Digital literacy skills of math students through e-learning in COVID-19 era: a case study in Universitas Riau

Z Zulkarnain¹*, S Heleni¹ and M Thahir²
¹Universitas Riau, Indonesia
²Universitas Islam Negeri Sultan Syarif Kasim Riau, Indonesia

*Corresponding author’s e-mail: zulkarnainfkip@lecturer.unri.ac.id

Abstract. The phenomenon of using social media as online media is getting more massive this decade. Young people as a millennial generation are the biggest users in the use of social media today. Research on digital literacy is still rare, especially in Indonesia. Based on this phenomenon, this study aims to map students’ digital mathematical literacy through e-learning in the Covid-19 era. This research uses a quantitative approach with a case study method. Informants were used as research samples of 8 postgraduate students at Riau University. Student digital literacy ability data was collected through online questionnaires using Google Form, then analyzed descriptively using SPSS Program version 23.00 for Windows. The findings obtained in this study indicate the importance of digital literacy capabilities that have a positive impact on knowledge, understanding and skills in using media, especially social media, which is now often used as a source of information by the public, especially by students. Seeing the results of the study, researchers recommended the need for universities or leaders so that students can improve their digital literacy abilities.

1. Introduction
The flow of globalization can not be stopped. This is balanced with the rapid development of technology which is now entering the era of industrial revolution 4.0. In the era of the industrial revolution 4.0, known as the digital revolution, all information can be obtained in real-time and quickly anywhere and anytime [1]; and the Industrial Revolution 4.0 is characterized by ubiquitous internet networks, artificial intelligence, and machine studies [2]. The industrial revolution 4.0 is one of the impacts of the development of information and communication technology that is moving so fast, reaching all sectors of life. One of them is the education sector in the learning process activities [3]. The 21st-century skills needed in the industrial revolution 4.0 era are needed, namely ICT and digital literacy information literacy as tools for working [4]. Thus, it can be understood that the development of information technology is part of the emergence of the era of the digital revolution and its rapid development can provide a major influence and dominate all sectors of people’s lives, especially in the world of education.

Digital literacy is defined as the skills and technological knowledge for individuals to develop long-term learning activities and contribute well to society [5]. Digital literacy is a key skill in education today. Digital literacy includes various types of literacy, such as information literacy, computer literacy, media literacy, communication literacy, visual literacy, and technological literacy [5][6]. This digital literacy can help young people to benefit from information sources connected with digital technology and prepare themselves to face the challenges of today’s technology [5]. Not only building knowledge
access skills, but digital literacy also builds critical thinking skills in the use of digital technology [7]. Success in building digital literacy skills is one indicator of achievement in education. Thus, we can understand that digital literacy can be interpreted as the ability of individuals to apply functional skills to digital devices so they can find and choose information, think critically, be creative, collaborate with others, communicate effectively, and still pay attention to electronic security.

Digital literacy is important to apply to mathematics learning. The application of digital literacy in mathematics learning provides opportunities for interaction, literacy of interesting reading sources, diverse material references, communication, and problem-solving [8]. Digital literacy can help students understand mathematics and make mathematics a practical game, competition and practice [9]. Seeing the importance of digital literacy in mathematics learning, the Ministry of Education and Culture in collaboration with the Ministry of Communications and Information is actively promoting digital literacy in the community, such as digital literacy activities [10]. This is also supported by Hague and Payton’s research showing that digital literacy can develop one’s knowledge, encourage curiosity and creativity, most students have good skills in using social networking, e-mail or Skype, surfing the internet as a community in cyberspace [11][12]. Therefore, this digital era requires students to be able to follow the development of science and technology so that learning is presented following the times and the needs of students.

However, the phenomenon that occurs in the educational environment, digital literacy capability in Indonesia is still low. This is referred to base on the 2015 PISA results [13], Indonesia’s reading/literacy level is ranked 62 out of 70 countries with an average score of 397. The average reading/literacy score of 70 countries is 493. This means the reading level/literacy in Indonesia is still low and below average [10]. This is confirmed by research which says that digital literacy in the aspect of content evaluation is still relatively low [14]. On average, students who go to school still apply traditional literacy or literacy of printed materials, such as textbooks, religious books, and storybooks [15]. This causes a limited source of information and learning for students. The application of literacy in Indonesia is still not in line with the concept of the Industrial Revolution 4.0, where all activities such as learning can utilize the internet network. At present, digital literacy is important to be applied and developed in learning in Indonesia, specifically applying digital mathematics literacy.

