Digital literacy and cognitive abilities of preservice physics teacher in physics for school course using LMS3: How are the both correlated?

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Abstract. The Covid 19 pandemic that hit Indonesia demands the physics for school course to be conducted online using a Learning Management System Supported Smartphone (LMS3). By using this application, prospective physics teachers can practice their digital literacy and strengthen cognitive abilities. This study aims to determine the correlation between digital literacy and cognitive abilities, in general and by gender, which are trained through physics for school course using LMS3. The descriptive research was conducted with survey method and involving 20 students at a university in Tasikmalaya. They are five males and fifteen females spread 18-20 years old. The instruments used in this research were digital literacy test and cognitive ability test. Both have been validated by 5 experts and have high reliability. The collected data were analyzed statistically using the Kolmogorov Smirnov test and the Pearson correlation test. The results of the normality test obtained $\alpha = 0.636$ which indicates that the data is normally distributed. The correlation coefficient $r = 0.626$ which indicates that digital literacy and cognitive ability are strong correlated. Based on the results the digital literacy of prospective physics teachers must be adequate to support learning success, one of which is shown by cognitive abilities.

1. Introduction

Since the discovery of the new corona virus known as Covid-19 in Wuhan, China, there have been significant changes in the pattern of human life in the world. The rapid transmission of the virus from person to person has made Covid-19 as a pandemic [1]. To avoid the spread of Covid-19, one of the steps that can be taken is to carry out physical distancing [2] so that there was the limitation of human activities in various sectors.

To maintain the continuity of human activities in various sectors, all citizens were directed to changes human activities pattern using online platforms [3], including various activities in education as an important component in forming human knowledge, attitudes and skills [4]. All learning activities that were usually carried out in classrooms are transferred to be virtual learning using internet technology. Hrastinski [5] stated that there are two types of online learning, namely asynchronous and synchronous online learning. Both have their own advantages and disadvantages, so instructors, organizations, and institutions should have a comprehensive understanding of the benefits and limitations of both.

To carry out online learning during the Covid-19 pandemic, the human resources involved in learning should have the competencies in utilizing digital technology. Digital literacy as a competency in utilizing
information and communication technology was a very important competency to be mastered by people. Digital literacy is the number of skills for ICT literacy focused on problem solving in a creative, flexible, and ethical manner [6]. [7] described the competence of digital literacy consisting of information and data literacy, communication and collaboration, digital content creation, safety, and problem solving. [8] adapted digital literacy competencies that can be trained through lectures by paying attention to the professional competences of physics teachers as shown in Table 1.

| No | Competence area | Specific competence |
|----|----------------|---------------------|
| 1  | Information and data literacy | 1.a. Browsing, searching and filtering information and digital content |
|  |  | 1.b. Evaluating data, information and digital content |
|  |  | 1.c. Managing data, information, and digital content |
| 2  | Communication and collaboration | 2.a. Sharing information through digital technologies |
|  |  | 2.b. Interacting through digital technologies |
|  |  | 2.c. Engaging in citizenship through digital technologies |
|  |  | 2.d. Collaborating through digital technologies |
|  |  | 2.e. Netiquette |
| 3  | Digital content creation | 3.a. Developing digital content in various format |
|  |  | 3.b. Copyright and license |

Table 1. Digital literacy for prospective physics teachers

Physics for school is a compulsory course of physics education at a university in Tasikmalaya. It has a main learning outcomes, to strengthen the cognitive abilities in physics concepts that have been learned in other previous courses. This cognitive abilities includes six abilities, namely remembering (C1), understanding (C2), applying (C3), analyzing (C4), evaluating (C5) and creating (C6) [9]. Since Covid-19 pandemic, the learning outcome of physics for school course is not enough just to strengthen the cognitive abilities so it need to be adapted by strengthening digital literacy competencies that will support the effectiveness of the online learning process. Therefore, this course will be oriented towards two learning outcomes, namely cognitive abilities and digital literacy.

To practice these two skills, lectures use an Android-based synchronous online learning application called the Learning Management System Supported Smartphone (LMS3). This application was developed independently by researchers for physics for school course. The application has been paying attention to needs of learning, has been validated by expert judgment and has been tested by users [10]. The use of LMS3 in physics for school has contributed to the improvement of digital literacy and cognitive abilities of prospective physics teacher. It take a more in-depth analysis whether the digital literacy trained in physics for school course is correlated with cognitive abilities.

