



Identifying Prospective Biology Teachers' Digital Literacy Competence at Cenderawasih University

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Received: August 5, 2023

Revised: October 8, 2023

Accepted: November 25, 2023

Published: November 30, 2023

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DOI: [10.29303/jppipa.v9i11.4908](https://doi.org/10.29303/jppipa.v9i11.4908)

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Abstract: Nowadays, integrating ICT into learning and teaching practice is a challenge faced in the education world. The current educational system requires teachers to master digital literacy competence. The purpose of the present study was to identify the digital literacy competence of prospective biology teachers at Cenderawasih University. A descriptive and quantitative approach, with the survey model, was applied in this paper. A random sampling technique was used with 71 student teachers as data informants. Data were collected from questionnaire items and documentation. Overall, prospective biology teachers' digital literacy competence was at a high level. Student teachers scored highest in information skills, rated at very high criteria, the second and third areas, namely communication and content-creation, were at high criteria. The lowest values were indicated in safety and problem-solving.

Keywords: Biology; Competence; Digital Literacy

Introduction

Human beings in the 21st century face major innovations in technology that can solve problems and contribute to individual's daily live (Agbo, 2015; Barbosa & Amariles, 2019). The internet, social media, and digital communication are part of modern technological developments which transform the way people access, process and use information (Guillen & Mayorga-Fernández, 2022; Nuraini et al., 2023). The use of Information and Communication Technology (ICT) in learning-teaching practices is of vital importance to improving the quality of education (Fernández-Morante et al., 2023; Infante-Moro et al., 2019).

Teachers are expected to create a powerful and flexible learning environments using digital technologies that can develop student's skills (Çebi & Reisoğlu, 2020). Integrating technology into curricula is seen as a significant instrument to facilitate the educational objectives such as skills for cooperation, communication, problem solving and lifelong learning (González Pérez, 2018). Innovative use of ICT could make learning process more accessible and enable students to intensify their collaborative activities (Heemskerk et al., 2011). As a professional teacher, the ability to integrate ICT into learning and teaching

process is the definition of digital literacy competence (Rusydiyah et al., 2020; Salcines-Talledo et al., 2020).

Digital literacy has to do with: the competence to work on the computer, technical skills, the use of digital technologies in daily life, participation in digital culture, formal and informal state of information in screening, communication, digital content creation, safety, problem solving, digital media, also learning about the advantage and disadvantages of digital technologies (Ferrari, 2021; Ilomäki et al., 2016; Napal et al., 2018; Solmaz, 2017). Fraillon et al. (2013) define digital literacy as the competence to use, understand, access, manage, and share information in secure and conscious manners. In this paper, the study focuses on five areas of digital literacy competence, namely: Information skills, communication skills, content-creation, safety, and problem solving (Ferrari, 2012; Ferrari, 2021).

Digital literacy as digital-based effort in learning-teaching practices have significantly changed social and educational dynamics (Salcines-Talledo et al., 2020). In order to integrate a proper use of ICT, digital literacy competence is necessary. Of these facts, recognition of the importance of teachers's digital literacy has become the main concern in the university (Bond et al., 2018; Çebi & Reisoğlu, 2019; Salcines-Talledo et al., 2020). This study is focused on undergraduate students as

How to Cite:

Nurbaya, N. (2023). Identifying Prospective Biology Teachers' Digital Literacy Competence at Cenderawasih University. *Jurnal Penelitian Pendidikan IPA*, 9(11), 10051-10058. <https://doi.org/10.29303/jppipa.v9i11.4908>

prospective biology teachers, who become a vital part in the continuation of education system.

University students are highly familiar with technology and have free access to information, but often they lack of knowledge on how to use these technological tools for educational goals (Salcines-Talledo et al., 2020). The number of studies related to digital literacy of prospective teachers is limited (Alarcón et al., 2020; Lázaro-Cantabrana et al., 2019). In the studies conducted, the result stated that the digital competence of higher education students is moderate and varies significantly based on gender and perceived level on digital literacy competence (Çebi & Reisoğlu, 2019; Infante-Moro et al., 2019; Napal et al., 2018).

Following the study, (Rusydiyah et al., 2020) said that the student teachers had good competencies in digital literacy as a learning resource including basic ICT indicators, skills to use information, media awareness and critical thinking. As teacher candidates, analyzing their digital literacy competencies must be given the appropriate portion (Carretero et al., 2017; Çebi & Reisoğlu, 2019). Therefore, this study is expected to identify the digital literacy competence of higher biology education students at Cenderawasih University.

Method

To identify the digital literacy of prospective science teachers', the survey was used as the method to collect the data required (Guillen & Mayorga-Fernández, 2022; Infante-Moro et al., 2019). More specifically, this study was a descriptive and quantitative approach that demanded the researchers to developed questionnaire in order to measure five competencies of digital literacy (information skills, communication skills, content-creation, safety, and problem solving).