One effort that can be done to develop and improve students’ digital literacy skills is through e-learning based learning. E-learning becomes a general reference for the learning process that requires students to sit, study in front of the computer and connect to the internet [16]. E-learning is developed as a learning media that can connect between lecturers and students in an online study room and must be connected to the internet. Yazdi [17] said that e-learning was an interactive learning media based on information technology. The use of the internet in learning mathematics has the potential to create a meaningful and enjoyable learning environment [18]. Also states that contextual learning can use learning media by utilizing the internet. Research on e-learning has also been carried out by Chandrawati [18] that the development of e-learning has three possibilities in internet-based learning systems, namely web courses, web-centric courses, and we enhanced courses. Koohang and Harman [19] stated that e-learning is the delivery of education (all activities that are relevant to learning, teaching and learning) through various electronic media, and the appropriate instructional design that includes principles and theories of learning is critical to learning success.

The e-learning function in learning can be categorized into 3 forms: supplement, complement, or enrichment. In implementing web-based e-learning 3 models can be chosen frequently, namely Web-Course, Web-Centric Course, or Web-enhanced Course [18][20]. In the web course, the internet is used for educational purposes in the form of distance learning without face-to-face activities. In contrast to web courses, in web-centric courses, there are learning activities that integrate face-to-face and distance learning activities. In web-enhanced courses, the internet is used to provide enrichment to students, other than as a means of communication between teachers and students, between students and students, or between students and resource persons [21]. E-learning is expected to develop student motivation in the learning process, one of which is in learning mathematics. Mathematical learning is a process of change both cognitive, affective, and cognitive towards maturity following the truth of logic. NCTM
recommends 4 principles of mathematics learning, namely: 1) mathematics as problem-solving, 2) mathematics as reasoning, 3) mathematics as communication, and 5) mathematics as relationships [22]. Mathematics learning needs to be given to students to equip them with the ability to think logically, analytically, systematically, critically, and creatively as well as the ability to cooperate.

Based on these explanations, the authors write a related idea about the effect of E-learning in learning to optimize digital literacy skills in mathematics learning. The purpose of this article can describe the effect of E-learning on mathematics, learning on digital literacy skills in mathematics.

2. Methods
This research is survey research to map student digital literacy and see the effect of e-learning on student digital literacy abilities. Data collection techniques using the instrument in the form of a questionnaire [23]. The five constructs referred to are 1) basic / basic literacy, 2) scientific skills, 3) information attachment, 4) technology skills, and 5) Visual skills. This needs to be done to be able to evaluate and know and identify digital literacy skills for students because this research will be carried out in Indonesia and especially in Riau province, which has different gender and ethnic characteristics. In this study, involving 8 respondents who came from students of mathematics education at the University of Riau. The researcher uses stratified sampling and random in this study to ensure that each member of the population has the same possibility to be chosen as part of the sample. After the data is collected from the distribution of digital literacy questionnaire instruments to students of mathematics education at Riau University, the data is then processed using the Statistical Package for Social Sciences (SPSS) version 23.00 for Windows.

3. Results and discussion
Achievement of student digital literacy is obtained using a questionnaire after applying e-learning. The use of e-learning in discrete mathematics courses was carried out 14 times. The results of the digital literacy achievement of students after applying e-learning can be seen in table 1 below.

| No. | The construct of digital literacy | N  | Mean | Category |
|-----|----------------------------------|----|------|----------|
| 1   | Basic                            | 8  | 2.69 | Good     |
| 2   | Scientific                       | 8  | 2.84 | Good     |
| 3   | Information                      | 8  | 3.00 | Good     |
| 4   | Technological                    | 8  | 3.42 | Good     |
| 5   | Visual                           | 8  | 3.65 | Good     |
| Mean|                                  |    | 3.12 | Good     |

Table 1 above shows that in the aspect of digital literacy, research subjects regularly have good digital literacy skills (mean = 3.12). Furthermore, from the data above it can also be understood that the technological and visual constructs are the highest in mapping digital literacy abilities of students.

