MATHEMATICS PRE-SERVICE TEACHERS' DIGITAL LITERACY AND THEIR READINESS TOWARDS 21ST CENTURY LEARNING: A MIXED METHOD STUDY

Pranata Lulus Soeparno [1*], Christina Ismaniati[2]

[1,2]*Instructional Technology, Faculty of Education, Yogyakarta State University*
Colombo St., No.1, Caturtunggal, Depok, Sleman, Yogyakarta, 55281, Indonesia

Corresponding author's e-mail: [1]* pranatalulus.2020@student.uny.ac.id

Abstract. *The rapid advancement of technology in Indonesia seems not in line with its utilization, especially in the educational field. According to studies, Indonesian teachers are not ready to implement ICT in their classrooms. Furthermore, most elderly teachers are not sensitive enough to technology changes. When it comes to emergency teaching and learning in the pandemic era, teachers as predicted do not have enough capacity to maximize the use of ICT as the only source. This study aims to find out: (1) if the lack of digital literacy skills already happened in college, and (2) pre-service teachers' readiness to face 21st century education. As the result, this study could not prove that the lack of digital skills occurs in college. The digital literacy skills of pre-service are good (77,6%) and they have received multimedia learning subject from university. Related to their readiness toward 21st century learning, most of them claimed not yet ready because of the lack of skills and knowledge in implementing ICT and because of the lack of ICT facility support.*

Keywords: *digital literacy, mathematics pre-service teacher, mixed method, 21st century learning.*

1. INTRODUCTION

Through the ministry of education and culture, Indonesia has made new breakthroughs in preparing a generation who are ready to face socio-cultural changes, the world of work, the rapid technological advances, and hopefuly competent with the needs of the times [1]. Education is organized to prepare professionals who can apply, develop, and create science, technology, and arts [2]. Indeed, it is a big challenge for Indonesian educators to carry out these responsibilities. They are often faced with unfavorable conditions such as poor distribution of educators for certain subjects, causing schedule changes, limited learning support facilities, and lack of support from experts [3].

Talking about duties and responsibilities of educators, this topic has undergone many changes in line with the development of a better education system. In the past, an educator was considered the center of learning (teacher-centered) who actively provided stimulus. Students were considered passive recipients or called behaviorism learning theory [4]. However, this view is shifting because students have many aspects (cognitive, affective, psychomotor, etc.) that need to be accommodated. Therefore, the role of educator turns into a facilitator [5] who facilitates the needs of students and creates a learning process that meets their needs. The definition of educational technology also states that an educator acts as a facilitator who facilitates learning and improves performance by creating, using, and managing processes and technological resources appropriately [6].

1.1 Understanding Digital Literacy

Skills that must be mastered in the 21st century, according to Trilling and Fadel [7], are information literacy, media literacy, and Information and Communication Technology (ICT) literacy, or commonly understood as digital literacy (see Figure 1). Digital literacy is defined as the ability to search for, understand, evaluate, create, integrate, and communicate information on various ICT tools to live, learn, and work in a digital society [8]. Understanding aspect in digital literacy refers to 1) accessing, evaluating, using, and utilizing information, 2) analyzing media and their use, and 3) applying technological tools effectively [7]. The process of mastering digital literacy should also be monitored so that ICT can be used properly. A survey conducted by Microsoft [9], namely the Digital Civity Index, found that Indonesian poorly use technology, such as spreading hoax news, fraud, and cyber-bullying. The implication is that educators facilitate students with teaching resources, teaching materials, and an uplifting technology environment while guiding and monitoring students' digital literacy mastery so ICT can be used wisely and adequately.
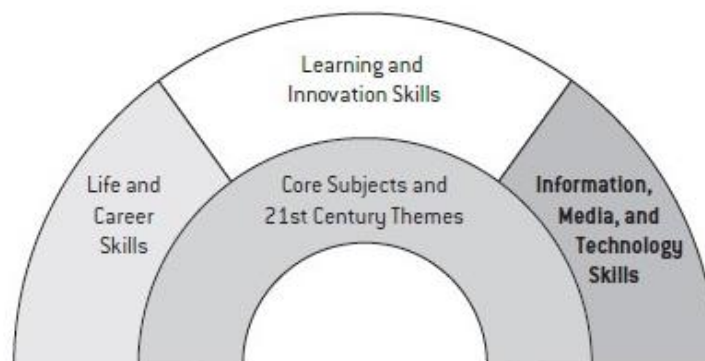

