Gender differences in digital literacy among prospective physics teachers

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Abstract. The rapid development of digital technology has stimulated teachers with the number of competencies called digital literacy. The purpose of this study was to describe gender differences in digital literacy among prospective physics teachers. This research was conducted using a descriptive method involving 71 prospective physics teachers at a university in Tasikmalaya. They consisted of 31 males and 40 females with age 19-21 years old. Data was collected using valid digital literacy tests and interview. The collected data was processed by determining the average score of male and female students then analyzed through interview. The results showed that the mean of male’s digital literacy was higher than female. The males had a mean 57 (moderate category) and the females had a mean 53 (low category). There was a difference in digital literacy between males and females prospective physics teachers. These distinctions were influenced by their tendency in using digital technology. Some recommendations were delivered to prospective physics teachers, especially for females. They should effectively increase their digital technology use and appropriate training in the use of digital technology is needed to achieve a higher level of digital literacy.

1. Introduction

The development of digital technology is currently happening so fast and has an impact on people’s life patterns [1]. Digital technology has changed the way people interact, live, and work in the world. Advances in digital technology also have a significant impact on the educational world with the presence of the internet. The internet provides the direction of the learning revolution and demands all the educational components to be able to adapt and equip themselves with several skills in searching for information [2]. Student involvement in utilizing various digital media will provide positive stimulus in developing knowledge, developing skills, and preparing for a good career in the future [3].

This condition gives a challenge to teachers as educators who carry a great task in preparing future human resources. Teachers should have the number of competencies to become professional teachers by utilizing technology for communication, personal building, and educational development activities. Furthermore, with the use of digital technology, teachers can give new meaning to learning activities [4].

The skills in using technology in educational activities are shaped by digital literacy. Digital literacy is a set of basic skills in using digital tools and information that can be used to develop strategies for solving problems in real life. Digital literacy is built continuously and leads to progressive steps [5]. Ferrari [6] stated digital literacy consists of five aspects of competence called information,
communication, content creation, security, and problem solving. Then Vourikari [7] revised competence of digital literacy whom Ferrari [8] developed into competences consisting of information and data literacy, communication and collaboration, digital content creation, safety, and problem solving.

Rizal [9] adapted three competency areas in digital literacy that have been developed by Vourikari. They are considered as the main competencies for physics teachers that can be trained by lectures and related to the pedagogical and professional competencies of physics teachers in accordance with government regulations. Three area competencies are 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. Storing data, information and digital content |
|    |                                             | 1.c. Evaluating 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. Netiquette |
| 3  | Digital content creation                    | 3.a. Developing digital content in various format |
|    |                                             | 3.b. Copyright and licenses               |

Many studies showed interesting results where the development of digital literacy does not show a similar condition between males and females. Aesaert [10] stated that digital literacy of female students was higher than male students. However, Markauskaite [11] and Meelissen [12] found the opposite result. Gender has different tendencies in the habit of using digital technology and motivation toward technology. Both factors are considered to have an effect on digital literacy [13].

The authors were very interested in investigating digital literacy of prospective physics teachers based on gender. Therefore, the research aimed to describe gender differences in the digital literacy profile among prospective physics teachers.

2. Methods
The research method used is descriptive. Participant of this research involved 71 students of physics education department at a state university in Tasikmalaya. They were consisted of 38 students (12 males and 26 females) in the first year and 34 students (15 males and 19 females) in the second year. Their age were 19 (21 students), 20 (37 students), and 21 (18 students) years old.

There are two types of instruments used in this study, namely a digital literacy multiple choice test and an interview guide. The digital literacy multiple choice test used in this study was a test that has been developed by a previous researcher that has been valid and reliable. This test accommodates three competency areas, namely information and data literacy, communication and collaboration, and digital content creation [14]. The interview guide was used as a reference for researchers to obtain depth information for analyzing result of digital literacy test. The example question of interview is “What purposes do you use digital technology for?”.

Data was collected through test and interview activities. The data analysis technique used in this research was to determine the mean of male and female students. The mean of digital literacy for both males and females was confirmed according to the categories shown in Table 2 [15].

| No | Mean         | Category  |
|----|--------------|-----------|
| 1  | 0.0 ≤ x < 30.0 | Very low  |
| 2  | 30 ≤ x < 55.0  | Low       |
| 3  | 55.0 ≤ x < 70.0 | Moderate  |
| 4  | 70.0 ≤ x < 85.0 | High      |
| 5  | 85.0 ≤ x < 100.0 | Very high |
3. Result and Discussion
The results of this research will reveal the digital literacy of male and female students in physics education accommodating three competency areas, namely information and data literacy, communication and collaboration, and digital content creation. The mean digital literacy for male and female students is shown in Table 3.

Table 3. Mean of digital literacy for male and female student

| No | Gender | N  | \( \bar{x} \) | Category |
|----|--------|----|-------------|----------|
| 1  | Male   | 31 | 57          | Moderate |
| 2  | Female | 40 | 53          | Low      |

Based on the information shown in Table 3 we can see that the digital literacy of male and female students was in a different category even though the mean scores did not showed the significant differences. The mean of male student’s digital literacy is 57 in the moderate category and the mean of female student’s digital literacy is 53 in the low category. The mean of male students was higher 4 points than the female student. Based on the results of interviews found that the period of use of digital devices to find information, communicate, and create digital content more dominated by males. Male students use digital devices 1.5 hours longer each day than female students.

This condition had the same pattern as the 90s research which stated that the dominance of males in using digital technology was very clear compared to women [16]. This research found male students had a positive attitude and a higher interest in using digital technology. In 2013, the International Computer and Information Literacy Study (ICILS) stated that 57% of male students used a computer at least once a day while the percentage of girls is lower by 53% [17]. This condition will have an impact on their skills and expertise. It was natural that the digital literacy of male students was higher than female students.