In basic constructs or basic/basic literacy skills, we get an average value of 2.69 in the good category. That is because most students have been able to meet the six indicators of mathematical reasoning ability. Based on the results of data analysis, it is known that students’ reasoning abilities show 5 students (62.5%) often and 3 students (37.5%) sometimes submit allegations; 6 students (75%) often and 2 students (12.5%) sometimes manipulate mathematics; 6 students (75%) often and 2 students (25%) conclude, compile evidence, give reasons or proof of the correctness of the solution; 6 students (75%) often and 2 students (25%) conclude from statements; 7 students (87.5%) often and 1 student (12.5%) sometimes check the validity of an argument, and 5 students (62.5%) and 3 students (37.5%) sometimes find patterns or properties of mathematical symptoms to make generalizations in understanding the material. This condition shows that at the level of reasoning ability, students often submit conjectures or in other words, students have the skills to submit allegations well. This result is reinforced by research, which says that students’ reasoning abilities are in quite good categories [24]. The results of other studies
also say that the average score of students’ reasoning domains is higher than the domains of knowledge and application [25]. Improved student mathematical reasoning certainly has an impact on improving student learning outcomes so that it can be understood that reasoning is very important for students in mathematical learning.

One way to help students develop their reasoning skills is through learning designs based on reasoning activities. Students are allowed to use their reasoning in each learning activity, especially in understanding a concept so that it is hoped that learning will be more meaningful. The importance of developing mathematical reasoning has been studied previously [26] which states that a teacher who wants to improve students’ mathematical literacy skills, can design learning by giving tasks that require mathematical reasoning in its completion. Habituation of lecturers to provide practice questions that contain mathematical reasoning, namely tasks whose completion process is not routine, is problem-solving, requires high-level thinking, the problem-solution requires two or more formulas, contains mathematical interpretation in various contexts, and can foster creative power college student. Tasks, whose completion process as above, can improve mathematical literacy skills [27]. Furthermore, the Ministry of National Education also explained that the importance of using reasoning on patterns and traits, carrying out mathematical manipulations in making generalizations, compiling evidence or explaining mathematical ideas and statements [28]. Thus, it can be concluded that with mathematical reasoning, students can practice ways of thinking and reasoning, make some assumptions or hypotheses and then compile existing evidence and explore mathematical ideas to manipulate mathematical problems and be able to conclude correctly and correctly. Therefore, lecturers must play an active role in developing students’ mathematical reasoning abilities.

In scientific constructs or scientific skills, we get an average value of 2.84 in the good category. Based on the results of data analysis, it is known that the scientific ability of students shows 5 students (62.5%) often and 3 students (37.5%) sometimes have knowledge and mastery of scientific concepts and processes; 2 students (25%) very often, 4 students (50%) often, and 2 students (25%) analyze answers to curiosity based on experience; 4 students (50%) often and 4 students (50%) sometimes can describe, explain and predict lecture material; 2 students (25%) often and 6 students (75%) read and understand scientific articles related to lecture material. Science education is currently directed to prepare students for a successful life in the 21st century. One of the skills needed in the 21st century is scientific literacy [29]. Scientific literacy has become a widely studied topic and is published in various science education journals [30]. The demand for mastering scientific literacy for the community at the national and international level arises because everyone is obliged to participate in solving real-world problems through an understanding of science and technology that is based on mastery of mathematics, physics, chemistry, biology, and the environment [31]. Scientific literacy is a 21st-century life skill. Scientific literacy is a skill to live in an era where scientific knowledge is the foundation of everyday life [32]. Scientific literacy views the importance of thinking and acting skills, which involves mastering thinking and using scientific thinking in recognizing and responding to social issues. Scientific literacy develops in line with the development of life skills [32], namely the need for scientific reasoning and thinking skills in a social context and emphasizes that scientific literacy is intended for all people, not just those who choose a career in science and technology.

The concept of scientific literacy expects students to have a high sense of concern for themselves and their environment in dealing with problems of daily life and make decisions based on the scientific knowledge that they have understood [33]. Science literacy as a requirement that must be had by students in adjusting the challenges of rapidly changing times so that in learning literacy is trained in tandem with the development of life skills [34]. Science literacy is important to be mastered by students concerning how students can understand the environment, health, economics, and other problems faced by a modern society that are very dependent on technology and the advancement and development of science.

