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Research Article

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Profile analysis of digital literacy skills of biology education students

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ABSTRACT

Today's world of higher education emphasizes the importance of digital literacy skills that cannot be underestimated. This study aims to investigate the state of digital literacy among students enrolled in the Biology Education Study Program at Universitas Negeri Malang, focusing on their proficiency in utilizing digital tools and resources, critically evaluating information, and responsibly navigating online domains. The study was a quantitative approach. Questionnaires with a Likert scale consist of 36 statements designed. Data were collected in the even semester of the 2023/2024 academic year from a total of 147 students. The research instrument adapted from validated sources assessed six key indicators of digital literacy (finding, using multiple sources, selecting, evaluating, considering sources effects, and using original work). These quantitative data were analyzed by descriptive analysis technique. The results showed that although most students obtained a moderate level of digital literacy (61.54%), there was a certain number of students with low (1.92%) and very low (0.96%) levels of digital literacy. These results suggest that more attention is needed to digital literacy development in biology education at all levels. These findings emphasized the importance of further and holistic empowerment of digital literacy skills among biology education students, particularly in evaluating and considering the source/effect of messages. Improvements in these areas and studies are critical to preparing students for academic and professional success and fostering their engagement with society in an increasingly digitalized world. Future research efforts should focus on implementing targeted interventions to improve digital literacy in programs and comparing the level of digital literacy across different biology education courses in different institutions. This study contributes to the ongoing discourse on digital literacy in higher education and underscores the need for adaptation and continuous improvement in educational strategies to meet the evolving demands of the digital age.

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INTRODUCTION

In today's digital era, technological advances have changed the way we communicate, access information, and interact with knowledge. Therefore, it is important to understand and cultivate digital literacy skills in higher education (Hsiao & Shiao, 2018). Digital literacy encompasses the ability to use digital tools and resources effectively, evaluate information critically, and navigate the online landscape responsibly (Sicilia et al., 2018). Digital literacy refers to the ability to use digital technologies, tools and resources effectively and critically to access, evaluate, create, and communicate information (Burton et al., 2015). This includes skills such as navigating online platforms, critically evaluating the credibility of information, using digital tools for research and analysis, and communicating ideas effectively through various forms of digital media (Caverly et al., 2019). Digital literacy can be seen from several indicators, namely indicators of finding, using various sources, selecting, evaluating, considering the impact of message sources, and using digital information to produce original work (Greenstein, 2012).

Rapidly growing digital literacy is also affecting the higher education sphere. Universities are increasingly incorporating digital tools and platforms into their teaching and learning practices (Smith & Storrs, 2023). The shift towards digital resources presents both challenges and opportunities in the context of biology education. One of the main challenges is the need for educators to adapt their teaching methods to effectively incorporate digital tools into the curriculum (Sayres et al., 2018). This requires a certain level of digital literacy among instructors themselves. In addition, there is a need to ensure that students develop not only basic digital skills but also the ability to critically evaluate the vast amount of information available online, especially in the field of biological sciences where accurate and reliable sources are essential (Antoniuk & Zasiadivko, 2023).

Besides presenting challenges, the digital era also presents unexplored potential to improve the quality of biology learning. Access to online databases, academic journals, and research tools allows students to learn about the latest advances in biological science (Sayres et al., 2018). Interactive simulations and virtual laboratories provide hands-on experiences that complement traditional laboratory work, making biology education more engaging and accessible (Zhao et al., 2021). The current state of digital literacy in higher education is characterized by a dynamic interplay of challenges and opportunities in the context of biology education. As educators and institutions continue to navigate this digital landscape, the integration of digital literacy skills into biology education has the potential to enrich the learning experience for students and prepare them for success in a digitized world (Spante et al., 2018).

Some researchers report that students' digital literacy profiles vary considerably for certain indicators. Monteiro et al. (2023) found that students showed proficiency in search and data editing skills but lacked the ability to create new digital solutions. Digital technologies are primarily used for communication and interaction with peers, with a limited focus on networking and lifelong learning skills. Morgan et al. (2022) also revealed that students have the lowest ability to use digital information, especially when it comes to evaluating and determining the bias and quality of information. De la Hoz et al., (2021) in their research revealed the low level of digital literacy possessed by current prospective teachers in the field of public health. The dependence of biological studies on digital tools and resources today creates the urgency to understand the level of digital literacy among students to effectively design what approaches are important in learning (Yuliani & Mercuriani, 2021). The rapid advancement of technology and the increasing dependence on digital devices in various fields, including biology, requires an exploration of digital literacy among biology education study program students (Virmani & Williamson, 2016).