[11] stated that the ability of students to use digital technology, especially the internet, does not have a direct influence on cognitive abilities. There are moderating variables that have not been investigated so it cannot be ascertained that digital literacy has the strongest correlation with cognitive abilities than other unknown factors. [12] supported Miao's opinion that there was no significant relationship between digital literacy and cognitive ability as shown in the results of tests for Chinese, English, and mathematics. However, some studies are more likely to see a direct correlation between skills in using digital technology and cognitive abilities. Digital literacy supports students in using digital devices in accessing various information and communication mediacritically by minimizing the possibility of using uncredible information sources and media. In addition, learning through digital content can activate certain cognitive processes which support a concept understanding [13]. [14] stated that internet literacy has a direct positive correlation with cognitive abilities. In addition, technology and information literacy has been shown to have a positive impact on cognitive abilities and creativity. Students who have a high level of digital literacy can show the high cognitive abilities. Conversely, students with weak digital literacy tend to show weak cognitive ability [15].

Based on the explanation that has been delivered, the main objective of this study is to determine the correlation between digital literacy and cognitive abilities, in general and by gender, which have been trained in physics for school course using LMS3.
2. Method
The descriptive research was conducted with survey method. There are 20 students of physics education department at a university in Tasikmalaya who were involved as participants. They were consisted of 5 males dan 15 females. Their ages were between 18-21 years old.

The research used two kinds of instruments. They are digital literacy test and cognitive ability test. They have been validated by 5 experts and has high reliability. Digital literacy test consisted of eighteen questions multiple choice questions to evaluate three competencies of digital literacy namely information and data literacy, communication and collaboration, and digital content creation. Cognitive ability test consisted of twenty seven multiple choice questions to evaluate five level abilities namely remembering (C1), understanding (C2), applying (C3), analyzing (C4), and evaluating (C5).

Data was analyzed statistically using kolmogorov-smirnov test and pearson correlation test. Kolmogorov Smirnov test was used to analyze data distribution and Pearson correlation test was used to analyze correlation between digital literacy and cognitive abilities of students. The degree of correlation of the Pearson correlation test was confirmed according information shown in Table 2 [16].

| No | Correlation coefficient | Category       |
|----|------------------------|----------------|
| 1  | 0.00 ≤ x ≤ 0.09        | Negligible correlation |
| 2  | 0.10 ≤ x ≤ 0.39        | Weak correlation   |
| 3  | 0.40 ≤ x ≤ 0.59        | Moderate correlation|
| 4  | 0.60 ≤ x ≤ 0.89        | Strong correlation |
| 5  | 0.90 ≤ x ≤ 1.00        | Very strong correlation |

3. Result and Discussion
The results and discussion of this research will be presented in the analysis of the correlation of digital literacy and cognitive abilities, both in general and differentiated by gender. The data processing is carried out using the SPSS application, which includes two stages, namely the normality test and the correlation test.

3.1. Correlation of Digital Literacy and Cognitive Abilities in General
Correlation analysis is generally carried out using two stages of data processing, namely data normality test and followed by correlation test.

3.1.1. Normality Test
Normality test of data was intended to determine the appropriate correlation test based on the data distribution. If the data obtained was normally distributed, the correlation test processing will use parametric statistic with the Pearson correlation. Yet, if the normality test of data shown that the data was not normally distributed, the processing of the correlation test will use the non-parametric statistical test with Spearman rank correlation.

The normality test of digital literacy and cognitive abilities was carried out using the Kolmogorov-Smirnov Test. Normality of data can be seen in Table 3.

| No                  | Unstandardized Residual |
|---------------------|-------------------------|
| N                   | 20                      |
| Kolmogorov-Smirnov Z| 0.745                   |
| Asymp. Sig. (2-tailed)| 0.636                   |
Based on the results of the normality test in Table 3, it was found that the significance of the normality test is 0.636. The significance value is greater than 0.05. Thus, it can be concluded that the data of digital literacy and cognitive abilities are normally distributed.

### 3.1.2. Correlation Test

The correlation test of digital literacy and cognitive abilities will be carried out through parametric statistical tests because the collected data had met the normal distribution requirements. Therefore, the correlation test for digital literacy and cognitive abilities will be processed using the Pearson correlation. The results of the Pearson correlation test are shown in Table 4.

