

## Review Article

# A Literature Review of Digital Literacy over Two Decades

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The COVID-19 pandemic has forced online learning to be a “new normal” during the past three years, which highly emphasizes students’ improved digital literacy. This study aims to present a literature review of students’ digital literacy. Grounded on about twenty journal articles and other related publications from the Web of Science Core Collection, this paper focused on the definition of digital literacy; the factors affecting students’ digital literacy (age, gender, family socioeconomic status, and parent’s education level); the relationship between students’ digital literacy and their self-control, technostress, and engagement; and the three approaches to gauge the level of students’ digital literacy. The study also provided some advice for educators and policymakers. Finally, the limitations and implications were presented.

## 1. Introduction

As a result of the COVID-19 pandemic, many sectors have been terribly affected, including the education sector. Plenty of students had to leave their school and stay at home. The educational sectors turned to online education immediately to fight against the pandemic crisis [1]. Online learning is a mixture possessing both benefits and challenges.

On the contrary, it enjoys many benefits. First and foremost, it is flexible and time-saving [2]. It simplifies learning methods compared to traditional approaches and allows people to stay at home and get access to knowledge. Moreover, it is effective since students can repeatedly listen to the recorded sessions to help themselves have a good grasp of the knowledge [3]. In addition, online learning also enjoys several characteristics like easy accessibility and flexibility, which enables the students in rural or remote areas to study and allows students to plan their time to complete their courses available online [4].

On the contrary, it also has some challenges. Some students are less satisfied with their courses since they could not get enough feedback and valuable comments [5]. In addition, students could not be fully engaged in the class as a result of the lack of human interaction [6, 7]. Compared with

face-to-face learning, students regard online learning as less interesting, and they are less motivated in the learning process [8]. Moreover, some teachers are not that proficient in manipulating the digital application, leading to that both teachers and students cannot have a good experience [9].

A study illustrated that from the online learners’ perspective, there were five aspects to be improved: teamwork, cognitive, operating, organizing, and emotional [10]. From these five aspects, a potential impact on developing students’ learning outcomes may be digital literacy. The students have not fully prepared for the abrupt switch to online learning. With different levels of digital literacy, they may have various perceptions of online learning.

Recently, many studies have been done to investigate students’ digital literacy through quantitative methods [11–15], but a few studies have made a comprehensive review of the literature related to students’ digital literacy. In this way, readers can have a comprehensive understanding of digital literacy over two decades. In addition, some advice is provided for educators and policymakers. In this study, the author intends to give a literature review of digital literacy over two decades and make references for educators and policymakers. This paper is presented as follows: Section 2 outlines the materials and methods used in this study.

Section 3 provides the selected studies for the main citation and raises research questions, followed by results in Section 4. The paper then provides the discussion part in Section 5, followed by a conclusion in Section 6.

## 2. Materials and Methods

*2.1. Identifying Research.* This review is mainly to comprehensively examine the past studies related to students' digital literacy and provides a reference for educators, policy-makers, and interested readers. To obtain this aim, we adopted the framework of the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) [16].

We adopted the following methods to locate and select related studies for the main citation of this review. We retrieved the data by using a hand search method. We first searched the studies through the online database Web of Science (Core Collection). Then, with the guidance of the following keywords, "digital literacy," COVID-19, and student or students, 55 related studies were obtained. After that, we looked through the abstract of these studies. If the abstract looked promising, then the item was obtained. Another complementary way was examining the references of selected papers closely and finding additional related studies.

*2.2. Inclusion and Exclusion Criteria.* To get specific findings from high-quality literature, we employed the criteria of selecting previous relevant studies. (1) This study should be only retrieved from the literature written in English. But we did not limit the outlet of publication to a specific country or area; (2) the study should illustrate and investigate students' digital literacy; (3) unpublished books or reports were excluded. Grounded on the criteria, 20 publications were found to be suitable for the main citations of the study (Figure 1). The relevant studies were just selected within the author's ability. There may inevitably exist other related studies beyond the author's ability.

## 3. Research Questions

After establishing the nature of the sample, we first retrieved the papers from the corpus and then categorized them into different themes. The concerned questions were proposed by carefully reading and analyzing the literature, which remained unsolved and urgent in digital literacy [17]. They were described in detail as follows (see Table 1).