Understanding the digital literacy levels of students in these programs is critical to designing effective educational strategies that incorporate digital tools and resources (Antoniuk & Zasiadivko, 2023). In addition, it is important to ensure that biology education students have the necessary digital skills to navigate and evaluate the vast amount of information available online, especially in the field of biology which prioritizes accuracy and reliability in its scientific studies. Therefore, it is important to explore students' digital literacy skills. The rationale for this research is rooted in the awareness of the growing importance of digital literacy skills in today's society. This study aims to investigate the state of digital literacy of students of the Biology Education Study Program, Department of Biology, Universitas Negeri Malang.

RESEARCH METHODS

This study uses a quantitative approach, using a questionnaire, to collect data on the level of digital literacy and practices of biology education students. The subjects of this study were Biology Education Study Program students class of 2022 totaling 147 students. This research was conducted in the even semester of the 2023/2024 academic year and analyzed using descriptive statistical techniques to summarize and interpret the overall digital literacy levels.

The data collection method was carried out by distributing digital literacy item instruments developed and adapted by Greenstein (2012). Digital literacy is measured using 6 indicators consisting finding, using multiple sources, selecting, evaluating, considering sources effects, and using original work indicators. The digital literacy indicator items can be seen in Table 1. The instrument consists of 36 statements designed and validated by 2 biology education lecturers (100% validator stated valid), all of whom at least occupy the functional position of lecturer.

Table 1. Digital Literacy Indicator Items

No	Digital Literacy Indicators	Description
1	Finds	Able to find sources of information that are relevant to the problems studied
2	Uses multiple sources	Able to use various sources of information such as text, video, music, etc.
3	Select	Able to choose good sources of information that are in accordance with the problems studied.
4	Evaluates	Able to understand and evaluate well the information that has been found
5	Consider Sources /Message Effect	Realize that sources may have biases that can influence my decisions
6	Uses to produce original work	Use analysis and evaluation in utilizing digital information to produce new thinking and newly understood knowledge

The test instrument used has been checked and declared valid. Each digital literacy questionnaire item has a rubric with categories of strongly agree (score 5), agree (score 4), doubt (score 3), disagree (score 2), and strongly disagree (score 1). This Likert scale data provides a numerical representation of students' responses, allowing for quantitative analysis of their digital literacy skills across various indicators. The following formula is used to calculate the percentage of students' digital literacy questionnaire results on each indicator.

Percentage of digital literacy abilities = $\Sigma obtained\ score$ / $\Sigma maximum\ score\ x$ 100%

Furthermore, the percentage of digital literacy results will be grouped based on the following criteria in Table 2. This grouping aims to provide a clearer picture of the respondents' digital literacy level in various aspects, such as the ability to access, understand, analyze, evaluate and create digital information. The results of this classification will later become the basis for formulating recommendations and appropriate strategies to improve students' digital literacy.

Table 2: Student Digital Literacy Criteria

No	Score	Category
1	153 < X < 180	Very High
2	126< X < 153	High
3	99 < X < 126	Moderate
4	72 < X < 99	Low
5	0 < X < 72	Very Low

(Sulisetijono, 2020)

FINDING AND DISCUSSION

The findings of the student-completed digital literacy instruments were used to assess students' Digital Literacy. Based on Figure 1, it is known that the average digital literacy of students of the Biology Education Study Program, FMIPA Universitas Negeri Malang is the highest at 61.54% with a medium category. The remaining percentage is divided into four categories, high (31.73%), very high (3.85%), low (1.92%), and very low (0.96%).

