Portraying University Students' Digital Literacy Competency in Problem Solving: A Multi-case Study in Higher Education

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Abstract. Adaption and resilience are crucial issues during and post-COVID-19 pandemics. A sudden change during COVID-19 pandemic forces individuals to adapt to a catastrophic situation, and technology assists them in coping with the difficulties. For instance, the traditional classroom is shifted to online classes requiring technological devices and digital competence of the users to support success. It appears that digital literacy competency plays a significant role in achieving the learning goals of technology-mediated learning. The demand for this competency is getting higher in higher education, and the study in this field is still limited. Therefore, this study attempts to portray university students' competency in digital literacy, particularly in the problem-solving area, as stated in DigCom 2.0 framework released by European Union. Specifically, the study investigates the students' competence in solving a technical problem, identifying needs and technological responses, creatively using digital technologies, and identifying the digital competence gap. Moreover, it explores how the students foster digital literacy competence in these areas. The study undergoes a multi-case study framework, and participants are from different ITB campuses: Bandung, Jatinangor, and Cirebon. Questionnaires and interviews are utilized as research instruments. The result of the study shows that most of the participants believe they are skillful enough to tackle difficulties in digital environment particularly in the four sub-competencies. In addition, participants have autonomy, focus, and choice in making academic decision, and high-quality individual can improve their problem-solving skills and digital literacy.

Keywords: Digital literacy · Problem-solving · Technology-mediated learning · multi-case study

1 Introduction

Technology development is very rapid, but it is not evenly distributed. The COVID-19 pandemic has forced all elements of society and the system to accelerate digital technology to defend itself in all systems, including the education system. During the pandemic, teaching and learning activities are carried out online [1]. The education system that is

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most dependent on using this online system is higher education. As mobilization is minimal and all activities can only be carried out sectoral, higher education has no option but to initiate massive online learning.

This massive acceleration also forces students to be proactive in online lectures. The online lecture system requires gadgets, internet connections, and other digital technologies. In the process of surviving online lectures, students need to understand the system and the use of specific tools, which not all students are skilled at and familiar with these digital tools. Understanding the system and using digital tools certainly do not escape the process of finding out and learning. Although this year's ITB students are all in the Generation Z category with an age range of 17–22 years as internet [2], this does not guarantee that all students can deal with this situation with an equal process. Many other factors, such as economic conditions, capture power, cultural or family background, student internal factors, and other factors, influence students' ability to understand the online lecture system and use digital technology.

The use of digital technology does not escape the ability of digital literacy that supports students in developing the ability to use digital technology. Good digital literacy is needed to support appropriate digital activities to survive with the online lecture system. The American Library of Association defines information literacy skills as digital literacy skills, including the ability to (1) be able to decide what information is needed, (2) access information efficiently and effectively, (3) evaluate information critically, (4) synthesize the information needed, (5) use the information effectively to solve problems, (6) understand the social, economic, local legal regulations, and (7) use the information ethically and legally [3]. In addition to the ability to operate digital systems, traditional literacy skills also greatly support digital literacy skills, such as the ability to write, read and listen [4]. With all those skills that students must possessed to achieve academic success, therefore this paper would like to depict digital literacy competence among university students, particularly in the area of problem-solving. The findings are expected to provide an overview of digital literacy skill in higher education in Indonesia.

2 Literature Review

2.1 Digital Literacy

Digital literacy is a term that has long been referred to as an essential skill today. The term digital literacy itself was first defined in the late 1990s and is defined as "the ability to understand and use information in various formats from various sources presented through computer devices" and the internet in particular [5]. This definition is a valuable starting point since digital practices have become more complex. The rise of mobile media, particularly in developing countries [6], is one example of further development and digital practices. How digital literacy is conceptualized is influenced by digital practices in different contexts, which have different educational, technological, and political histories that influence the use of digital technology.

There is a need to standardize the concept of "digital literacy" so that it can be measured and compared in an increasingly globalized educational environment. One of the examples is UNESCO, which is developing a "Global Framework for Measuring Digital Literacy" [7], which focuses on technical and vocational skills for employment, decent

work, and entrepreneurship. Moreover, the EU, through DigCom 2.0, proposed a conceptual reference model for the Digital Competency Framework for Citizens [8]. It covers five competency areas: information and data literacy, communication and collaboration; digital content creation; security, and problem-solving. Each region sees several areas of competence. Four competencies are assessed for the fifth competency area: solving technical problems, identifying technology needs and responses, creatively using digital technology, and implementing digital competencies. The attempt to standardize the concept of digital literacy is an "instrumental" way to enhance workforce-oriented skills. It has become necessary since in the 21st century, digital literacy is considered a necessity to master the tasks of professional and personal life successfully. This skill becomes even more critical, particularly in online educational settings.