Most of the studies adopted quantitative methods, investigating the factors affecting students' digital literacy, the relationship between students' digital literacy and other factors, like students' self-control. There exist some studies focusing on measuring students' digital literacy. The following research questions were thus raised based on the previous studies, and they were discussed as follows:

RQ1: What is the definition of digital literacy?

RQ2: What are the factors affecting digital literacy?

RQ3: What is the relationship between students' digital literacy and their self-control, technostress, and engagement?

RQ4: How to gauge students' digital literacy level?

## 4. Results

*4.1. The Definition of Digital Literacy.* Digital literacy is not a new term. Many people have put forward their different understandings of digital literacy in the past few years. Among these various definitions of digital literacy, they can be roughly divided into two branches. On the one hand, people defined this term only focusing on technical skills. On the other hand, people proposed the definition of this term, paying much attention to the grasp of ideas.

The following two definitions of this term focus on technical skills. Gilster proposed the term digital literacy in 1997, which referred to the competence to derive useful information from various sources through the Internet [32]. Shortly after, the scholar Pool defined this term, which referred to the competence to adapt to new media [33]. He also emphasized that the users' experiences largely depended on their ability.

The following two definitions of this term paid much attention to the grasp of ideas. In 2005, Martin offered his version of the concept of digital literacy, which indicated that people possessed the ability, attitude, and awareness to use digital devices in a proper way to handle the digital resources first and then create new knowledge and expressions to make communications with others and make meaningful social actions [34].

In 2017, Chan introduced another definition of this term, which referred to the ability to understand and use information in various formats, highlighting the role of critical thinking rather than a simplistic grasp of Information and Communication Technology (ICT) skills [35]. In a nutshell, some of the definitions only place emphasis on digital skills, while others focus on the multidimensional concept. It is of vital significance to increase both the basic digital skills and those skills by which people understand and use the online content.

*4.2. What Are the Factors Affecting Digital Literacy?*

When it comes to the factors affecting digital literacy, many types of research have been done from various dimensions such as gender, age major, and so on [10, 13, 14, 18]. The factors that affect students' digital literacy may be caused by the students themselves or other factors.

Previous studies have investigated whether age was an important factor affecting students' digital literacy, which led to inconsistent results. A study showed that age was not a statistically significant factor affecting students' digital literacy because, compared with experience, age was not that important in improving students' digital literacy [14]. Another study also reported that age was an important factor of digital literacy, but it was not the only determinant of digital literacy and it was not that important to be taken into

