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Digital Competence: A Study from the Prospective Biology Teachers in Papua

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Abstract: As a professional teacher candidate in the 21st century, prospective biology teachers have to master ICT-based learning. The ability to integrate ICT in the teaching and learning process is called digital competence. This study aims to analyze the digital competence of prospective biology teachers through working on video projects in molecular biology courses. By using mixed methods (quantitative and qualitative research), this research was carried out on 2nd semester biology students who were the subject of the study, accounting for 35 students. Questionnaires, observations and interviews are the data collection techniques used. Quantitative data were obtained from questionnaire scores while for qualitative data obtained from observations and interviews. Research data were analyzed using descriptive statistical analysis. The results of the study show that the digital competence of prospective biology teachers for information and communication skills are in the high category. The dimensions of content-creation and problem solving are in the medium category, and safety is in the low category

Keywords: Digital competence; ICT; Papua; Prospective biology teachers

Introduction

Education and research policies in the 21st century have a trend towards digital competence of higher education students (Fernández-Morante et al., 2023; Guillen Gamez & Mayorga-Fernández, 2022). According to the European Union, digital competence is one of the keys to implementing learning in education systems in various European regions (Salcines-Talledo et al., 2020). Education regulations in Indonesia are no exception. With the implementation of the Merdeka Curriculum, the education scenario in tertiary institutions requires students with digital capabilities to be able to use technology in a dynamic, applicable, up-to-date and innovative manner. To produce student output with digital competence that is ready to face the professional world, then in the learning process at universities ICT-based learning is a must (Infante-Moro et al., 2019, 2022). ICT integration at universities is aimed to familiarizes students interacting with digital tools and making the learning process more interactive and flexible. This is why digital competence has received great attention in university-level education (Cabero-Almenara et al., 2019; Cabero-Almenara & Palacios-Rodríguez, 2020; Rodríguez-Hoyos et al., 2021).

The ability to integrate ICT in learning is called digital competence. Digital competence (digital literacy) is the ability to operate a computer, use technology in life, the ability to collect information, communicate on social media, create digital media, data protection, and problem solving (Ferrari, 2012, 2013; Fraillon et al., 2013; Ilomäki et al., 2016; Napal Fraile et al., 2018). Evaluation of digital competence can be developed from the Framework for Developing and Understanding Digital Competence in Europe. The digital competence referred to in this study is the ability for information, communication, content-creation, safety, and problem solving (Carretero et al., 2017; Ferrari, 2012; Vuorikari et al., 2016).

Biology is concerned with living organisms, their structures, form and function, and heredity (Kareem, 2018). One branch of biology is molecular biology.

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Molecular biology is a subject that deals with the functional components of cells microscopically (Sanni & Emeke, 2017). As a fundamental science subject, biology served the basis for understanding complexities to the world of knowledge of self, the current and unapproachable environment (Taiwo & Emeke, 2014). The complexity of molecular biology material requires the visualization of ICT-based learning media with the aim that the material is interesting and easy to understand, therefore, in the process of learning molecular biology courses, technology tools are applied. As one of the main pillars of teaching innovation, the integration of ICT into the teaching and learning process will increase student learning activities which will certainly have a positive impact on their learning outcomes (Espejo Villar et al., 2022; Røkenes & Krumsvik, 2016; Tan & Wong, 2020).

University students, called 'Society of Learning' regarding of their situation and context, are familiar with using technology and have easy access to information, but they lack knowledge in the use for educational goals (Aguaded, 2014; Salcines-Talledo et al., 2020). Lecturers see it a momentum to integrate ICT in learning by giving molecular biology video project assignments in responding to teacher digital competence ability and improving school learning (OECD, 2010). This video project is a student's assignment to create interactive learning media that requires digital competence skills. In compiling the video, ICT integration is required and students have to master digital competence in order to create the expected video content. Analyzing the prospective biology teachers' digital competence based on the video projects they are working on is the aim of this research. Knowing digital competence of biology students, will contribute to future training policies at Universitas Cenderawasih which directly associated to the public and government policies.

