Online Learning and Scientific Literacy in Elementary Schools during the Covid-19 Pandemic

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Abstract

This study aims to investigate the relationship between online learning and scientific literacy of students in fifth grade of elementary school in the Covid-19 era. Employing a correlational research design, this study involved 54 fifth grade students of an elementary school in Bandung City, Indonesia. The data were collected using a scientific literacy test referring to the indicators of PISA 2018 and a questionnaire in an online learning evaluation. The analysis of the data was carried out using descriptive statistics through calculating the average and percentage scores. The data were also analyzed using inferential statistics in the form of the Pearson correlation test to determine the relationship between online learning and scientific literacy. The results of this study revealed that, based on the Pearson correlation test, the sig score was 0.81. There was no relationship between online learning and scientific literacy of fifth grade students of elementary school. Therefore, efforts should be made to improve the scientific literacy of elementary school students, one of which is through optimizing online learning.

Keywords**: *online learning, scientific literacy, elementary school.*

Abstrak

Penelitian ini bertujuan untuk menyelidiki hubungan antara pembelajaran daring dengan literasi sains siswa kelas 5 sekolah dasar (SD) di era Covid-19. Dengan menggunakan desain penelitian korelasi, penelitian ini melibatkan 54 siswa kelas 5 sekolah dasar di Kota Bandung, Indonesia. Data diperoleh dengan menggunakan tes literasi sains yang merujuk pada indikator PISA 2018 dan kuesioner pada evaluasi pembelajaran daring. Analisis data dilakukan dengan menggunakan statistik deskriptif dengan menghitung skor rata-rata dan persentase. Data juga dianalisis menggunakan statistik inferensial berupa uji korelasi Pearson untuk mengetahui hubungan antara pembelajaran online dan literasi sains. Hasil penelitian ini menunjukkan bahwa, berdasarkan uji korelasi Pearson, diperoleh skor sig 0,8. Pembelajaran online tidak memiliki hubungan dengan literasi sains siswa kelas 5 sekolah dasar. Maka dari itu, perlu ada upaya untuk meningkatkan literasi sains siswa sekolah dasar, salah satunya dengan mengoptimalkan pembelajaran online.

Kata kunci: *pembelajaran online, literasi sains, sekolah dasar.*

INTRODUCTION

The 21st century has marked the advance of technology. Technology has an impact on human behavior, and it makes technology a very important tool for human life (Klimova & Kacet, 2017). Technology has also become a way of life for people (Murati & Ceka, 2017). The development of technology and its use, especially in the field of education, is often a topic of discussion in various aspects and in various countries (Moshinski, 2021). The development of the times helps students to get an authentic and meaningful learning experience. It creates a more fun and effective learning atmosphere. Technology also has a positive impact on the creation of a collaborative system; it makes it easier for students to access information and develop their learning experience (Fatimah & Santiana, 2017). In this regard, the ability of teachers to use technology will affect the learning process. The integration of technology with other factors, namely pedagogy, content, and technology, has resulted in significant implications for teacher education and teacher professionalism (Koehler & Mishra, 2005). Therefore, the use of technology in elementary schools will make learning meaningful. It also creates experiences that is more acceptable in today's era.

The Covid-19 pandemic unexpectedly occurred in December 2019 and has spread throughout the world very quickly (Tümen-Akyıldız et al, 2021). The occurrence of a global pandemic has been felt by people all over the world, and it has caused a severe damage and a very influential threat to human life (Cheng et al., 2020). The Covid-19 pandemic has become a very serious outbreak and has impacted on various sectors of human life; based on the historical records, it has created the biggest disruption, especially in the field of education (Teräs, 2020). One of the efforts made to conduct learning activities during the time of the pandemic is through indirect learning. The Covid-19 pandemic has made digital learning an alternative that can be used in the learning process (Dhawan, 2020). However, according to Selwyn (2020), in choosing online learning at this time of crisis, care should be taken to avoid negative impacts on students. To reduce the possibility of negative impacts, teachers must be able to utilize knowledge about online learning. More varied ways in

obtaining information via online learning than conventional information delivery methods are necessary.