#### Table 4. Pearson Correlation Test Results for Digital Literacy and Cognitive Abilities

|                  | Digital literacy | Cognitive abilities |
|------------------|------------------|---------------------|
| **Pearson Correlation** | 1                | 0.626**             |
| **Sig. (2-tailed)**     | 0.003            | 1                   |
| **N**               | 20               | 20                  |

**. Correlation is significant at the 0.01 level (2-tailed).**

Based on the results of the correlation test in Table 4, it is found that the significance of the Pearson correlation is 0.003. This value is less than 0.05, so it can be stated that there is a correlation between digital literacy and cognitive abilities. The Pearson correlation coefficient between digital literacy and cognitive abilities was 0.626. If confirmed at the Pearson correlation degree shown in Table 2, it can be concluded that digital literacy correlates with cognitive abilities with a strong correlation.

This strong correlation is in line with several studies that have been conducted by other researchers. [17] studied the effect of computer availability and digital literacy on student academic performance. The results of his research indicate that digital literacy has a positive effect on students' academic achievement. [18] studied the relationship between internet literacy and academic achievement using survey data for 718 children and adolescents in Hong Kong. Overall, their results showed those adolescents who had higher digital literacy (with indicators of being able to find, explore, and access different sources of information and who had knowledge of the predetermined context of information) were had better academic performance.

[19] studied the relationship between digital literacy and academic performance in secondary school online learning programs. This study found that conditions for better access to ICT had a positive effect on digital literacy and academic performance in terms of cognitive abilities. [13] also observed the relationship between digital literacy and cognitive abilities in 2025 students spread across 100 classes of 51 different schools. The results of his research showed that in general the students' digital literacy had a very significant positive correlation with their cognitive abilities. The effect of digital literacy on students' cognitive abilities varies greatly depending on the characteristics of the students. The strong relationship between digital literacy and cognitive abilities is very visible in groups of students with low socioeconomic backgrounds. [20] conducted observations on improving student digital literacy as an effort to improve the quality of higher education courses in Europe. The results of this study are empirical evidence that shows that the use of ICT in higher education has an impact on increasing students’ digital literacy and students' cognitive abilities.

### 3.2. Gender Based Correlation of Digital Literacy dan Cognitive Abilities

Gender based correlation analysis was generally carried out using two stages of data processing, namely data normality test for male and female and followed by correlation test for male and female
3.2.1. Normality Test
The data normality test for male and female was processed using the Kolmogorov Smirnov test. The normality of both male and female data is shown in the Table 5.

| Gender | N  | Kolmogorov-Smirnov Z | Asymp. Sig. (2-tailed) |
|--------|----|----------------------|------------------------|
| Male   | 5  | 0.486                | 0.972                  |
| Female | 15 | 0.529                | 0.942                  |

Based on the results of the data normality test of the digital literacy and cognitive abilities, the results of data processing show that the significance for male and female are 0.972 and 0.942. Both values were greater than the significance of 0.05 as an indicators that the two data are normally distributed.

3.2.2. Correlation Test
Since the data normality requirements have been met, the correlation test applied to digital literacy and cognitive abilities is the Pearson correlation test. The results of the correlation test for digital literacy and cognitive abilities in males and females are shown in the Table 6.

| Gender | N  | Pearson Correlation | Asymp. Sig. (2-tailed) |
|--------|----|---------------------|------------------------|
| Male   | 5  | 0.876               | 0.049                  |
| Female | 15 | 0.658               | 0.008                  |

Table 6 provides information that the significance male dan female were 0.049 and 0.008. These values are less than 0.05 which indicates that the two variables are correlated. To determine the level of correlation between the two variables we can use the Pearson correlation value. The Pearson correlation value for male is 0.876 with strong correlation category. While the Pearson correlation value for female was 0.658 with strong correlation category.

The correlation between digital literacy and cognitive abilities that are differentiated by gender cannot be separated from the characteristics of gender in mastering digital literacy and cognitive abilities. [8] said that in general male’s digital literacy skills are superior than the female’s. Based on it’s component, male was superior than female in data and information literacy as well as digital content creation.

The research of [21] showed that there were in line result in data and information literacy skills. Male had a higher average score than female. The superiority of male in information and data literacy will have an impact on the superiority of male in their cognitive abilities. The students who had good skills in finding, storing, evaluating and processing data and information will help them to get quickly and accurately the useful information. It has good impact on students’ skills to construct knowledge in completing new concepts with an existing framework of thought as a component of cognitive abilities [22].