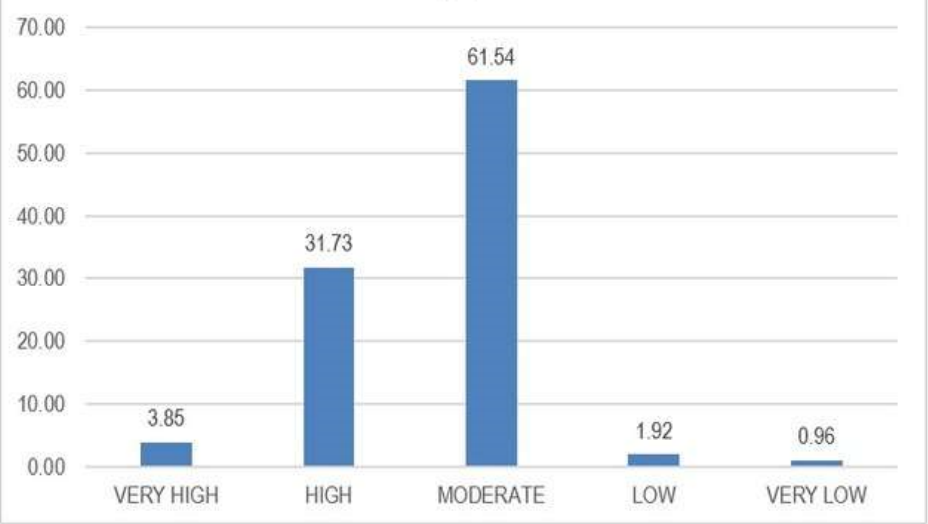

Figure 1. Percentage Results of Student Digital Literacy

Figure 1 show that most students are already at a moderate level of digital literacy. This shows that although students already have a level of proficiency in digital literacy, there is still room for improvement (Rayendra et al., 2020). While the results show that most students have at least a moderate level of digital literacy, it is important to consider the implications of the remaining percentage. The fact that 31.73% of students fell into the high category, and a small percentage of students fell into the low and very low categories, raises concerns about the breadth and depth of digital literacy among Biology Education Study Program students (Witherspoon et. al., 2022). Students with low (1.92%) and very low (0.96%) digital literacy scores require special attention to be improved. These findings indicate that further development of digital literacy skills in Biology Education Study Program students is needed. Furthermore, it should be

noted that research results show a positive trend in the use and choice of digital media in learning among students (Setiawan et al., 2021).

It is important to realize that even moderate levels of digital literacy may not be enough in today's rapidly evolving technological landscape (Smith & Storrs, 2023). As technology becomes more integrated in various fields, including education, the need for higher digital literacy skills increases. The digital divide, where some students have higher levels of digital literacy than others, has the potential to cause disparities in access to information and opportunities (Tınmaz et al., 2022). Therefore, it is imperative to ensure that all students have the opportunity to improve their digital literacy skills to meet the evolving demands of the digital age. It is important to delve deeper into the factors that contribute to these results. Understanding the specific areas where students excel and identifying areas that require improvement will be crucial in formulating targeted interventions to improve digital literacy in this program. Students should be equipped with digital literacy skills that focus not only on basic abilities but also critical thinking, information literacy and technological adaptability. By addressing these areas, students can develop a well-rounded set of skills that will prepare them for success in academic and professional endeavors, as well as in their digital interactions and engagement with society (Bejaković & Mrnjavac, 2020).

The proportion of digital literacy in each indicator is calculated from the results of the digital literacy assessment. Based on Table 3, only one indicator, the use of multiple sources is in the high category. Five indicators consisting of finding, selecting, evaluating, considering the impact of the source/message, and utilization to produce original work fall into the medium category. The indicator of using various sources (72.25%) obtained the highest percentage score of the six indicators examined. Followed by the search and use indicator to produce original work (70%), the search and use indicator to produce original work (70%), the selection indicator (69%), the evaluation indicator (66%), and the consideration of the source/message effect in the moderate category. Based on the findings of digital literacy in each of these indicators, improvements need to be made, especially in indicators that are in the moderate category.

Table 3. The Average Percentage Score of Student Digital Literacy Indicators

No	Indicators of Digital Literacy	Average Score	Category
1	Finds	70	Moderate
2	Uses multiple sources	72.25	High
3	Select	69	Moderate
4	Evaluates	66	Moderate
5	Consider Sources /Message Effect	64	Moderate
6	Uses to produce original work	70	Moderate

Students' digital literacy in finding indicators is categorized as moderate with an average percentage of 70%. The finding indicator is categorized as moderate because students are able to find information using digital sources, but there is still room for improvement in terms of the depth and accuracy of the information collected. While it is encouraging that the indicator of using multiple sources scored a high percentage, it is important to delve deeper into the types of sources that students use. Whether they are reliable and credible sources, or whether they simply take information at face value from the first source they find (Bhat, 2023).

Using multiple sources is the ability to utilize a variety of different sources when conducting research (Thompson et al., 2013). The high percentage score for the “using multiple sources” indicator is a positive sign of students' ability to gather information from various sources (Li, 2012). Therefore, this can strengthen why the use of various sources is included in the high category with an average score of

72.25%. When compared to the results on other digital literacy indicators, this is the highest average percentage result. However, to truly assess their digital literacy in this area, it is important to delve deeper into the types of sources they use. Are they reliable and trustworthy, or do students simply accept information at face value from the initial source they encounter (Haliq et al., 2023).