In dealing with the impact of the Covid-19 pandemic, many teachers have choosen online learning activities assisted by internet connections, employing media, platforms, or digital social networks (Almonacid-Fierro, 2021). There has been a change in the pattern of the education system, from the previous face-to-face learning conducted directly in the classroom to learning from home using online mode (Mielgo-Conde, 2021). It is because during the Covid-19 pandemic, the only alternative is to implement online learning. Students and teachers can carry out learning in separate rooms using various information technology-based devices (Nguyen, 2021).

Previously, online learning had been widely implemented in universities. However, the pandemic era has forced all levels of education, including elementary education, to inevitably implement online learning. In this study, online learning is interpreted differently. Online learning is learning carried out during the Covid-19 period without direct contact from students and teachers. Students can carry out online learning at home (AlHamad et al, 2014). Online learning is not only limited to the access to the technology used but also the connectivity, flexibility, and ability to promote a variety of communication interactions in learning (Hilts & Turoff, 2005).

According to Fauzi et al (2021), there are four main factors that must be present in the implementation of online learning: students, teachers, parents, and access to learning (Fauzi et al., 2021). The success factors for online learning are described in Figure 1 below.
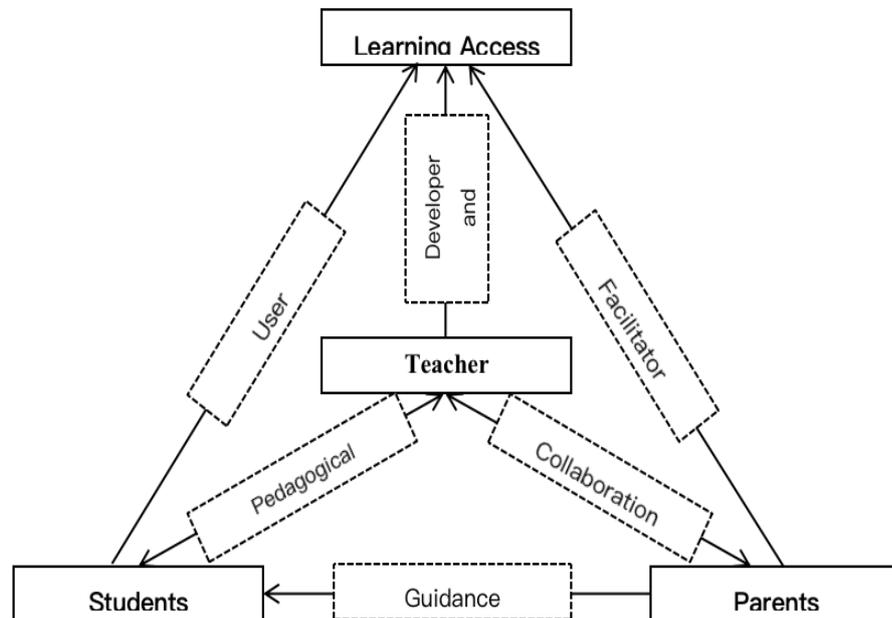
Figure 1. The Success Factors for Online Learning in Elementary Schools

As shown in Figure 1, teachers are responsible for carrying out online learning. Their responsibilities include: 1) Building relationships with students in the learning process; 2) Building collaboration and communication with parents; and 3) Becoming a facilitator of learning access. Meanwhile, the responsibilities of parents include: 1) Building collaboration with teachers; 2) Guiding children at home; and 3) Providing facilities of learning access for children. Finally, the responsibilities of students include: 1) Building pedagogic relations

with teachers and parents; 2) Accepting the parents' help and guide in learning; and 3) Optimizing the use of access to learning provided by the teachers.

One of the goals of implementing online learning is to develop hard skills and soft skills. Various organizations, academics and practitioners argue that students need to equip themselves with the 21st-century skills projects (Gravemeijer, 2017). According to Vooget & Pareja (2010), some of the skills that students must possess in the 21st century are problem solving, critical thinking, initiative, cross-network collaboration, adaptability, and entrepreneurship. Some of these skills have to be supported by good literacy skills. Literacy skills must be part of every student's competence. Literacy comprises of several skills, including reading and spelling, reading comprehension, and writing (Winarni et al, 2020). Literacy is closely related to real life, so poor literacy will impact on everyday life and the future (Breadmore et al., 2019). In the 21st century, the understanding on literacy begin to shift. Literacy used to be understood only as reading and writing. Today, literacy is interpreted as a context for understanding everything. Scientific literacy is one of the most important types of literacy.