In the information construct or information attachment, we get an average value of 3.00 in the good category. Based on the results of data analysis, it is known that the ability of student information shows 4 students (50%) often, 3 students (37.5%) sometimes, and 1 student (12.5%). I can distinguish what I
want to know and need from sources differ based on source credibility; 4 students (50%) very often, 4 students (50%) often I can identify relevant information; 4 students (50%) often, 3 students (37.5%) sometimes, and 1 student (12.5%) uses for specific purposes using several tools and media). The presence of the internet with various electronic and digital sources makes people increasingly aware of the importance of information skills, to be able to help find information that suits their needs and empowers the information obtained.

The development of information technology has brought drastic changes in procurement, organization, management and information dissemination [35]. However, according to Walker and Jones [36], advances in communication and information technology do not always facilitate the process of information retrieval, it may even complicate tracing. On the other hand, technological development is closely related to changes in the attitude and ability of users to find information and use the information they need. For some end-users, interacting directly with information systems is complicated. This happens because of an increase in the amount of information and the quality of information that is not clear to the user [35]. In addition, information is received in various media including images, aquatics and text. People also begin to question the validity or authenticity, validity and reliability of the information they obtain. To make information retrieval effective and clear, people are required to “information literate”, because it requires the ability to obtain and manage information.

Research on information literacy lately is increasingly prevalent and has even become a trend in scientific studies. In some countries research on this topic has long been carried out, research on the integration of information literacy into web-based tutorials is a collaboration between faculty and librarians in Thailand [37]. In Indonesia alone, research on this topic has not been done much. Researchers only began to study information literacy activities in the early 2000s, including Research conducted to educators and non-formal education educators in DKI Jakarta province which said that the literacy ability of civil service information was still low (19.71%), where they are generally based on new information literacy theory at the level of knowing information needs, knowing how to access information, being able to evaluate information, and being able to use information [38]. Furthermore, Apriyanti’s research shows that the information literacy of users in the DKI Jakarta Provincial Public Library shows that public library users in the DKI Jakarta province have fairly good information literacy ability [36]. Various studies have been carried out in various countries to examine how the abilities and skills of users in obtaining and managing information in utilizing ICT facilities. Even so, research on this topic is still rarely done in Indonesia and is being a busy topic being studied for application in tertiary institutions, considering the ability and skills to search for and manage information is needed by the academics amid the rapid development of ICT.

In the technological construct or technological attachment, we get an average value of 3.42 with a good category. Based on the results of data analysis, it is known that the technological abilities of students show 4 students (50%) often, 3 students (37.5%) sometimes, and 1 student (12.5%) use various kinds of technology to increase productivity; 4 student (50%) very often, 4 students (50%) often use various communication tools to communicate ideas to others; 4 students (50%) often, 3 students (37.5%) sometimes, and 1 student (12.5%) uses technology to solve problems. The progress of information and communication technology is indeed unstoppable. Its influence is increasingly extended to all aspects and fields of human life, including in the field of education. To implement this technology in the education sector, efforts are needed in understanding what the technology itself is. One of them is by promoting the technological literacy movement. This literacy is related to campus efforts to develop innovations in education. This literacy is defined as the ability to use and utilize new media such as the internet to access, disseminate, and communicate information effectively [39]. ICT literacy is also interpreted as media literacy that positions humans who can understand, master, and utilize mass media content [40]. Thus it can be understood that technological literacy is an activity in using digital technology, communication equipment, and / or networks to access, organize, integrate, evaluate, and create information for benefits in a social collection.

Technology literacy can be classified into three parts, namely groups relating to technological knowledge, groups of abilities in using technology, and groups of attitudes growing from the critical
reflection of technology use [41]. Along with changes and developments, the term technology literacy has expanded into several different terms such as technology literacy, and computer literacy, and internet literacy [42]. Furthermore, information technology also plays a vital role in the social needs of students, such as interactions in social media, enjoying hobbies, creating creative ideas, and finding information related to learning [43]. Through the technology literacy program, students are expected to have some technological skills. This skill is crucial in finding and determining information from unlimited sources, communicating through computers and manipulating certain information for specific purposes such as completing assignments, presentations, and data analysis. Therefore, it cannot be denied anymore. Technology literacy must be implemented into the education level as early as possible as one of the efforts to carry out educational renewal and innovation in facing the 21st century. The application of this technology literacy program can be carried out starting from elementary, secondary, to higher education levels. In addition, technological literacy must also be applied to other education personnel, not only applied to students but also the teachers and education administration staff.