In addition, it is important to encourage the use of different sources when conducting research. This will not only broaden their understanding of a topic but also contribute to the development of their digital literacy skills (Gibson & Smith, 2018). Implementing strategies to guide students in understanding reliable information from multiple sources will be crucial in improving their overall digital literacy profile.In the medium category, the average percentage of digital literacy indicators in the selection indicator is 69%. Assessing an individual's capacity to recognize and confirm reliable sources of information in the digital age is critical, making the selection of digital literacy indicators an important task (Toff et al., 2020). The selection of digital literacy indicators involves consideration of various factors, including information, technical skills, communication skills, and innovative aspects (Nazarova & Nazarov, 2021).

The students' ability to assess indicators in general is in the moderate category with an average percentage of 66%. This indicates that the evaluation indicator relates to the ability to critically analyze information obtained in the digital environment (Isabel et al., 2016). This not only involves understanding how to interpret digital data but also requires skills to question and validate the accuracy and reliability of information. Students must be able to distinguish between credible and non-credible sources, recognize bias, and evaluate the relevance of information to a particular context (Sparks et al., 2016). Developing these critical thinking skills is crucial to their success not only in academic achievement but also in their future careers.

The measurement of the indicator “considering source/message effects” showed an average percentage of 64%. This is the lowest average among all the digital literacy indicators. This suggests that students struggle to understand how sources or messages can impact on the credibility and reliability of information (Coffey, 2024). They may not fully understand how the intent or bias of the source can affect the information presented (Leliana et al., 2021). This is a critical aspect of digital literacy, as the ability to discern credible information from misinformation or disinformation is essential in the digital era (Guess et al., 2020).

The indicator of using to produce original work obtained an average percentage of 70% in the medium category. This skill relates to the ability to generate new ideas and content without relying too much on external sources. This shows that students are able to create original work without relying too much on external sources, demonstrating a level of creative thinking and originality through digital access (Kimbell-Lopez et al., 2016). Digital literacy skills, such as using technology effectively and navigating online resources, play an important role in improving students' ability to produce original content (Baber et al., 2022).

Generally, improving students' digital literacy requires teachers' creativity in planning and developing learning materials so as to develop students' digital literacy as a habit (Tınmaz et al., 2022). Through various active learning methods, teachers should engage students in learning situations that foster critical thinking skills (Dewanti et al., 2021). This can be achieved by incorporating ICT tools and collaborative writing activities into the classroom (Nguyen & Habók, 2023). Digital literacy is the ability to navigate, evaluate, and use information effectively and ethically in a digital environment (Statti & Torres, 2020).

Some strategies to improve students' digital literacy are providing hands-on opportunities for students to engage with technology, teaching them how to critically evaluate online sources, and

encouraging collaboration and communication through digital platforms (Khan, 2018). In addition, conducting literature reviews, formulating research questions, developing hypotheses, discussing, presenting, and analyzing the problem-solving process can improve students' digital literacy skills (Zubaidah, et al., 2023). While the future of digital Biology education lies in the integration of online and offline learning environments through a diverse range of digital platforms (Maghfiroh et al., 2022). Some of learning online media are mobile apps with multimedia content can help students learn which suited with digital era (Safitri, 2024).

This study has several limitations. Firstly, the focus of this research is limited to internal efforts to improve students' digital literacy in the biology study program at the State University of Malang, without evaluating similar efforts at other institutions. Secondly, this study has not compared the digital literacy of students in various biology study programs at other universities, so the findings cannot be generalized. Thirdly, this study has not conducted an in-depth study related to the measurement of digital literacy in triangulation. These limitations are the basis for further research that is more comprehensive and generalizable.

CONCLUSION

This study concludes that student digital literacy is dominated in the medium category (61.54%), however, there were the certain number of students in the low (1.92%) and very low (0.96%) level of digital literacy. Students with these digital literacy scores require special attention to be improved. This mean that more attention need to be given to digital literacy development in biology education in all level. These findings emphasized the importance of further and holistic empowerment of digital literacy skills among biology education students, particularly in the indicators of evaluating and considering the source/effect of messages.

Future research needs to expand the scope by comparing the digital literacy of biology students in various universities, evaluating digital literacy improvement programs in various institutions, developing more comprehensive digital literacy measurement instruments, tracking the development of students' digital literacy longitudinally, and expanding the focus of research to other aspects of digital literacy. This is expected to provide a more thorough understanding of the digital literacy of biology students and help improve the quality of biology education in the digital era.

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