Figure 1. 21st Century Skills [7]

Technological sources must be introduced in a classroom context for the following reasons: 1) familiarizing students with an increasingly computerized work environment, 2) technological learning resources can make learning activities more efficient, 3) technology becomes a symbol of an educational institution, and 4) technological sources contribute to higher motivation levels and achievement [10]. Learning multimedia in common has proven to be effective in increasing learning achievement, triggering active learning, containing low cognitive load, providing a meaningful learning process, facilitating understanding through a deep learning process, increasing learning motivation, etc. [11]–[14]. Following the prediction of the ministry of education and culture, technological learning resources should be utilized effectively by educators because of their great potential to support the learning process [15].

1.2 Digital Literacy in Indonesia

Related to ownership of facilities that support technology-based learning, most of the students have been equipped with adequate facilities [16]–[18] and many schools have some supportive facilities and infrastructures [19], although there are still some 3T areas (leading, remote, underdeveloped) that did not have the proper infrastructure [20]. Especially in emergency online learning since a pandemic occurs, students seem to be forced to have smartphones or laptops as the main facilities to support online learning. Datareportal [21] explicitly finds the increase in smartphone and laptop ownership by Indonesian people, where 98.3% of the people have smartphones and 74.7% of the people have laptops or computers.

Educators in Indonesia apparently have low mastery of digital literacy, but they perform very well in material mastery based on their field of study [19], [22]–[29]. Moreover, elderly educators have low sensitivity to technology in learning. These studies prove that the use of technology by educators in learning is limited to online presentations and showing pictures and videos for ice-breaking activities or explaining material only. Educators are aware that using technology will increase the quality of the learning process so learning objectives can be achieved easily [30]–[32], but they are still confused about how to adopt the technology into a learning activity.

From the condition of educators in dealing with online learning, there is a tendency that they are not ready yet. There are no variations in interactions because they are not technology literate, so training is needed to improve digital literacy mastery [33], [34]. Indonesian educators agree that online learning during the pandemic was very sudden, so people felt not ready to face online learning.

Because educators in the upper generation already have low mastery of digital literacy, researchers are interested in seeing the digital literacy mastery by new generations or pre-service teachers. The results of this study are expected to find 1) whether or not the low mastery of digital literacy in Indonesia has started since undergraduate by measuring the digital literacy level of pre-service teachers, and 2) what are the difficulties faced by pre-service teachers in preparing online learning. These pre-service teachers are expected to meet the demands of 21st century education to prevent problems that arise due to low digital literacy mastery and improve the quality of education in Indonesia. Later, suppose it is found that pre-service teacher also has low digital literacy mastery. In that case, the results of this study can become a suggestion for the university to grant extra attention to its students to prepare competent pre-service teachers in all aspects.

2. RESEARCH METHODS

This research aimed to find the digital literacy mastery level of pre-service teachers in Yogyakarta and expected to reveal their difficulties in preparing for 21st century learning. A mixed-method with questionnaires and interviews was chosen as the method and instrument for data collection to enrich the data variety and overcome the limitations of quantitative and qualitative methods [35]. In addition, semi-structured interviews were used to deepen the narrative and the perceptions of pre-service teachers regarding the difficulties experienced in mastering digital literacy [36].

2.1 Respondents of Study

The respondents of this study were 16 pre-service mathematics teachers with some qualifications: 1) students who are currently taking undergraduate courses majoring in education (mathematics/English/elementary school teachers with B accreditation of study program), and 2) students who are currently or have already participated in a field practice program. (PPL). Participants were selected randomly. The researcher contacted the secretariat of the study program, then contacted representatives from each class and asked for help in distributing questionnaires that the researchers had prepared. Because only 1 class fully returned the questionnaire, the researcher took that class as a sample. The distribution and fulfillment of the questionnaire were carried out for ten working days (May 17, 2021 – May 28, 2021) throughout the Google Form platform.