Scientific literacy is a skill needed to understand a scientific concept and process; it is used to solve various issues and problems in everyday people's lives (OECD, 2019). According to Marpaung et al. (2021), scientific literacy is highly essential in enhancing the students' awareness to understand various problems that occur. Scientific literacy is a goal to be achieved in science education (Yuliana et al., 2021; Hoolbrook & Rannikmae, 2009). According to Nainggolan et al. (2021), 21st century learning focuses on achieving various competencies, one of which is scientific literacy, and it is important to be taught to students. There are three scientific literacy competencies in PISA 2018, namely: 1) Scientifically explaining phenomena, 2) Evaluating and designing scientific inquiries, and 3) Scientifically interpreting data and evidence (OECD, 2019).

In fact, from the results of the PISA survey from 2015 to 2018, the scientific literacy ability of Indonesian students was in the low category with a score of 403, while the average score of scientific literacy in OECD countries was 493 (Narut & Supardi, 2019). In a study conducted by Widodo et al. (2019), scientific literacy is in the less category (65%). Therefore, collaborative efforts need to be made in creating learning that leads to the improvement of the students' scientific literacy skills, especially in elementary schools.

Studies on scientific literacy skills at various levels of education have been conducted by several researchers. In a study by Kadaritna et al. (2020), elementary school students often experienced misconceptions in solving problems based on phenomena. Lestari et al. (2017) analyzed the low scientific literacy of elementary school students regarding the lowest scientific literacy indicators, namely the aspect of understanding and interpreting basic statistics and solving problems. Hernawati et al. (2019) analyzed that the experience of project activities had a significant influence on scientific literacy skills. Setiawan (2020) analyzed the application of scientific literacy-oriented thematic programs that had a positive linear correlation with learning motivation and mastery of concepts.

In addition, several studies on scientific literacy were carried out in the Covid-19 period. A study by Widodo et al. (2020) explained the effectiveness of gadget-based interactive multimedia in increasing Gen-Z scientific literacy. The research was conducted in two junior high schools. The results revealed that there was no mean in the two schools. It was because the learning only led to the use of multimedia. The students suggested using

multimedia that combined audio, visual, and music. In addition, a study by Dwisetiarezi & Fitria (2021) which analyzed the scientific literacy of elementary school students in science learning found that, in the aspect of science application and science knowledge, the percentage was 79.23%, followed by the aspect of scientific process (43.08%), and the aspect of attitude (60.26%). The results of the studies above have shown that there are still students who have difficulty in understanding scientific literacy. Thus, it is necessary to investigate the conditions and the relationship between the students' scientific literacy skills and online learning in the Covid-19 period, especially in elementary school settings. In addition, this study also tries to get deeper insights on the success factors of online learning in elementary schools, which have been described in Figure 1 by Fauzi et al. (2021). Therefore, this study seeks to find out the relationship between scientific literacy and online learning. In addition, this study also provides an overview to academics and practitioners in evaluating online learning in the Covid-19 era. Thus, in the future, learning can be more optimal and there are improvements on the scientific literacy of elementary school students.

METHODS

This study aims to determine the relationship between online learning and elementary school students' scientific literacy. This is quantitative research with correlational research design. Correlational research is defined as exploring the relationship between variables (Creswell, 2012).

The subjects of this study were 54 fifth grade students of elementary school in two classes. They were chosen on the grounds that they were on par with other fifth graders at the school, with the similar facilities, the curriculum used in each class, and the learning system used during the Covid-19 pandemic. On this basis, the subjects were considered representative.

This study employed a scientific literacy test instrument on ecosystem materials in the fifth grade of elementary school. The test comprised of 7 multiple choice questions and 3 essays questions. The arrangement of questions was based on scientific literacy indicators on the OECD (2019). In addition, the questionnaire was used to measure the evaluation of online learning. The questionnaire indicators referred to the opinion of Fauzi et al. (2021) with several statements about 1) teacher-student pedagogic relations, 2) getting guidance from parents, and 3) using the access to learning provided by the teachers.