Method

Digital competency analysis uses mixed methods (Infante-Moro et al., 2019; Parmin & Savitri, 2022), quantitative data obtained from questionnaire scores and qualitative data obtained from observations and interviews. The sampling technique used was a systematic sampling technique, with 35 students as the research subject. The subjects are prospective biology teacher candidates in the biology education study program. Data was collected through questionnaires, observations, and interviews. The questionnaire sheet was developed from 5 digital competency indicators based on Ferrari (2012), which was developed by Infante-Moro et al. (2019) consisting of 25 question items. Questionnaire items use a Likert scale with the highest points 5 (strongly agree) to 1 (strongly disagree) (Bond et al., 2018; Xiang et al., 2014). Observations were made during the course of molecular biology. Interviews were conducted with 35 prospective biology teacher students who were compiling video projects.

The instrument was tested for validity and reliability. The validity test used Aiken's Value with items categorized as valid if more than 0.3 (Rusydiyah et al., 2020). Table 2 shows the results of Aiken's Value validation. It can be seen that 25 questionnaire items were indicated valid, because their value was greater than the coefficient of 0.3. Therefore, digital competency questionnaire is valid to use.

For the reliability test, the Cronbach's Alpha was used with the help of IBM SPSS version 24.0 (Bond et al., 2018). The results of the reliability test of the questionnaire items were 0.912, indicating that the questionnaire items were reliable to use as research instrument. The data that has been analyzed will be interpreted using the digital competency categories in Table 1 (Riduan & Akdon, 2006; Sudaryono, 2017). The conceptual framwork this research can be seen in figure 1 below.

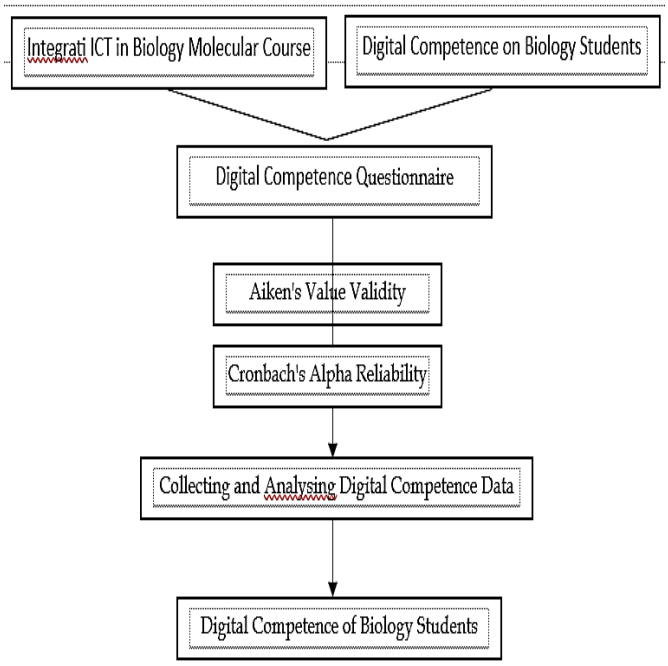

Figure 1. Research design

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 Value of the Questionnaire

Item	Value V	Item	Value V	Item	Value V
Q1	0.833	Q10	0.750	Q19	0.833
Q2	0.750	Q11	0.833	Q20	0.667
Q3	0.750	Q12	0.667	Q21	0.750
Q4	0.667	Q13	0.667	Q22	0.916
Q5	0.916	Q14	0.750	Q23	0.750
Q6	0.750	Q15	0.916	Q24	0.667
Q7	0.667	Q16	0.750	Q25	0.916
Q8	0.75	Q1	0.83		
Q9	0.916	Q18	0.667		

Result and Discussion

Information

The first indicator to be discussed is information. Information refers in one's abilities to formulate and analyze the information critically and systematically, to search for content and data, critical evaluation and interpretation (Gutiérrez Porlán & Serrano Sánchez, 2016). These skills include the ability of students to 1) browse (to access and search online information), 2) evaluate information (to gather, process and understand information), and 3) store and retrieve information (to manipulate and store information). All of these indicators were developed into 5 indicators based on Ferrari (2012) which are described in Table 3. The results of the questionnaire showed that the digital competence of prospective biology teacher students in the information aspect was in the high category (72%). This shows that students have the ability to find information related to molecular biology material that will be compiled in a video project.