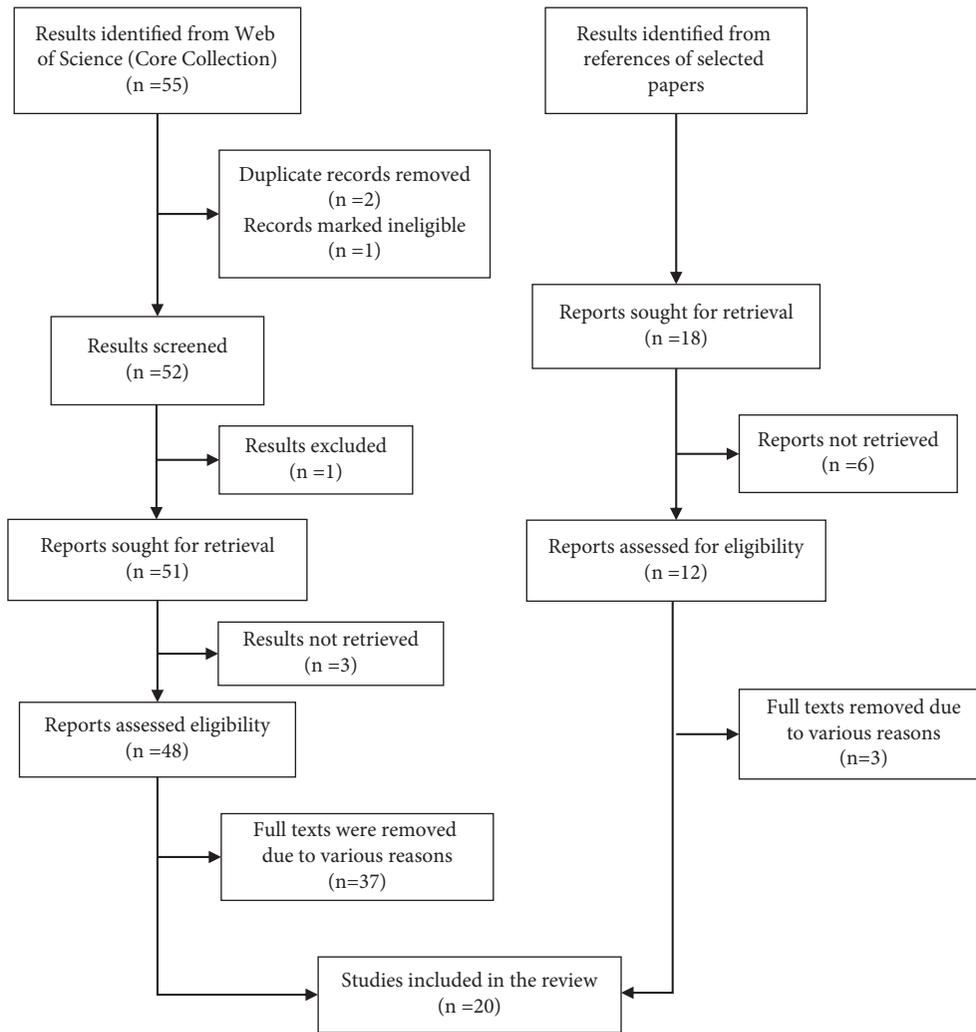


FIGURE 1: A flowchart of literature inclusion.

consideration in the process of making educational policies [36].

Another factor affecting students' digital literacy is gender, which also leads to different research findings. In some studies, girls enjoyed a higher level of digital literacy than boys [14, 19, 20]. Other results revealed that boys were more digitally literate than girls [21, 24]. However, some studies demonstrated that there was no statistically significant difference between gender and digital literacy [22, 23]. A study illustrated that the only difference existed in the grasp of general knowledge. The male students had a better mastery of it than female ones, which may be caused by the male students' preferences for digital devices [12].

Family socioeconomic status is also a vital factor affecting students' digital literacy. Previous studies revealed that family socioeconomic status positively correlated with students' digital literacy [10, 37]. The students cherished a higher level of digital literacy in economically advantaged families with more books [22]. On the contrary, the students who were from lower socioeconomic backgrounds tended to have a lower level of digital literacy [10, 38]. A possible reason may lie in that it was a little bit difficult for students

from lower-economic backgrounds to get access to modern digital devices compared with students from wealthy families, which limited their potential to improve their digital literacy.

Parents' education level is also an important factor affecting students' digital literacy. Some studies showed that there was a positive relationship between students' digital literacy and their parents' education level [10, 39]. A possible reason was that the parents who possessed a higher level of education can guide their children to use digital devices. This finding was consistent with another study in which secondary students' digital literacy was affected by their fathers' high education level [40]. In addition, 15-year-old students who had a father with higher qualifications tend to outperform those students who had a father with lower educational backgrounds [41].

To sum up, there are various factors affecting students' digital literacy. This paper illustrated 4 main factors, which are students' age, gender, family socioeconomic status, and parent's education level. Researchers draw contrasting results about whether students' age and gender affect their digital literacy. In addition, researchers are consistent that

TABLE 1: Authors, foci, and major findings of the included literature guiding this study.