The digital literacy of student is related to own of internet connection [18]. The results of interviews with students involved in the study found that 65% of male students had internet quota more than 6 GB per month while women only 45%. Some male students who had low internet quota connected to free campus wi-fi. Some male students stayed on campus until late night to get internet access so that their internet connectivity became longer.

The observed digital literacy was divided into three competency areas. The profile of each competency area for male and female students is shown in Figure 1. Figure 1 shows that digital literacy in each competency area had various mean. The mean of information and data literacy was a similar low category for male and female students, but the male student mean was 5 points higher than of female students. The superiority of males in information and data literacy was also found in other research which stated that the mean score of data and information literacy for males was higher than for females with significant differences [19].
In communication and collaboration, males and females were in a similar moderate category, but female’s mean was 3 points higher than male. Studies in several countries such as Croatia, Slovenia, Norway, Germany, and the Slovak Republic also showed the same findings. No significant differences were found between male and female students in the use of ICT for social communication [20]. It caused the necessity to communicate and collaborate through digital space or social media was similar. Interview results found male and female students use digital facilities to communicate and collaborate through various applications such as WhatsApp, Facebook, Instagram, Twitter, and Telegram. Although not significantly different, the score of the females was superior to males in communication and collaboration skills. This condition was also seen in a number of studies in developed countries which found that female students prefer to use computers for the purposes of social networking and email communication [21].

Digital content creation had a significant difference between male and female students. Male students were 22 points ahead of female students. Digital content creation competencies for male students were in the medium category, while female students were in a low category. Based on interviews with representative samples of male and female students, authors can state that male students used digital devices more often to create digital content than women. Most of the male students used digital devices to create documents, analyze data, or to create interesting animations that students often use in making presentations. It shows that the skill in using the application word, excel, and PowerPoint was more trained in males than females. This condition is in line with the results of research conducted by Maxwell at Kogi State University. The research found that 11% male students and 7% female students often used word processing applications, 7% male students and 0.1% female students often used applications to analyze data, and 4% of male students and 3% of female students often used the Corel Draw application to create images or layout views [22].

To deepen the digital literacy profile of the prospective physics teachers, a deeper analysis of specific competency of digital literacy is carried out as shown in Table 4.

| No | Competence area | Specific competence | Male Mean | Male Category | Female Mean | Female Category |
|----|-----------------|---------------------|-----------|---------------|-------------|-----------------|
| 1  | Information and data literacy | Browsing, searching and filtering information and digital content | 7.1 | Low | 10.6 | Low |
|    |                  | Storing data, information and digital content. | 50.0 | Low | 40.2 | Low |
|    |                  | Evaluating data, information, and digital content | 57.1 | Moderate | 54.5 | Low |
| 2  | Communication and collaboration | Sharing information through digital technologies | 50.0 | Low | 46.2 | Low |
|    |                  | Interacting through digital technologies | 53.6 | Low | 61.4 | Moderate |
|    |                  | Engaging in citizenship through digital technologies | 82.1 | High | 87.9 | High |
|    |                  | Netiquette | 78.6 | High | 80.3 | High |
| 3  | Digital content creation | Developing digital content in various format | 57.1 | Moderate | 38.6 | Low |
|    |                  | Copyright and licences | 64.3 | Moderate | 50.0 | Low |

Generally, male students had higher mean than female students in information and data literacy, yet in “browsing competence, searching and filtering information and digital content” female students have higher mean than male students. This is in line with Halder's found. He [23] stated there were significant differences concerning gender in information seeking behavior among participants. Female students can find information better than males. Female students tend to focus on the root of a particular problem.
with perseverance and depth. Female students were more interactive and could find information larger than male students. The female students looked for value information very much and they sought and used various categories of information about education, profession, and personal life [24]. Female students have a stronger motivation to search for information than males. Female students looks to have more enthusiasm, motivation, and perseverance until goals are reached.

Most communication and collaboration competencies were superior to female students than to males. But in the specific competence of sharing information through digital tools, the mean of male students was 3.8 points higher than female students. This is in line with the results of Fraillon’s research which stated that male students more often used their digital devices to share and exchange information and entertainment. The Organization for Economic Cooperation and Development's (OECD) Program for International Student Assessment (PISA) [25] reported that male students were greater use of ICT for exchanging information in seven countries (Turkey, Croatia, the Czech Republic, the Slovak Republic, Germany, Lithuania, and Norway).

In the digital content creation competency area, the superiority of male students appeared over female students. This also happened to every specific skill in developing digital content in various formats and copyright. This condition was also found at Universiti Kebangsaan Malaysia (UKM) where male students used more various applications in carrying out activities related to computer use such as word, ppt, dos, AutoCAD, etc [26]. Logically, digital content creation of male students was better than female students.

4. Conclusion
There was a difference in digital literacy between male and female prospective physics teachers. In general, digital literacy of male students was better than female students. But specific competences of prospective physics teacher were various for male and female students. Male students were greater in information and data literacy and digital content creation. Female students were better in communication and collaboration. The gender differences in digital literacy of prospective physics teachers were influenced by the number of activities in using digital devices and motivation toward technology.

Some recommendations were delivered to prospective physics teachers to have the higher level of digital literacy. They should use digital devices more effectively to search, store and evaluate information, communicate interactively and collaborate through digital technology, and create useful digital content. To help accelerate the increase in digital literacy, appropriate and continuous courses are needed. They need to learn more about how to search information more effectively and how to operate basic office application optimally.

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