Table 3. Digital Literacy Competence - Information

Indicator	Frequency				
	1	2	3	4	5
I can explore the internet to collect data related to biology molecular course (e.g., journal/articles, e-book, or literature study)	0	0	3	3	29
I can evaluate the data sources related to biology molecular course	0	0	5	9	21
I can select the information I get from the internet	1	1	2	6	25
I can specify the exact keywords on the internet related to biology molecular course	0	0	3	8	24
I can download and upload document (e.g., using formats: .word, .pdf, .pptx, jpg, .mp4) related to biology courses	1	2	2	3	27
Average	0.4 (1.14%)	0.6 (1.71%)	3 (8.57%)	8.8 (16.5%)	25.2 (72%)

Informational competence is the significant indicator in digital competence (Keskin & Yazar, 2015). This competence is essential to help students as lifelong learners to assimilate, construct and be conscious of new information needed (Kirkwood & Price, 2005; O'Callaghan et al., 2017), and based on data analyzed, students already have the skill to apply. The table shows that students' information skill already in the high category, which means prospective biology teachers have the ability to search for material related to molecular biology and download/upload that material. Similar studies conducted by Cebi et al. (2020), Nurbaya (2023) and Rusydiyah et al. (2020) found that the informational skills of higher education students the have-very high criteria, indicated the students have good skills in browsing, searching, filtering data, evaluating data and managing data. Research on information of digital competence can be found in study by Pieterse et al. (2018) that conducted on Hebrew and Arabic majority at Israeli College. The language students' informational skill stood at the high-level category, but they lack on speed and accuracy in accessing information.

The interesting thing in table 1 is that indicator 1 related to searching for material on the internet has the highest value, but indicators related to evaluation of reference sources are still low. The prospective teachers will, in one way or another, be role models for their future pupils in terms of the use of digital media in class, therefore integrating ICT in teavhing-learning process is essential (Krumsvik et al., 2016; Røkenes & Krumsvik, 2016). The results of interviews with biology students showed that students already knew the specific ways of looking for biology material, downloading/uploading material in various formats and selecting according to their needs. But the results of observations from researchers indicate that even though students know how to find molecular biology material, they do not yet know a good and credible website in finding articles/journals to be used as references.

Communication

The second digital competence measured in this research is communication skill. Communication developed in 5 indicators as seen in Table 4, 1) discuss topics, 2) share files and materials through digital media, 3) use various online communication tools, 4) maximize the use of digital media, and 5) participate as an active student during e-learning course (Infante-Moro et al., 2019). Communication refers to interaction using digital

tools and application, including sharing information, data and content to others along with the data resource and citation (Çebi & Reisoğlu, 2019). Based on the table provided, this competence stood at high category, with a presentation of 70.25%. This competence is slightly lower than information skills. It can be seen that students have knowledge of various online communication tools and are familiar with the use of these digital media in learning-teaching process.

The results of the interviews show that students are inseparable from the use of digital communication media every day, whether used for learning purposes or used in daily activities. In carrying out assignments related to molecular biology video projects, students work in groups. In the process they form a communication group on Wapp and telegram. They also access many examples of learning videos on the Youtube channel as references in working on projects. This shows that students already have digital competence related to communication skills through digital media. A study conducted by Cebi et al. (2020) found that the respondents have high-level in communication and collaboration due to their use of these digital media in daily lives. In line with other study, according to Zhao et al. (2021), communication and collaboration of 536 in-service teachers from Guansu Agricultural Univeristy of China resulted themselves better in this area.

Table 4. Digital Literacy Competence: Communication

Indicator	Frequency				
	1	2	3	4	5
I can discuss topic/material related to biology molecular course through various paltforms (e.g., WAppG, Google Classroom, Youtube, Telegram, or Instagram)	0	0	2	7	26
I can share files and materials about biology molecular course through digital media (e.g., WAppG, Google Classroom, Youtube, Telegram, or Instagram)	0	0	5	5	25
I can use various online communication tools (e.g., e- mail, blog, web conferencing, chat services or discussion groups)	0	0	3	2	30
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	0	0	6	9	20
I can participate as an active student during e-lerning biology molecular course (e.g., WAppG, Google Classroom, Youtube, Facebook)	0	0	3	10	22
Average	0 (0%)	0 (0%)	3.8 (10.8%)	6.6 (18.8%)	24.6 (70.2%)

The results of observations during the process of preparing the video project showed that they already had digital competence related to communication, especially discussing the topic of the project being worked on. However, a slight drawback that is visible from students is efficiency and focus when working on project assignments. Often their focus is diverted from working on molecular biology video projects due to the excessive use of social media. This has little effect on the completion time of project assignments.