In the visual construct, we get an average value of 3.65 in the good category. Based on the results of data analysis, it is known that the visual ability of students shows 6 students (75%) often and 2 students (25%) sometimes understand the basic elements of visual design; 5 students (62.5%) One, 3 students (37.5%) sometimes applied the knowledge acquired visually to electronic media; 5 students (62.5%) once, 3 students (37.5%) sometimes could create visual media to present lecture material. Entering the era of digital literacy as it is today, everyone is required to be able to master a variety of literacy, including visual literacy. The ability in visual literacy can be applied as a medium in learning resources because in visual literacy there is a mastery of images that are sometimes outlined in a work [44]. This makes variations in the learning process that do not rely on text writing alone, which is generally found in most references.

Visual literacy is included in the list of 21st-century skills, namely that a learner must have the ability to interpret, recognize, appreciate and understand the information presented through actions, objects and symbols that are visible, natural or man-made [45]. To create meaningful images and the ability to read images has become a standard in this century. Visual literacy is defined as the ability to understand and use images, including the ability to think, learn, and express oneself in terms of images [45]. Visual literacy is the ability to interpret, use, and create visual media to improve processes, decision making, communication, and learning [46]. Visual literacy is the ability to interpret visual messages and create messages in communication. Awareness and knowledge of visual literacy are closely related to the thought process. Raiber’s Cognitive mentions Cognitive visual inclusion graphics that are used for attention gaining, presentation and practice [47]. Visual literacy is one of the competencies that must also be learned and becomes a must competency in all lines of education. Visual literacy encourages appreciation and understanding of visual communication. Lack of awareness of the ability to read visually may have an impact on the development of the communication process. By understanding the basic principles of visuals, a person can read or produce images and communicate with a higher level of complexity.

4. Conclusion
Students’ mathematics digital literacy skills can be seen from five constructs, namely 1) basic, 2) scientific, 3) information, 4) technological, and 5) visual. Based on the analysis, the results of research and discussion that have been previously disclosed, it is concluded that there is an increase in students’ mathematics digital literacy after learning by using e-learning, although the increase is in a low category. The use of e-learning in learning activities at the University of Riau is a model for strengthening students’ mathematics digital literacy. The existence of e-learning makes lecturers who teach courses required to master new media so that it can indirectly improve their individual mathematics digital literacy skills. The contribution of this research is in the form of a model of strengthening student digital literacy through the use of e-learning at the Universitas Riau. This research needs to be done to analyze the five constructs of digital literacy. Research recommendations are also intended for policymakers at
the Universitas Riau to maximize the use of e-learning as an effort to strengthen digital literacy, especially in the elements of communication and collaboration.