2.2 Instrument Validity

The questionnaire in this study consisted of two sessions. The first session is in closed-ended questions adapted from Ng [37] to determine the perception and digital literacy mastery level. The second session was in the form of open-ended questions to determine the difficulties and obstacles experienced by respondents in mastering digital literacy skills. Ng's instrument was translated using the forward-backward translation technique, where the original instrument in English was translated into Indonesian, then translated back into English and compared [38]. After there was no meaning refraction, the instrument was tested for construct validity through a Focus Group Discussion with the 2nd author to test the clarity, depth, and detail of each item, and to eliminate items that did not represent digital literacy theory [39]. The 17 closed-ended questions that passed the validity test consisted of 17 closed-ended questions using 5 Likert scales, namely 5 = strongly agree, 4 = agree, 3 = neutral, 2 = disagree, and 1 = strongly disagree.

2.3 Instrument Reliability

The reliability test was done with the help of SPSS 25 through a procedure proposed by Arifin [40]. The instrument obtained an Alpha coefficient score of .945. According to Creswell & Creswell [41], the good Alpha coefficient vulnerability is at a score of .7 to .9, while the reliability score of this research instrument shows >.9, even close to 1.0. Researchers can state that this research instrument has a good level of internal consistency and shows similar data if redistributed over several periods.

Table 1. The Result of Instrument Validity Test

Reliability Statistics		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.921	.924	17

3. RESULTS AND DISCUSSION

The research result, analysis, and discussion results will be divided into several sub-topics.

3.1 Access to ICT

Based on the data in Table 2, all pre-service teachers have full access to personal laptops and smartphones (100%). This data strongly supports the statement in the introduction that almost all pre-service teachers have facilities to support the implementation of ICT-based learning. The implication is that prospective educators can equip themselves with an understanding of digital literacy so that they are expected to apply it in learning.

The data also shows that pre-service teachers are digital natives who spend about 10 hours per day using ICT. Digital natives are defined as humans who grew up in a digital environment where digital activities are a big part of their lives [37].

Table 2. Pre-Service Teachers' Access to ICT Facilities

Ownership of ICT	Laptop	Smartphone	Tablet
N	16	16	2
%	100%	100%	12.5%
Average Time on Using ICT (Hour)	10.18	-54,9519	0,0001

3.2 Educational Background

Related to teaching experience (see Table 3), almost all pre-service teachers (81.25%) have teaching experience other than teaching practice (PPL). All students (100%) also received multimedia learning courses while studying at their university, which means that the university successfully produced digitally literate pre-service teachers who can apply ICT in certain learning processes (Admiraal et al. in [42]). These results

indicate that pre-service teachers have been prepared with knowledge of the use of ICT in learning and at least have experience using ICT in actual teaching situations.

Table 3. Pre-Service Teachers' Educational Background

Teaching Outside Formal Classroom Context (Year)	0	<1	1 – 2	>2
N	3	6	2	5
%	18.75%	37.5%	12.5%	31.25%
Having Multimedia Subject	100%			

3.3 Pre-Service Teachers' Digital Literacy Mastery

The questionnaire is used to measure the digital literacy mastery of pre-service teachers is divided into four main aspects: 1) the perspective on the use of ICT in learning, 2) the technical dimension of digital literacy, 3) the cognitive dimension of digital literacy, and 4) the social dimension of digital literacy, with a total average of 3.88 followed by 4.08, 3.4, 4.09, and 4.4 in order. Although the previous discussion shows that all pre-service teachers have been provided with multimedia learning courses and most of them have teaching experience, the technical aspect of their digital literacy has the lowest score compared to other aspects. Statement 8 T1 reveals that the average student still has difficulty overcoming technical problems related to ICT. Therefore, they need assistance or guidance from others.