The higher correlation between digital literacy and cognitive abilities in male than female is also affected by male superiority in digital content creation. This is in line with research conducted [23] that at Kogi State University, the percentage of male activities is greater than that of female in using word applications, analyzing data, and creating images or layout views. While at Universiti Kebangsaan Malaysia (UKM), male students mostly use various applications such as auto CAD, ppt, and word in completing their tasks [24]. The transcendence of male in creating digital content will have an impact on providing and delivering various content related to the material discussed in learning activities. This digital content creation will be related to learning motivation generated by interest in the presented content. With high motivation to learn, good cognitive abilities will also be produced [25].
4. Conclusion
There is a strong correlation between digital literacy and the cognitive abilities of prospective physics teachers who have taken school physics courses using LMS3. This strong correlation between digital literacy and cognitive abilities does not only apply in general but also specifically in different gender. Both male and female had the strong correlation in their digital literacy and cognitive abilities.

Based on the findings of this study, the authors convey some suggestions in implementing learning to involve technology in accordance with the conditions of available facilities. By being trained in the ability to utilize technology, it will provide a high boost in achieving cognitive abilities as one of the learning outcomes.

5. Acknowledgments
The authors would like to express our gratitude to all parties who have been involved and assisted in this research. In particular, the author would like to express our gratitude to Deputy for Research Strengthening and Development, Ministry of Research and Technology / National Research and Innovation Agency which has funded this research.

6. References
[1] Li Q, Guan X, Wu P, Wang X, Zhou L, Tong Y, Ren R, Leung K S, Lau E H, Wong J Y and Xing X 2020 N. Engl. J. Med. 382 1199
[2] Red Crossed 2020 J. Health Policy and Management. 5 103
[3] Adedoyin A B and Soykan E 2020 Interact. Learn. Environ. 1 1
[4] Ridwan I M, Kaniawati I, Suhandi A, Samsudin A and Rizal R 2021 J. Phys.: Conf. Ser. 1806 012135
[5] Hrastinski S 2008 Educ. Q. 31 51
[6] Ferrari A 2013 DIGCOMP: A framework for developing and understanding digital competence in Europe (Spain: European Commission Joint Research Centre Institute for Prospective Technological Studies Contact)
[7] Vuorikari R, Punie Y, Carretero S and Van Den Brande L 2016 DigComp 2.0: The digital competence framework for citizens (Spain: European Commission Joint Research Centre Institute for Prospective Technological Studies Contact)
[8] Rizal R, Rusdiana D, Setiawan W, Siahaan P and Ridwan I M 2021 J. Phys.: Conf. Ser. 1806 012004
[9] Anderson L W and Krathwohl D R 2001 Taxonomy for Learning, Teaching, and Assessing: A Revision of Bloom Taxonomy of Education Objectives (New York: Addison Wesley Lonman Inc.)
[10] Rizal R, Rusdiana D, Setiawan W and Siahaan P 2020 J. Pendidik. IPA Indones 9 600
[11] Miao T C, Gu C, Liu S and Zhou Z K 2020 Behav. Inf. Technol. 1 1
[12] Aboderrin O S 2019 J. Manag. Adm 1 1
[13] Pagani L, Argentin G, Gui M and Stanca L 2016 Educ. Stud. 42 137
[14] Santos G M, Ramos E, Escola J and Reis M 2019 Turkish Online J. Educ. Technol. 18 19
[15] Abbas Q, Hussain S and Rasool S 2019 Glob. Soc. Sci. Rev. 4 154
[16] Schober P and Schwarte L A 2018 Anesth. Analg. 126 1763
[17] Amiri S 2009 Int. J. Educ. Dev. Using Inf. Commun. Technol 5 141
[18] Leung L and Lee P 2012 Soc. Sci. Comput. Rev. 30, 4 p. 403
[19] Islas J R 2013 Digital Literacy and Academic Success in Online Education for Underprivileged Communities: The prep@net Case (Austin: University of Texas)
[20] Shopova T 2014 J. Effic. Responsib. Educ. Sci 7 26
[21] Liu T and Sun H 2012 Int. J. Mod. Educ. Comput. Sci 2 23
[22] Shymanski J 1992 J. Sci. Teacher Educ 3 53