Authors	Foci	Major findings
Karagul et al. (2021)	Whether age, gender, and school degree significantly influence students' digital literacy	There is a statistically significant relationship between students' digital literacy and their gender and school degree, while age is not a statistically significant variable [13]
Krelva et al. (2021)	The differences between students in terms of the study specialization and form and level of study	The study program specialization, level, and form of study significantly influence digital literacy [18]
Monteiro and Leite (2021)	The role of university students' digital in enhancing personal and social skills	There are no significant differences between students' digital competencies and their academic year and age [14]
Tran et al. (2020)	The relationship between digital literacy and the student's socioeconomic status, family background, gender, and school location	Economic status and parents' level of education are positively correlated with digital literacy; school location does not correlate with students' digital literacy but with their gender [10]
Aesaert and van Braak (2015)	The relationship between gender, socioeconomic status, and ICT competences	Girls outperform boys in technical ICT skills and ICT competencies. The educational level of the mother is positively related to students' skills and competencies [19]
Kim et al. (2014)	Individual- and school-level variables affecting the ICT literacy level of Korean elementary school students	Female students outperform male students at the ICT level [20]
Kaarakainen et al. (2018)	Teachers' and students' ICT skills	The performance in the ICT skill test is divided by gender and educational level [21]
Hatlevik and Christophersen (2013)	The factors predicting students' digital competence	Language integration and cultural capital, together with mastery orientation and academic aspirations did predict digital competence [22]
Umar and Jalil (2012)	The level of ICT skills among secondary school students in Malaysia	There is no difference between students' levels of ICT skills and gender. There exist differences in terms of ICT skills between urban and rural school students [23]
Zhong (2011)	The divide of self-reported digital skills among adolescents	The ICT penetration rate of a country negatively correlates with adolescents' digital skills. Private or public schools do not affect students' digital skills. Self-reported digital skills are affected by home ICT access, adolescents' socioeconomic status, and gender [24]
Purnama et al. (2021)	The influence of digital literacy, parental mediation, and self-control on online risk during the COVID-19 pandemic in Indonesia	Digital literacy, parental mediation, and self-control influence online risk. Parental mediation failed in promoting students' self-control [15]
Essel et al. (2021)	The relationship between digital literacy, technology dependence, technostress, and academic achievement and academic productivity	Technology dependence and digital literacy contribute to technostress, and technostress negatively affects academic achievement and academic productivity [11]
Kara (2021)	The learners' characteristics on their engagement in online education during the COVID-19 pandemic	Self-directed learning and motivation mediate the relationship between digital literacy and engagement, while perceived stress moderates the relationship of digital literacy with self-directed learning, but not with motivation for learning [12]
Ana et al. (2020)	Students' perceptions toward e-learning usage	E-learning positively affects students' learning [25]
Sa et al. (2021)	The digitalization processes in education for creating a sustainable digital society	Digital education has experienced a strong increase, reinforced by COVID-19, creating a digital presence in everyday life [26]
Cicha et al. (2021)	The digital skills young people and students should achieve	A set of skills that should be expected to be possessed by young people and students during their education are proposed [27]
Prior et al. (2016)	The effects of students' attitude, self-efficacy, and digital literacy on their online learning behavior	Positive student attitude and digital literacy upgrade students' self-efficacy. Self-efficacy positively affects peer engagement and learning management systems [28]
Shu et al. (2011)	The impact of computer self-efficacy and technology dependence on computer-related technostress	Both employees' self-efficacy and technology dependence positively correlate with their computer-related technostress [29]
Wei and Chou (2020)	Whether online learning perceptions and readiness influence students' online learning performance and their course satisfaction	Students' computer self-efficacy and motivation for learning exerted a direct, positive effect on their online discussion score and course satisfaction [30]
Kahu (2013)	Student engagement framework in higher education	Present a conceptual framework of student engagement in higher education [31]

family socioeconomic status and parents' education level positively correlate with students' digital literacy. This finding has wider implications for educators and policymakers. They are advised to keep students in mind, pay more attention to the students' family socioeconomic status and their parent's education level, and use proper methods to teach them.

*4.3. What Is the Relationship between Students' Digital Literacy and Their Self-Control, Technostress, and Engagement?* When it comes to the aspects that digital literacy can affect, various kinds of research have been done. The factors can be students' self-control, technostress, engagement, and so on [11, 12, 15].

Digital literacy plays an essential role in promoting students' self-control. Studies have found that digital literacy enabled students to explore and use the information from the Internet with digital literacy skills, significantly minimizing online crime [15, 42, 43]. These studies were in accordance with the following studies [44, 45], which indicated that the children with low digital literacy tended to have a low self-control level and become suspects or victims online or offline. A possible reason may lie in that the students with low digital literacy had difficulty in finding, evaluating, and using online information.

Digital literacy is vital in reducing the technostress. A study revealed that digital literacy had a statistically significant negative effect on students' technostress [11]. The students who enjoyed a higher level of digital literacy can have lower technology-induced stress. This result can be explained by the fact that the students cherished enough knowledge about the omnipresent ICTs. The students with a higher level of digital literacy tended to use ICTs to finish their homework confidently, which in turn overcome the sense of academic insecurity and technostress [28, 29].