References

[1] Setyaningsih R, Abdullah, Prihantoro E and Hustinawaty 2019 *J. ASPIKOM* 3 1200–14
[2] Cahyadi I F 2019 *J. Akunt. Syariah* 2 69–82
[3] Warsito, Bimata M and Djuniadi D 2016 *J. Pendidik. Mat. FKIP Unissula* 4 91–9
[4] Griffin P and Care E 2015 *Assessment and teaching of 21st century skills* (London: Springer)
[5] Çam E and Kiyici M 2017 *Malaysia Online J. Educ. Technol.* 5 29–44
[6] NCREL M G 2003 *enGauge 21st century skills: Digital literacy for digital Age* (Napierville. IL & Los Angeles: CA: NCREL & Metiri)
[7] Muliawanti S and Kusuma A B 2019 *Pros. Sendika 5* (Purworejo: Universitas Muhmmadiyah Purworejo) pp 637–46
[8] P Swan Lm 2009 *Proc. 22nd Biennial Conf. Australian Asso. Math. Teacher Inc.* (Fremantle: The Australian Assosiation of Mathematics Teacher Inc.) p 256
[9] National Council of Supervisors 2015 *Consort Sch. Netw.* (Englewood: NCSM)
[10] Pratama W A, Hartini S and Misbah 2019 *J. Inov. Pembelajaran Fis.* 6 9–13
[11] Akbar M F and Anggaraeni F D 2017 *Indig. J. Ilm. Psikol.* 2 28–38
[12] Shopova T 2014 *J. Effic. Responsib. Educ. Sci.* 7 26–32
[13] OECD 2016 *Country Note – Results from PISA 2015: Indonesia* (Paris: OECD)
[14] A’yuni Q Q 2015 *J. Fak. Ilmu Sos. Univ. Airlangga Surabaya* 4 1–15
[15] Brown C 2013 *Literacy boost Indonesia endline report* (London: Save the Children)
[16] Fitriana D 2018 *Pros. Semin. Nas. Penguatan Pendidikan Karakter Pada Siswa Dalam Menghadapi Tantangan Global* (Kudus: Universitas Muria Kudus) pp 58–62
[17] Mohammad Yazdi 2012 *J. Ilm. Forstek* 2 143–52
[18] Sri Rahayu Chandrawati 2010 *J. Cakrawala Kependidikan* 8 172–81
[19] Koohang A, Riley L and Smith T 2009 *Interdiscip. J. e-Skills Lifelong Learn.* 5 91–109
[20] Gartika R and Rismiati R 2013 *Elearning pembelajaran jarak jauh untuk SMA* (Jakarta: Referensi)
[21] In in Supianti 2016 *J. Teor. Ris. Mat.* 1 1–6
[22] Siagian M D 2016 *J. Mat. Educ. Sci.* 2 58–67
[23] Creswell J W 2012 *Educational research: Planning, conducting Abd evakuating quantitative dan qualitative research* (Boston: Pearson Education, Inc)
[24] Musthafa R A, Sunardi and Fatahillah A 2014 *J. Edukasi UNEJ* 1 1–6
[25] Ceylan E 2013 *J. Educ. Future* 35
[26] Kusumawardani D R, Wardono and Kartono 2018 *PRISMA, Pros. Semin. Nas. Mat.* (Semarang: Universitas Negeri Semarang) pp 588–95
[27] Hasmawati, Sumarna N, Hamid R and Ili L 2019 *J. Wahana Kaji. Pendidik.* IPS 3 35–45
[28] Fatimah A E 2019 *J. Math. Educ. Sci.* 4 217–25
[29] Liu X 2009 *Int. J. Environ. Educ.* 4 301–11
[30] Cavas B, Cavas P, Ozdem Y, Rannikmae M and Ertepinar H 2012 *J. Balt. Sci. Educ.* 11 94–103
[31] Cardwell V B 2005 Literacy: *J. Nat. Resour. Life Sci. Educ.* 34 112–7
[32] Nejla Gultepe Z K 2015 *Int. J. Environ. Sci. Educ.* 10 111–32
[33] Wulandari S 2018 *Edusains* 8 66–73
[34] Holbrook J and Rannikmae M 2009 *Int. J. Environ. Sci. Educ.* 4 275–88
[35] Mishra R N and C.Mishra 2010 *J. Emerg. Trends Comput. Inf. Sci.* 1 48–54
[36] Sitti Husaebah Pattah 2014 *Khizanah Al- Hikmah* 2 117–28
[37] Shopova T 2014 *J. Inov. Pembelajaran Fis.* 6 9–13
[38] Helaludin 2019 *PENDAJS* 1 44–55
[40] Syarifuddin 2014 *J. Penelit. Komun.* **17** 153–64
[41] Oye N D, Iahad A and Rahim A 2012 *ARPN J. Sci. Technol.* **2** 98–110
[42] Christiany Juditha 2011 *J. Penelit. Komun.* **14** 41–52
[43] Ahmad M, Jamaludin Badusah, Mansor A Z, Karim A A, Halid F, Daud M Y, Din R and Zulkefle D F 2016 *Turkish Online J. Educ. Technol.* **15** 151–61
[44] Rachmi Afriani M 2018 *Edumedia J. Kegur. Ilmu Pendidik.* **2** 89–93
[45] P.B S N 2017 *J. Pendidik. Pembelajaran Sekol. Dasar* **1** 48–59
[46] Johanna Riddle 2009 *Engaging the eye generation: Visual literacy strategies for the K-5 classroom* (USA: Stenhouse Publishers)
[47] Linda L. Lohr 2003 *Creating graphics for learning and performance: Lesson in visual literacy.* (New Jersey: Merrill Prentice Hall).