Content-Creation

The third dimension of digital competence is content-creation, which refers to ability in creating digital content (with differet formats), expressing idea through digital media, making changes and editing content made by others, and also knowing the programming skills and software (Çebi & Reisoğlu, 2020). This competence is developed into 5 indicators, 1) making learning material related to course, 2) writing an article,3) searching information to upgrade knowledge, 4) identifying content created, 5) citing the sources/references of informating in writing articles (Infante-Moro et al., 2019). Content-creation indicated in the medium category, which is 56% based on Table 5. In this dimension, there are still students who do not have the ability to create learning content, such as articles and video projects. A study by Fernandez-Morante et al. (2023), conducted on 610 teachers at Universities of Glacia Spain, found that digital competence of teachers stood at medium low level.

The results of the interviews revealed that they were able to find material related to molecular biology, were able to find material from various sources, but to compile it into an article, students still needed further guidance. The study by Gutierrez Porlan et al. (2016) also found the difficulty faced by 134 students of Murcia University in citatition. Students still lack of knowledge about aouthor's right, copyright and licence to the resource they use.

Table 5. Digital Literacy Competence: Content-Creation

Indicator	Frequency				
	1	2	3	4	5
I can make learning material content related to biology molecular course in different formats (e.g., .ppt, .mp4, .jpg, .mp3)	2	2	5	7	19
I can write an article related to biology molecular course through digital media and transform that material in video (e.g., WAppG, Google Classroom, blog)	0	0	6	7	22
I can search information to upgrade my knowledge	3	0	5	6	21
I can identify content created by Ministry of Research, Technology and Higher Education Indonesia.	1	1	5	7	21
I can cite the sources/references of information in writing article related to biology molecular course	2	3	7	8	15
Average	1.6 (4.5%)	0.2 (3.4%)	5.6 (16%)	7 (20%)	19.6 (56%)

Research on content creation at low category also found on research of Hinojo-Lucena et al. (2019), Gutierrez Porlan et al. (2016), and Napal Fraile et al. (2018). In the studies conducted, teachers' competence in creating digital content integrating digital media in teaching process still at low level due to lack of knowledge or skills, therefore the study emphasized the urgent need of didactic training aspects of ICT integration.

The results of observations of students while working on a molecular biology video project showed that in one group there were students who needed assistance from other friends to create content (learning videos). On one of the content-creation indicators, namely citing the source/reference of information in writing articles, it can be seen that students do not understand the correct way to cite the citations they make. The video project also looks very lacking in the citations that should exist. As prospective biology teacher in who will be professionals in their future career, students are highly encouraged to integrate digital media as tools within their performance, which indicate the understanding of pedagogical purpose (Biasutti, 2017; Peterson, 2012; Tømte et al., 2015; Weidlich & Kalz, 2023).

Safety

Of the five dimensions of digital competence, safety has the lowest presentation. In this dimension, the indicators measured according to Table 6 consist of: 1) ability to protect oneself from cyber bullying, 2) ability to filter information, 3) ability to upgrade security systems on social media, 4) ability to tell the effect of digital media on health and psychology, 5) ability to use digital media in a respectful manner (Infante-Moro et al., 2019). This dimension stood at 39%, accounting for the low category. This finding has close similarity with the study by Gutierrez Porlan et al. (2016), students were aware of certain types of personal information and privacy issue, but they lacked of knowledge to avoid cyber bullying.