Table 4. Pre-Service Teachers' Digital Literacy Mastery

No	Statement	Mean
Pre-Service Teacher Digital Literacy (r = 3.88; α = .924)		
Perspective/Attitude Towards the Use of ICT in Classroom (r = 4.08; α = .844)		
1 P1	I like using ICT for learning	4.125
2 P2	I learn better with ICT	3.625
3 P3	ICT makes learning more interesting	4.125
4 P4	I am more motivated to learn with ICT	3.75
5 P5	ICT enables me to be a self-directed and independent learner	4
6 P6	There is a lot of potential in the use of mobile technologies (e.g., mobile phones, PDAs, iPods, smartphones etc) for learning	4.5
7 P7	Teachers/lecturers should use more ICT in their teaching of my classes	4.5
Technical Dimension of Digital Literacy (r = 3.4; α = .951)		
8 T1	I know how to solve my own technical problems	2.9375
9 T2	I can learn new technologies easily	3.5
10 T3	I keep up with important new technologies	3.375
11 T4	I know about a lot of different technologies	3.125
12 T5	I have the technical skills I need to use ICT for learning and to create artefacts (e.g., presentations, digital stories, wikis, blogs) that demonstrate my understanding of what I have learnt	3.75
13 T6	I have good ICT skills	3.75
Cognitive Dimension of Digital Literacy (r=4.09; α=.738)		
14 C1	I am confident with my search and evaluate skills in regards to obtaining information from the Web	3.9375
15 C2	I am familiar with issues related to web-based activities e.g., cyber safety, search issues, plagiarism	4.25
Affective and Social Dimension of Digital Literacy (r=4.4; α=.576)		
16 A1	ICT enables me to collaborate better with my peerson project work and other learning activities	4.125
17 A2	I frequently obtain help with my university work from my friends over the Internet e.g., through e-mail, Facebook, Google Drive, WhatsApp	4.6875

Even the score of the technical aspects is low, pre-service teachers manage to show a wide variety of software and websites mastery. Each student is proven to master at least one software or website for word processing, image processing, video and animation processing, presentations, supporting learning activities, and learning management software (see Figure 2).
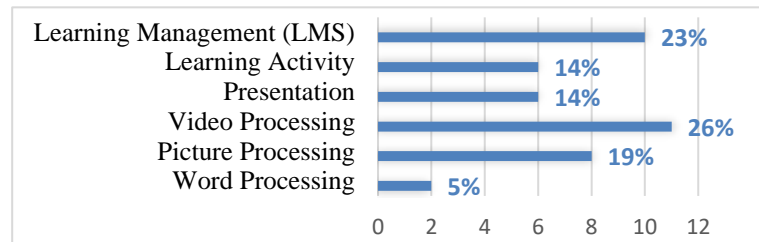

Figure 2. Software and Website Variations Mastered by Pre-Service Teachers

3.4 Pre-Service Teachers' Readiness and Problems Faced in Implementing ICT in The Classroom

The pre-service teachers are asked about their readiness to face 21st century learning on a scale of 1 to 5. On average, they are pretty ready (r = 3.68) to face 21st century learning. Researchers further investigate obstacles faced when applying ICT in the learning context through open-ended questions. Most of them agree that they still have not mastered digital literacy (factors 1 and 3). Some of them are aware of the lack of support for facilities, especially in the 3T area (factor 2). A small number of them have a negative perception of the use of ICT in learning (factors 4 and 5). These findings have been predicted by Hew and Brush [43] in their research, which also finds that limited ICT facilities and lack of knowledge and skills are the two main interfering factors in utilizing ICT.

Table 6. Interfere Factors of Implementing ICT

No	Factors	N
1	Lack of knowledge and skill	6 (37.5%)
2	Lack of ICT facilities	6 (37.5%)
3	Confuse on how to utilize ICT	2 (12.5%)
4	ICT makes learning ineffective	1 (6.25%)
5	ICT is not involve students in learning	1 (6.25%)

4.   CONCLUSIONS

This research succeeded in breaking the first assumption, which stated that low digital literacy mastery of educators in Indonesia has started since undergraduate. The university of the subject in this study has taught pre-service teachers digital literacy through multimedia learning courses. The questionnaire results also state that the digital literacy mastery is beyond the average, and the students also master various types of software and websites that can be used in learning. The results also show an increase in ownership of ICT facilities compared to previous studies. Many researchers have predicted this phenomenon [44], and Indonesians may have full access to ICT facilities in the next few years. Therefore, it creates excellent opportunities to utilize ICT in learning contexts from elementary to university.

Several factors interfere with pre-service teachers' dealing with 21st century learning, including having trouble overcoming technical problems without the help of others; being confused about integrating ICT into learning; and being half-educated about how to deliver ICT to encourage students' interest and participation. Lack of skills and knowledge of ICT have been proven as factors that interfere with the implementation of ICT in learning [45], and most of the students in this study experienced it. The researcher comes up with a solution for students by providing additional teaching materials or guidance to help them develop digital literacy skills. All students in this study are willing to improve their digital literacy skills. Further studies may help these desirous pre-service teachers by conducting training, guiding books, or video tutorials related to ICT use in learning. Those three methods are considered the most suitable for them, and some even expect direct feedback.

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