This research's population is made up of all biology students at Cenderawasih University, accounting for 250 prospective science teachers. Of these students, 71 members were selected as research informants using random sampling technique and *Slovin's formula* (Amirin, 2011). The instrument used was questionnaire that included 25-questions based on five indicators of digital literacy (Çebi & Reisoğlu, 2020; Kareem, 2018;

Roopa & Rani, 2012), with a rating scale used, the Likert scale (the 5-point scale: from 1-strongly disagree to 5-strongly agree) (Bond et al., 2018; Xiang et al., 2014).

As for the validity of the instrument, this study used the *Aiken's Value* technique, shown at the following formula (1), and the questionnaire items called valid if the coefficient value of *Aiken's V* higher than 0.3 (Azwar, 2012; Rusydiyah et al., 2020).

$$V = \frac{\sum s}{n(c-1)} \tag{1}$$

With: $s = r - l_0$

- l_0 : the lowest score
- c : the highest score
- r : score given by the rater
- n : number of raters

Formula 1 shows the *Aiken Value* results towards the 25-statements used as instrument. A glance at the table provided reveals that the instrument used is valid based on the calculation of all the *Aiken's Values* surpass 0.30 (Bond et al., 2018; Nurgiyantoro, 2017), therefore the researcher can collect data using those questionnaire items.

With the assistance of IBM software for SPSS' quantitative data analysis version 24.0, the Cronbach's Alpha conducted to estimate the reability of the questionnaire (Bond et al., 2018). All of the items of the questionnaire scored 0.905, which resulted the instrument in a high reability (Rusydiyah et al., 2020).

The questionnaire distributed through *Google Form* link to all respondents on January 2023. The data collected from questionnaire were primary data (Hasan, 2002), and will be analyzed with descriptive analyses. The score categories used to measure the prospective teacher's perceptions is shown in this following Table 2, ranked from very low criteria to very high criteria (Riduan & Akdon, 2006; Sudaryono, 2021).

Table 1. Interpretation of Questionnaire Data

Interval (%)	Criteria
81 - 100	Very high
61 - 80	High
41 - 60	Medium
21 - 40	Low
0 - 20	Very low

Table 2. Results of *Aiken's Values* of The Questionnaire Items

Item	Value V	Item	Value V	Item	Value V
Q1	0.833	Q10	0.750	Q19	0.833
Q2	0.916	Q11	0.916	Q20	0.667
Q3	0.833	Q12	0.750	Q21	0.750
Q4	0.916	Q13	0.667	Q22	0.833
Q5	0.833	Q14	0.750	Q23	0.667
Q6	0.833	Q15	0.916	Q24	0.916
Q7	0.750	Q16	0.750	Q25	0.916
Q8	0.750	Q17	0.833		
Q9	0.667	Q18	0.667		

Result and Discussion

Information

The first digital literacy competence measured in this present study is information. It is evident from the Table 4 that the average level of prospective science teacher in informational competencies represents a very high-criteria, at 80.2% (based on Likert scale, item 5), which means the majority of students have a good understanding of the information's area. The indicators used in this research are adapted from Ferrari (2012). Information skill is consisted of abilities in using the

internet such as exploring the internet to collect data; evaluating the data; selecting the information; specifying the keywords; and downloading/ uploading document in different formats.

Based on Table 4 provided, the first indicator from information skill is the ability of students to explore the internet in order to collect data related to biology courses. According to Keskin & Yazar (2015), this indicator is the core of digital competence. Prospective biology students have the ability in using basic internet tools to obtain information from digital media, such as browsing journal or article.

Table 3. Digital Literacy Competence - Information

Indicator	Frequency				
	1	2	3	4	5
I can explore the internet to collect data related to biology courses (e.g., journal/ articles, e-book, or literature study)	0	0	2	11	58
I can evaluate the data sources related to biology courses	1	0	6	8	56
I can select the information I get from the internet	0	2	7	5	57
I can specify the exact keywords on the internet related to biology courses	0	1	1	10	59
I can download and upload document (e.g., using formats: word, .pdf, .pptx, jpg, .mp4) related to biology courses	0	1	6	9	55
Average	0.2 (0.2%)	0.8 (1.15%)	4.4 (6.1%)	8.6 (12.1%)	57 (80.2%)

The information collected from internet required students to evaluate and select the data, which the ability of filtering the information is significant to have. Regarding to data collected, majority of students have the confidence to conduct the indicators mentioned. Meanwhile to get the information related to biology courses on the internet, students must have the ability to find the right keywords. And the table given shows that most of biology students understand the importance of finding the right keywords. The same result found in the last indicator of information, students can store and retrieving information.