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)	4	3	6	10	12
I can filter my information related to biology courses before sharing/uploading to social media (e.g., WAppG, Google Classroom, Youtube, Facebook, orInstagram)	6	4	7	6	12
I can upgrade my security system on social media (e.g., WAppG, Google Classroom, Youtube, Facebook, or Instagram)	4	2	8	6	15
I can tell that digital media affect health and psychology	1	1	7	12	14
I can tell how to use digital media in respect manner	0	0	10	9	16
Average	3 (8.5%)	2 (5.7%)	7.6 (21.7%)	8.6 (24.5%)	13.8 (39.4%)

Based on the results of the interviews, it can be seen that students do not have the knowledge to protect their personal data. Students easily provide information if requested on platforms on the internet. But in terms of avoiding cyber bullying, students are proficient not to leave negative comments that can cause disputes. This is actually dangerous regarding the spread of personal data on social media. A study conducted by Cebi et al. (2020), with 518 pre-service teachers from different region in Turkey, found that teachers aware of safety in

terms of leaving digital footprints when using digital communication and knowing how to create digital online profile, also capable of handling online threats.

From the observation results, it can be seen that students do not pay attention to upgrading the system on their smart phones in order to strengthen self-protection. The video projects made by students can be seen giving positive and constructive comments to each other. In general for the safety dimension students still need guidance to be proficient in the safety dimension as an aspect of digital competence.

Problem Solving

The fifth dimension is problem solving. This dimension is expanded into 5 indicators, namely: 1) the ability to apply various media as learning tools, 2) the ability to use digital technology to assist learning process, 3) the ability to optimize the use of ICT based learning media, 4) the ability to use digital media with technical knowledge, and 5) participate in webinarsto upgrade soft skills in accessing digital technology. This dimension is in the medium category (53.1%). Research on Problem Solving has drawn interest during these decades, based on Cabezas-Gonzales et al. (2022), the study found students with high level of problem solving area perform a better competence of their use for school and non-activities, as long as they use it for academic purpose and associated with leisure and entertainment activities (Hortigüela-Alcalá et al., 2020; Vila-Counago et al., 2020). It seems that the use of digital media in learning is still low. They generally know the functions of these digital tools, but technically they don't know how to use them. As previously mentined, probling solving area stood at medium criteria. A study from Esteve-Mon et al. (2020), Cebi et al. (2019), Cebi et al. (2020), and Napal Fraile et al. (2018) found that the digital competence of student teachers in problem solving was indicated at low level. Based on research by Margaryan et al. (2011), Ng (2012), and Thompson (2015), said in recent studies that student at university have already used digital technology for learning but not in collaborative ways.

Table 7. Digital Literacy Competence: Problem Solving

Indicator	Frequency				
	1	2	3	4	5
I can apply various digital medias as learning tools	2	2	10	6	15
I can use digital technology to assist my learning process related to biology molecular course	2	2	7	8	16
I can optimize the use of Google Classroom as an ICT-based learning media	1	2	6	5	21
I can make use of digital media using my technical knowledge	1	1	5	7	21
I participate in webinars/online trainings to upgrade my soft skills in accessing digital technology	0	0	6	9	20
Average	1.2	1.4	6.8	7	18.6
	(3.4%)	(4%)	(19.4%)	(20%)	(53.1%)

The results of the interviews show that students are active in participating in webinars to increase knowledge related to learning media. In working on projects, students have used technical knowledge well in completing video projects. But it is still limited in terms of creating it on various platforms, so that there are videos that seem monotonous and less innovative as learning media. Observations show that students sometimes only focus on one digital media platform so they don't use other digital media.

Conclusion

This research focuses on the digital competence of biology students as prospective teachers who will integrate ICT in the teaching and learning process. The results of the research on the five areas/dimensions of digital competency that were measured were obtained from questionnaires, interviews and observation results. For information ability, students are in the high category. Students already have knowledge of accessing the internet to obtain information related to biology video projects. The second ability is communication, which is at the same level as information, namely the high category. Students have demonstrated high ability in conducting discussions on digital technology to complete video projects. The third aspect is context creation which is at the medium level. There are still students who don't have the knowledge in creating content related to the project assignments given, so they need help from their group mates. The fourth aspect is safety. This aspect is at a low level, with indications that some students still don't know how to protect themselves from digital media. The last competency of digital skills is problem solving. This dimension is in the medium category. In the sense that students have sufficient knowledge in using digital technology in completing assignments/projects given in the learning process.

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Conflicts of Interest
The authors declare no conflict of interest

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