification. However, the use of technology-based learning media cannot be generalized because it depends on the needs, available facilities and infrastructure as well as the characteristics of students. Thus, teachers can design and adjust the methods and media that will be used to carry out the teaching and learning process optimally.

A high level of multicultural literacy indicates that learners have a good ability to accept and appreciate existing diversity. This is an important basis for students to be able to collaborate which is also one of the 21st century skills according to the Caena & Redecker (2019) that's "The 4Cs". Teachers can direct collaborative biology learning both directly and online through various supporting media and applications, so that it is expected to make biology learning more interesting and effective.

According to Caena & Redecker (2019), global issues can be integrated in learning so that students can become good citizens with all related indicators, therefore teachers must be able to manage these global issues into learning resources. One of the efforts that can be made to improve the domain with the lowest average score is that teachers can encourage learners to search for various digital information such as articles or scientific journals related to biology material. This is expected to train students to be able to search, synthesize and evaluate digital information so as to improve students' information literacy. By reviewing various journals in English, it is hoped that it can improve language skills which are part of basic literacy.

Formulation of digital-age literacy domain implementation in biology learning

The implementation of digital-age literacy in biology learning can be done by integrating all or some digital-age literacy domains that are relevant to the learning material. For example, in class XII biology learning, basic competencies: 3.5 Apply the principle of inheritance of the nature of living things based on Mendel's law. Table 3 shows an example of the implementation of the digital-age literacy domain on the material principles of inheritance of living things based on Mendel's law. The basic literacy domain in numeracy competence can be applied when students calculate the probability of monohybrid and dihybrid crosses based on Mendel's law. Examples of activities that can be done in the application of the science literacy domain include: understanding the concept of inheritance of the traits of living things based on Mendel's law; Explaining natural phenomena in everyday life such as the cause of phenotypic differences in filial 1 from the crossing of *Mirabilis jalapa* plants; Reading interpret and describe the results of the crossing diagram. The application of the economic literacy domain can be done by identifying the application of Mendel's law in agriculture and animal husbandry in improving the community's economy. Technological literacy can facilitate learners in finding information related to the material and as a tool to make crossing diagrams. An example of the application of the visual literacy domain is creating visual media to present the results of crosses and examples of the application of Mendel's law in everyday life. In addition, activities in the form of searching and evaluating information from various sources related to the inheritance of the nature of living things based on Mendel's law can hone students' information literacy skills. After understanding the process of inheritance of traits in living things, it is expected that learners can accept and appreciate the diversity that exists as one of the competencies of the multicultural literacy domain. The global awareness domain can

be applied by examining the issue of global racial and cultural diversity as an example of inheritance of traits.

Table 3. Example of digital-age literacy domain implementation in biology learning

Domain	Competence
Basic Literacy Science Literacy	Numeracy: Using mathematical reasoning <ul style="list-style-type: none"> • Knowledge and understanding of scientific concepts and processes • Have the ability to describe, explain, and predict natural phenomena in everyday life. • Reading and interpreting data
Economic Literacy Technology Literacy Visual Literacy	Considering the benefits and risks in every action related to the economy Use various technologies for positive and ethical activities Create various visual media such as images, videos, models to present data to make it more interest and easy to understand using computers and other technologies.
Information Literacy Multicultural Literacy	Access relevant information from various sources Value diversity: Appreciate and accept similarities and differences in beliefs, appearance, and lifestyles.
Global Awareness	Participate in a globalized society by staying abreast of international news.

CONCLUSION

The digital-age literacy profile of public high school students in Pontianak City is mostly in the medium category. Based on the digital-age literacy domain, technological literacy, multicultural literacy, and global awareness are in the high category, while in the basic literacy domain, information literacy, science literacy, visual literacy, and economic literacy are in the medium category. The implementation of digital-age literacy in biology learning is expected to create more interesting and effective biology learning and improve students' digital-age literacy skills in order to prepare a quality generation that is ready to meet the demands of the 21st century.

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