2.2 Digital Literacy in Indonesia

Unlike developed countries, digital Literacy in Indonesia has started from the movement of many non-profit organizations or non-government organizations (NGOs). In contrast, in advanced countries, the government sets up policy and competence standards of digital literacy for their citizens and embeds these into schools' curricula.

From the NGO movement, the Ministry of Communication and Information (Kominfo) measured the Digital Literacy index together with Siber Kreasi and the Katadata Insight Center (KIC) in 2021 [9]. Four pillars are being assessed for the Digital Literacy Index, including digital culture, digital ethics, digital learning (digital skills), and digital safety. The results show that the Indonesian Digital Literacy index has increased to 3.49 (moderate). This increase results from government policy encouraging the literacy movement in Indonesia, including digital literacy. In 2017, the government released the Guide for National Literacy Movement [10], which can be used to encourage literacy at school, in families, and community. This guide is a supported by the government and is in line with the government development plan. However, the standard to measure digital literacy competence has not been set up yet, such as in advanced countries.

2.3 Flow Theory

The fast digital era changes force people to pursue digital literacy competence, and this phenomenon also occurs in Indonesia, particularly during the COVID-19 pandemic. This pandemic causes people to experience work from home or school from home due to social distancing. These activities lead them to count more on digital devices than before the pandemic. Moreover, this circumstance emerges as difficulties during the adaptation period, particularly in a classroom setting, and how students adapt to these conditions is reflected in Flow theory.

Mihaly Csikszentmihalyi first introduced flow theory in the 1970s. This theory aims to understand how people who enjoy themselves the most feel when and why. In education, what is most encouraging is the fact that streams are consistently observed in unique school contexts. Students often stream in their nonacademic classes, which provide several conditions such as choice, autonomy, and focus that are not usually present in academic subjects. Likewise, students tend to experience flow when engaged in hands-on learning tasks [11].

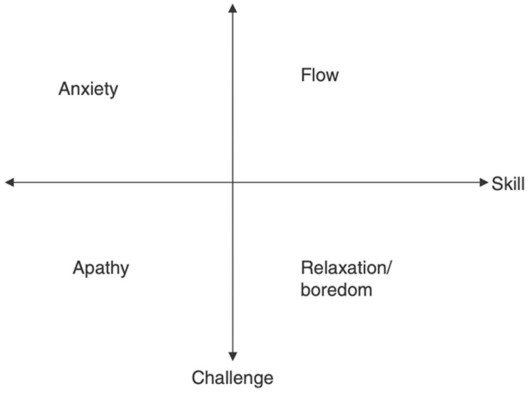

Fig. 1. Flow Model

Table 1. Questionnaire Example

Problem Solving	Questions
Solving technical problem	I can identify the technical problem while using digital devices. I can solve the problem.
Identifying needs and technological responses	I can choose digital devices to support my study. I can combine some digital devices to complete my assignment.
Using digital technology creatively.	I can use various digital devices creatively to solve a problem.
Identifying the digital competence gap	I can recognize my competence gap in using digital devices.

The flow model and related research provide a solid foundational knowledge of how students can engage in their learning and how they feel when they are engaged. It is dynamic since it is designed by considering changes in ability and circumstances, such as skillful vs. unskillful and challenging vs. not challenging. Below is the flow model.

Flow experience requires two major conditions: challenge and skill. Individuals' flow experiences will be determined by the relationship between those two factors. Individuals will experience flow when the challenge and skill are high. Similarly, when the challenge and skill are low, individuals tend to experience apathy. Individuals will experience anxiety when challenge is high but the skill is low, whereas relaxation/boredom will ensue when challenge is low but the skill is high. Those basic four channels of experience are further developed into more than 15 channels, but still these basic channels remain the primary experience (Table 1).

2.4 Digital Literacy Research

Studies and research related to digital literacy cover a broad scope. The themes discussed are not only in the social and educational context but also in the health context. Likewise, the research objects used are very diverse, ranging from students, the younger generation, parents [12], students with special needs [13], and the elderly [14].

In an educational setting, studies on digital literacy merely emphasize using digital devices in teaching-learning activities, meaning that it neglects the other digital competence areas, such as in DigCom 2.0 framework, specifically problem-solving [15]. It happens because digital literacy is the key for student success in online learning setting. In addition, since digital literacy is thought to be one of fundamental tools for promoting lifelong learning, study on this field have to include every aspect of digital competence areas.

3 Method

Merriam [16] claims that a qualitative study investigates how people interpret what they experience in their lives, and a case study is one of its types. In addition, it is possible to undergo multi-sites to investigate their similarities and differences. Therefore, this study employs a mix-method comparative case study or a multi-case study since it examines university students digital literacy competence and how they cultivate it, particularly in problem-solving in three different settings during the COVID-19 pandemic.