In the study conducted by Rusydiyah et al. (2020), the respondents are students of universities with USAID partnership have the same level of informational skills, that indicated the very-high criteria. The student

teachers showed good skills in the variable of digital literacy (ICT competenceies, information, media awarenesss and problem solving/computational thinking).

Communication

Table 5 illustrates communication skills of biology students according to five indicators that represent the ability: to discuss and share topic/materials about biology courses, to use different types of digital tools, and to participate as an active student during class. Indicators for communication are developed by Çebi & Reisoğlu (2020). It can be seen from table provided that the highest Likert's score- accounting for 72.9% of communication competence- are indicated on item 5.

Table 4. Digital Literacy Competence : Communication

Indicator	Frequency				
	1	2	3	4	5
I can discuss topic/material related to biology courses through various paltforms (e.g., WAppG, Google Classroom, Youtube, Telegram, or Instagram)	1	2	2	15	51
I can share files and materials about biology courses through digital media (e.g., WAppG, Google Classroom, Youtube, Telegram, or Instagram)	0	0	5	23	43
I can use various online communication tools (e.g., e-mail, blog, web conferencing, chat services or discussion groups)	0	0	2	10	59

I can maximize the use of digital media (e.g., WAppG, Google Classroom, Youtube, Telegram, or Instagram) in order to collaborate with collague/friends in completing assignments	1	1	4	12	53
I can participate as an active student during e-learning biology courses (e.g., WAppG, Google Classroom, Youtube, Facebook)	2	2	5	9	53
Average	0.8 (1.1%)	1 (1.4%)	3.6 (5.1%)	13.8 (19.4%)	51.8 (72.9)

The knowledge and competence of the prospective biology teachers based on the item responses were at high-level. Students have the skills to use different platforms in communication. In this context, the prospective biology teachers have the important ICT skills to face the future professional performace in their life. A study by Infante-Moro et al. (2019), analyzing the importance of higher students' communication and collaboration as a part of ICTs' skills such as observing the collaboration and publication using digital media; observing if students communicate idea and information; observing if they actively participate in groups to finish the project, stated that digital literacy competence has relevant role in today's work, therefore students deserve to master these ICT skills.

A study conducted by Çebi & Reisoğlu (2020), focused to analyze the opinion of 518 pre-service teachers in different province of Turkey, found that the respondents have high-level in communication and

collaboration due to their use of these digital media in daily lives. More specifically in term of using digital technologies, the male service teachers had better understanding than female pre-service teachers. Based on literature, the competence of male teachers in using computer and collecting information was higher than female teachers (Keskin & Yazar, 2015).

Content-Creation

Content-creation as the third digital competence measured in this study is summarized at Table 6. One particularly interesting fact highlighted by the figure is that item 5 (strongly agree) is presented as the highest Likert's scale, about 61.6%, indicated as high-criteria (based on Table 2). This paper uses indicators developed refers to abilities in making learning material content; writing an article; searching information to upgrade knowledge; identifying the source's content; and citing the sources/references in articles.

Table 5. Digital Literacy Competence: Content-Creation

Indicator	Frequency				
	1	2	3	4	5
I can make learning material content related to biology courses in different formats (e.g., .ppt, .mp4, .jpg, .mp3)	1	1	12	13	44
I can write an article related to biology courses through digital media (e.g., WAppG, Google Classroom, blog)	2	0	12	10	47
I can search information to upgrade my knowledge	0	0	20	12	39
I can identify content created by Ministry of Research, Technology and Higher Education Indonesia.	3	1	8	17	42
I can cite the sources/references of information in writing articles related to biology courses	2	2	5	15	47
Average	1.6 (2.2%)	0.8 (1.1%)	11.4 (16.1%)	13.4 (18.8%)	43.8 (61.6%)

Content-creation indicates the high-level criteria, slightly lower than information and communication digital literacy competence. In the study by Gutiérrez & Serrano (2016), the digital competence of 134 students of primary school teachers at Murcia University in content-creation area stood at low level. Students still find it hard to see the different between author's right, copyright, licence to information and the resources they used.

Research on content-creation can be found in Hinojo-Lucena et al. (2019). The digital competence of Permanent Education Centers were analyzed as the aims of this study. Teachers indicates to have low level of

content-creation criteria, due to some factors prior training on ICT, degree, and experience in teaching.

In study by Napal et al. (2018), it is found that preservice teachers digital competence in content-creation, copyright and licensing was low. This competence refers to one's abilities in developing digital content, integrating & reworking of digital content, programming and know how to apply content rights and license for use.

Safety

Table 7 shows safety as the next digital competence measured in this study. It has 5-indicators developed

based of Ferrari (2012), which elaborate on the Table 6 (have the ability of self-protection, the ability to filter the required information, the ability to upgrade security system, understand well the effect of digital media to health and psychology, and the ability to use digital

media in respect manner). As previously mentioned, 3-digital literacy competence (information, communication, and content-creation) shows the average percentage on item 5 more than 50%, as for safety's area, it has 41.9% for the maximum frequency.