Students' digital literacy positively affects their engagement in learning. A study revealed that students' digital literacy directly affected their engagement [12]. This finding was congruent with the previous studies, which illustrated that students' digital literacy was an essential precondition for online learning, implying that a higher level of digital literacy caused an increased level of students' engagement [30, 46]. This finding was also consistent with the framework of Kahu [31], which indicated that students' digital literacy affected their engagement, mediated by psychosocial factors—motivation and self-directed learning. This finding suggested that the increased students' digital literacy can enhance students' self-directed learning and motivation, which in turn advanced their engagement in learning.

In conclusion, students' digital literacy significantly affects their self-control, technostress, and engagement in learning. The improved digital literacy can upgrade their self-control to reduce their online crime. In addition, a higher level of digital literacy can significantly decrease their technostress and enhance their learning experience. Furthermore, students' improved digital literacy can dramatically improve their engagement in learning. There are so many benefits of enhancing students' digital literacy. Thus, it

is advised for educators and policymakers to pay more attention to making strategies to improve students' digital literacy during the COVID-19 pandemic crisis and maximize their online learning outcomes.

*4.4. How to Gauge Students' Digital Literacy?* After reviewing the definitions of digital literacy, the factors affecting digital literacy, and the relationship between students' digital literacy and their self-control, technostress, and engagement, the approaches to gauge students' digital literacy will be presented. Only students' digital literacy is properly measured, can teachers and other educators make the corresponding method to teach them. Various kinds of approaches to measure students' digital literacy have been proposed. But they can be roughly divided into three types.

The first way is to apply the existing digital literacy scales. A study directly employed Ng's nine-item scale to measure students' digital literacy, containing technological, social-emotional, and cognitive constructs [11]. A study also applied the existing Ng's digital literacy scale, but the scale was adapted to their own language context [12]. A study gauged students' digital literacy by incorporating nineteen questionnaires from Rodriguez-de-Dios et al. [15]. In a study, students' digital literacy was measured by using the existing questionnaire developed by the NAFL analytical center Russian Teachers' Digital Literacy [47]. The second method is to combine different existing digital literacy scales. Some scholars raised a digital literacy scale, which was developed from DIG-ICOMP 2.0—a framework for developing and understanding digital competence in Europe—and added some other elements from the authors' understanding of digital literacy [14]. The third method is to create a new digital literacy scale based on the scholars' understanding of digital literacy. Some scholars have created their own digital literacy scales to test students' digital literacy [10, 18].

To sum up, there exist three approaches to gauge students' digital literacy. The first way is to apply the existing digital literacy scales. The second way is to refine the existing digital literacy scales from the authors' understanding of digital literacy. The third way is to create a new digital literacy scale. These three approaches enjoy equal importance, so people can employ one of them to test students' digital literacy from their own purpose. It is advised that teachers, educators, and policymakers should use these ways to test students' digital literacy before making important decisions.

## 5. Discussion

This study discussed the definition of digital literacy. This term has been defined by many scholars. But their definitions can be roughly classified into two branches. One branch mainly focuses on technical skills that people can grasp. The other pays much attention to the mastery of ideas. Nowadays, we live in a digital world, with various kinds of information around us. It is of vital significance to upgrade both the basic digital skills and those skills by which people

can fully understand and wisely use online content. This can help people to manipulate online information and prevents them from being fooled or trapped in the digital world.

This study also illustrated many factors affecting digital literacy: age, gender, family socioeconomic status, and parent's education level. There were no consistent findings on whether age and gender influenced students' digital literacy [19, 21, 22]. A possible reason may be that compared with the differences in students' age and gender, their experience using digital devices matters. However, consistent findings demonstrated that if the family enjoyed high socioeconomic status or the parents had a high educational level, their children tended to process a high digital literacy level [10, 22, 41]. This may be because their counterparts tended to be more capable of improving their children's digital literacy, compared with the families having low socioeconomic status and parents having a low educational level. This phenomenon can lead to inequality since the students do not have equal access to improving their [48]. Thus, it is advisable for educators and policymakers to take action to reduce this phenomenon.

In addition, this study investigated the relationship between students' digital literacy and their self-control, technostress, and engagement. The level of students' digital literacy can positively affect their self-control, which can be explained by the fact that students with a high digital literacy level can understand and use online information wisely [45]. In addition, students with a high digital literacy level can significantly decrease their technostress [28]. Furthermore, improved digital literacy can substantially enhance students' engagement in class. A possible reason may lie in that the students cherishing a high level of digital literacy do not have to bother worrying about the technological problems, and they can be fully engaged in the class [30]. There exist so many benefits of upgrading students' digital literacy, so it is suggested that teachers and relevant educators should make strategies to enhance students' digital literacy levels and maximize their learning outcomes in class.