3.1 Participant

This study involves 138 university students from different faculties in a university with three different campus sites: Bandung (G), Jatinangor (J), and Cirebon (C). In detail, 86 students are from Bandung, and 37 of them originate from Cirebon, while the rest are from Jatinangor. These students are those responding to the distributed survey that explores the students' digital literacy competence in problem-solving. Only 30 out of 138 students were selected to be interviewed to gain a deep understanding of the collected data from the survey as purposeful sampling. This selection is based on specific criteria that emerged from the survey data.

3.2 Data Collection

This study is based on explanatory sequential design, meaning that quantitative data is garnered first, followed by qualitative data to seek an explanation of a particular data gained from the quantitative one. This study utilizes a questionnaire to gather quantitative data, while for qualitative, it uses interviews.

Table 2. Index Value in the Three Campuses

No.	Indicator	Index Value (%)		
		Campus G	Campus J	Campus C
1	Solving technical problems	80,46511628	75,38461538	82,10526316
2	Identifying needs and technological response	88,13953488	83,84615385	87,63157895
3	Creatively using digital technologies	82,90697674	76,15384615	82,10526316
4	Identifying digital competence gaps	83,48837209	83,73626374	85,18796992

3.3 Instrument

3.3.1 Questionnaire

A questionnaire is constructed to depict a general picture of the student's competence in digital literacy, particularly in problem-solving, under the DigCom 2.0 framework, and it functions as quantitative data. This questionnaire contains two sections: general and specific information. The general part investigates the participant's background. In contrast, the specific part examines four aspects: solving technical problems, identifying needs and technological responses, using digital technology creatively, and identifying the digital competence gap. The questionnaire is presented in open-ended question forms and an indicator question is presented on a Likert scale.

In the second part, the author gives a score for each answer, where the statement "Strongly Disagree (STS)" is given a score of 1, "Disagree (TS)" is given a score of 2, and "Hesitating (RR)" is given a score of 3, "Agree (S)" was given a score of 4, and "Strongly Agree (SS)" was given a score of 5. This effort attempts to simplify the questionnaire for the reader to respond then the scores were added up and interpreted using the % index (Table 2).

3.3.2 Interview

The Interview functions as qualitative data as it purposes to explain data that commonly emerges from the questionnaire, and it needs more explanation to gain comprehensive data. Therefore, the Interview consists of follow-up questions from the questionnaire.

3.3.3 Data Analysis

The data garnered from the questionnaire is analyzed using the Likert scale with the percentage index formula, while theme analysis is applied for interview data. This analysis utilizes Dig.Com 2.0 framework, specifically competence in problem-solving with four sub-areas: solving technical problems, identifying needs and technological responses, using digital technology creatively, and identifying the digital competence gap. Furthermore, Flow theory is utilized in the analysis.

4 Findings and Discussion

4.1 Qualified Competence in Problem Solving

The survey data indicates that most of the participants in three campuses (G, J, and C) consider themselves skillful enough to solve the problem they encounter in the digital environment, specifically for the four sub-competencies. This condition is reflected in the general index values of each indicator showing a positive number at > 80%.

At the G campus, the average index value for the Solving technical problems indicator is 80.46511628%, which means that students can solve the technical problems they encounter. For the second indicator, identifying needs and technological responses, the average index value is 88.13953488%, which means that the students can identify technological needs and responses. For the third indicator, creatively using digital technology, the average index is 82.90697674%, which means that students can use digital technology creatively. As for the last indicator, identifying digital competence gaps, the average index value of students is 83,48837209% which means students can identify their digital competency gaps.

At the J campus, the results of the questionnaire on campus showed slightly different results from those shown by respondents at the G campus. Although the results show a slight difference, this difference must be highlighted because it can be the basis for a deeper analysis. For the first indicator, solving technical problems, the average index shows a value of 75.38461538%. This figure is slightly different from that shown by respondents at the G Campus. J campus students can interpret this figure as being able to solve technical problems they encounter when using digital devices. For the second indicator, identifying needs and technological response, the average index value is 83.84615385%, which means that students can identify needs and respond to the technology used. For the third indicator, creatively using digital technologies, the average index value is 76.15384615%, which means that students at the J campus can use digital technology creatively. For the last digital competency indicator, identifying digital competence gaps, the average index value shows a value of 83.73626374%, which means that students can identify their digital competency gaps.

At the C campus, the questionnaire results showed scores that were not much different from the scores of respondents at the G campus. For indicators of solving technical problems, the average index value is 82.10526316%; in other words, Cirebon campus students are very capable of solving technical problems. For the second indicator, identifying needs and technological responses, the average index is 87.63157895%, which means that respondents can identify technology needs and technological responses. For the third indicator, creatively using digital technology, the average index number is 82.10526316%, which means that respondents can use digital technology creatively. For the last indicator, identifying digital competence gaps, the average index number of respondents is 85.18796992%, meaning that respondents can identify gaps in digital competence owned by themselves and others.