Table 6. Digital Literacy Competence: Safety

Indicator	Frequency				
	1	2	3	4	5
I can protect myself from cyber bullying (e.g., sending mean texts, pranking someones's cell phone, or hacking social networking profile)	0	1	23	28	19
I can filter my information related to biology courses before sharing/uploading to social media (e.g., WAppG, Google Classroom, Youtube, Facebook, or Instagram)	1	5	15	20	30
I can upgrade my security system on social media (e.g., WAppG, Google Classroom, Youtube, Facebook, or Instagram)	2	2	29	15	23
I can tell that digital media affect health and psychology	0	5	18	20	28
I can tell how to use digital media in respect manner	0	0	12	10	49
Average	0.6 (0.8%)	2.6 (3.6%)	19.4 (27.3%)	18.6 (26.1%)	29.8 (41.9%)

Based on the figure provided, safety's area has a medium level with the lowest score out of all digital literacy competences. This finding has close similarity with the study by Gutierrez Porlan & Serrano Sanchez (2016), students were aware of certain types of personal information and privacy issue, but they lacked of knowledge to avoid cyber bullying.

In the study by Napal et al. (2018), Protection of information and digital identity, protection of health and the environment as part of teacher digital competence found that student teachers at Spanish Ministry of Education was the second highest after informational skills. In stark contrast, Çebi & Reisoğlu (2020) stated that the knowledge of pre-service teachers in protection from threats, awareness of psychological and the effect of digital media in environment were at good (high criteria).

Problem Solving

The last competence to measure in digital literacy is problem solving. This competence analyzed the ability of respondent to use digital technology in learning process. It is apparent from the Table 8 that students' average in their digital literacy competence indicate

medium-criteria, at 59.7% on item 5 (strongly agree) based on the Likert's scale.

The indicators used in this study developed by Çebi & Reisoğlu (2020; Infante-Moro et al. (2019) problem solving area's include skills to apply digital media as learning tools; use digital technology to assist learning process; optimize the use of ICT tools-based learning media; use technical knowledge to access digital media; and participate in webinars/online trainings to upgrade skills.

As previously mentioned, problem solving area stood at medium criteria. A study from Çebi & Reisoğlu (2020); Esteve-Mon et al. (2020); Napal et al. (2018) found that the digital competence of student teachers in problem solving was indicated at low level. These studies have seen problem solving from a number of indicators, identifying the needs for using digital resources; making decisions of which tools to use according the purpose; solving the conceptual and technical problems through digital media; updating their own competence. On the other hand, the study by Gutiérrez & Serrano (2016) show that future primary school teachers at Murcia University were aware of using a new device and program to solve routine activities.

Table 7. Digital Literacy Competence: Problem Solving

Indicator	Frequency				
	1	2	3	4	5
I can apply various digital medias as learning tools	2	0	10	11	48
I can use digital technology to assist my learning process related to biology courses	1	0	8	23	39
I can optimize the use of Google Classroom as an ICT-based learning media	1	1	7	15	47

Indicator	Frequency				
	1	2	3	4	5
I can make use of digital media using my technical knowledge	3	0	10	21	37
I participate in webinars/online trainings to upgrade my soft skills in accessing digital technology	3	0	18	9	41
Average	2 (2.8%)	0.2 (0.2%)	10.6 (14.9%)	15.8 (22.2%)	42.4 (59.7%)

Conclusion

In this study, it was aimed to identify the digital literacy competence of prospective biology teachers at Cenderawasih University. As a result of the study, it can be said that information skill is categorized at very high criteria. It covers the ability to collect data, to evaluate, to select, to specify, to store data. The second and the third competence, communication skills and content-creation, can be categorized at high criteria. Communication consisted the skills to discuss and share topic/materials, to use different types of digital tools, and to participate as an active student during class. Content-creation is an aspect related to make content, write an article, search information to upgrade knowledge, identify the source's content, cite the sources/references in articles. Meanwhile, safety as the fourth indicator measured is still on the medium criteria. This study show that student teachers urgently need to improve the ability of self-protection, the ability to filter the required information, the ability to upgrade security system, understand well the effect of digital media to health and psychology, and the ability to use digital media in respect manner. The last area of digital literacy is problem solving. The study findings show student teachers still on the medium criteria, therefore university need to integrate ICT skills in learning process they can improve the ability to apply digital media as tools. Only with proper exercise that student teachers have good digital literacy in information skills, communication skills, content-creation, safety and problem solving. Subsequently, these skills will help the prospective teachers to be a professional teachers.

Author Contribution

This article was written by one author from start to finish.

Funding

This research received no external funding.

Conflicts of Interest

The authors declare no conflict of interest.

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