Finally, this study discussed three ways of gauging students' level of digital literacy. The first way is to apply the existing digital literacy scales, like Ng's nine-item scale. The second way is to refine existing digital literacy scales based on the authors' understanding of digital literacy. The third way is to create a new scale to test students' digital literacy. These three ways of measuring students' digital literacy are equally important. But the scholars must understand the rationale of the scale when applying them. If the scholar wants to refine the existing scales to test students' digital literacy, the scholar must pay attention to the different scales' domains. If the scholar intends to create a new digital literacy scale, the reliability and validity of the scale should be verified.

## 6. Conclusions

**6.1. Findings.** This study has demonstrated a literature review on students' digital literacy, which provided precious references for parents, educators, and policymakers. This study, founded on about twenty related publications and

journal articles, investigated some aspects of digital literacy, containing the definition of digital literacy, the factors affecting digital literacy, the relationship between students' digital literacy and their self-control, technostress, and engagement, and the approaches to gauge the level of students' digital literacy.

The term digital literacy referred to not only the mastery of essential technical skills but also the wise use and complete understanding of online information. The study also presented some factors affecting students' digital literacy, including age, gender, family socioeconomic status, and parent's education level. No consistent findings revealed that students' age and gender positively affected their digital literacy. However, consistent results indicated that family socioeconomic status and parents' education level positively correlated with students' digital literacy. Students' digital literacy could affect students' self-control, technostress, and engagement in learning. Students' high level of digital literacy could significantly enhance their self-control and engagement in learning and reduce their technostress in class. The study also illustrated three ways of gauging students' digital literacy levels, namely, using the existing digital literacy scales, refining existing digital literacy scales, and creating a new digital literacy scale.

**6.2. Limitations.** There are some limitations to this study. The major limitation of this study lies in the coverage of the literature. Even though we retrieved the data from the extensive database "Web of Science Core Collection," it is inevitable to miss some findings due to the payroll and language limitation. In addition, we also excluded reports and unpublished works excluded from this study. Meanwhile, this study researched students' digital literacy by simply investigating and analyzing previous studies. Even though this literature review can give educators, policymakers, and interested readers a comprehensive understanding of students' digital literacy, it lacks substantial evidence to testify whether the factors statistically affect students' digital literacy and whether students' digital literacy is a significant variable in affecting students' self-control, technostress, and engagement. Thus, it is advised that further studies adopt quantitative approaches or mixed methods to investigate students' digital literacy.

**6.3. Implications.** This study only investigated whether students' digital literacy is affected by their gender, age, family socioeconomic status, and parent's education level. There are still many other factors affecting their digital literacy. Students' digital literacy can vary if they have different specializations, school locations, or school levels. Further studies could investigate whether these factors significantly affect students' digital literacy. In addition, this study only examined the relationship between students' digital literacy and their self-control, technostress, and engagement. The study of students' cognitive loads, motivation, self-efficacy, and learning outcomes also has gained popularity recently [49, 50]. Thus, it is suggested that further

studies can illustrate the relationship between students' digital literacy and these aspects.

Besides, this study only included three ways to measure students' digital literacy without developing a new approach. Future studies can adopt the existing scales or refine them. It is also advisable for scholars to develop new scales to measure students' digital literacy based on their understanding of digital literacy. What should be pointed out is that the reliability and validity of the scales should be verified when creating a new scale. In this way, digital literacy scales can be diversified. In addition, scholars are also encouraged to develop scales to gauge teachers' digital literacy since it is not only students' digital literacy but also teachers' digital literacy that can affect students' online learning experience [47].

Furthermore, this study only examined students' digital literacy. In the process of online education, both students' and teachers' digital literacy may play an important role in enhancing students' learning outcomes. Further studies could shed light on the factors affecting teachers' digital literacy, the relationship between teachers' digital literacy and students' learning motivation, outcomes, and the relationship between teachers' digital literacy and their interaction with students in class. It would be greatly appreciated if the scholars and other readers could offer more findings to extend and diversify this result.

## Data Availability

All data and materials are available from the corresponding author upon request.

## Conflicts of Interest

The authors declare that they have no conflicts of interest.

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