4.2 Autonomous Learning

In line with the survey data, the interview data reveal that most respondents actively react to critical circumstances during the COVID-19 pandemic. Social distancing forces them

Table 3. Interview Data

Solving Technical Problem	Identifying Needs and Technological Responses
#C22 *"Find a solution through Google and ask other people familiar with those technical problems".* ***#G25*** *"Find a way on the internet and ask friends who are experts".* ***#J6*** *"Try to find a solution from other sources such as media information or ask friends."*	***#C28*** *"University student needs to be able to understand and operate hardware and use software or apps that support learning such as Canva, Miro, and Microsoft office."* ***#G68*** *"I need to compete to find accurate information to solve a problem, take benefits from digital resources to build self-development, and qualified to utilize various digital applications that support daily activities."* ***#J9*** *"As a university student, I need digital literacy competence such as operating google workspace, Microsoft office, and Canva, editing video, or other applications that support academic task completion."*
Using Digital Technology Creatively	**Identifying the Digital Competence Gap**
#C13 *"I study by using multiple apps."* ***#G3*** *"I usually complete my assignments with my friends through video conference out of the class session. By doing this, it makes it easier to do my task".* ***#J8*** *"Sometimes, my digital devices get trouble completing the task, so I decide to complete my assignment in advance and back it up on other devices."*	**#C22** *"I need to improve my skill in programming languages such as python and math lab."* **#G4** *"As a design student, I need to improve my capability in using various apps that support my study."* **#J9** *"As a student, I need to be able to operate Microsoft office, design and edit apps, and use organizer apps such as Google calendar and notion to encourage more productive."*

suddenly to live in the digital environment, causing them to count on digital devices and internet connections. They undoubtedly encounter many difficulties, particularly in learning, starting with digital equipment, digital competence, and emotional matter. However, these conditions challenge them to seek help from friends, lectures, and online sources such as YouTube and search engines to solve their digital problems in completing their academic tasks.

The feedback from respondents clearly shows that digital literacy competence derives from a synergy between an idea(s), a person's qualities, and supporting tools. In this context, the synergy will comprise elements that are personal qualities, courses and assignments, and digital technologies [17].

Qualities determine a person's success in carrying out their daily activities. These qualities can be in the form of many things, such as experience and knowledge. Thus, these qualities also apply when someone uses tools to support their work productivity based on their knowledge and experience. When using digital technology, these qualities affect a person's ability to use and understand the latent telic of a digital device, both hardware, and software (Table 3).

Course and Assignments are elements relating to the content delivered in class. Courses and assignments generally consist of two categories, namely theory and practice. These categories and their variations cause different rules, methods, and content.

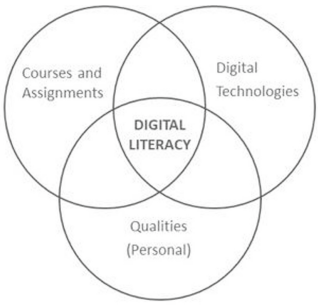

Fig. 2. Digital Literacy Map

Therefore, these elements consider the elements of digital literacy because they relate to students' ability to understand the content and do exams and assignments (Fig. 2).

Digital Technologies closely relate to the sophistication of digital devices, hardware, and software. Each technological upgrade offers various alternative operational possibilities that can be utilized by users or, in this case, students. Figure 1 shows the mapping between qualities, courses, assignments, and digital technologies. These three elements work synergistically to foster students' competence in digital literacy, particularly in problem-solving.

This finding corroborates the Flow theory that claims students often stream in their nonacademic classes, which provide several conditions such as choice, autonomy, and focus that are not usually present in academic subjects. Likewise, students tend to experience flow when engaged in hands-on learning tasks [12]. The garnered data identifies that the participants have choices, focuses, and autonomy in determining their live decision regarding their academic tasks. Those with high qualities can elevate their capacity in digital literacy competence, specifically in problem-solving.

5 Conclusion

University students on three different campuses are qualified enough in problem-solving as part of digital literacy competence. They demonstrate good ability in solving technical problems, identifying needs and technological responses, creatively using digital technologies, and identifying the digital competence gap. This quality derives from their intrinsic motivation to complete academic tasks while taking online classes during the COVID-19 pandemic. They foster this competence autonomously for the sake of completing the class assignment. Even though digital literacy competence is not explicitly stated in the course's syllabus, the students are still capable of cultivating their digital literacy capacity. Even, students with high qualities experience flow which allows them to improve their digital literacy skill.

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