The scale used in the questionnaire referred to the Likert scale with the criteria of strongly agree, agree, neutral, disagree, and strongly disagree (Dawes, 2008). The scale is described in Table 1 below.

Table 1. Likert Scale

Assesment Criteria	Positive Scale	Negative Scale
Strongly agree	5	1
Agree	4	2
Fair/Netral	3	3
Disagree	2	4
Strongly disagree	1	5

Descriptive statistics and inferential statistics were two types of data used as the basis for this research. Descriptive statistics describe the subject under study through data

obtained from the sample or population (Susetyo, 2017). Descriptive statistics were used to analyze the results of the students' scientific literacy test scores and the percentage of online learning evaluations. Inferential statistics were used to find out and analyze the Pearson correlation between online learning and scientific literacy. Intervals and interpretation of percentage scores are described in Table 2 below.

Table 2. Intervals and Interpretation of Percentage Scores

Presentase	Positive Scale	Negative Scale
0 % - 20 %	Very not good	Very good
21 % - 40 %	Not good	Well
41 % - 60 %	Enough	Enough
61 % - 80 %	Well	Not good
81 % - 100 %	Very good	Very not good

After that, the correlational test with the research hypothesis was administered. The hypothesis of this study was: "there is a relationship between online learning and scientific literacy."

The analysis and interpretation of the correlation coefficients are described in the Table 3 below.

Table 3. Interpretation of Correlation Coefficient

Relationship Level	Coefficient
0 – 0,2	Very low
0,21 – 0,4	Low
0,41 – 0,6	Strong enough
0,61 – 0,8	Strong
0,81 – 1	Very strong

The data in this study were collected using a scientific literacy test referring to PISA indicators, and a questionnaire in the form of an online learning evaluation. Scientific literacy test instruments and questionnaires were distributed to 54 fifth grade students of elementary school. The data obtained were analyzed using Microsoft Excel, Ms. Excel, and SPSS version 25. Descriptive statistics were used to calculate the average score and percentage. Meanwhile, inferential statistics in the form of the Pearson correlation test were used to find the relationship between online learning and scientific literacy, and finally to analyze in detail the data that had been collected. In general, this research is described as follows.
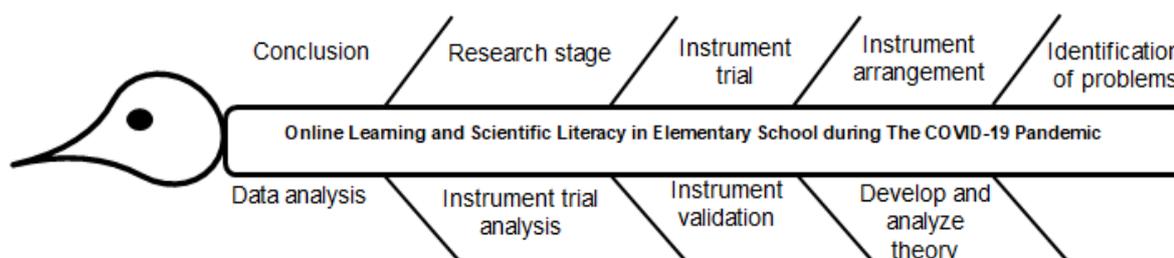
Figure 2. Fishbone Research Flow

This research started with identifying problems both in theory and practice regarding scientific literacy and online learning in the Covid-19 era. Various problems were found regarding scientific literacy and online learning in elementary schools. Afterwards, the

researchers found out relevant theories and made various supporting instruments related to the research. The instruments made were then validated by experts to see the suitability of content knowledge and practical knowledge. The instruments were then tested on students and analyzed for validity and reliability with the aim of strengthening the instruments. Instruments with valid and reliable categories were used and tested on 54 research subjects in 2 classes. The data obtained were then analyzed using quantitative methods. The scientific literacy tests were measured by calculating Pearson correlation, whereas the online learning questionnaires were measured by calculating percentages. After being analyzed in depth, the researcher carried out the last stage, namely drawing conclusions.

RESULTS AND DISCUSSION

Online learning is an integral part in the field of education during the Covid-19 pandemic. Until now, it is still used in the arena of education. The effectiveness of knowledge needs to be studied in detail to evaluate the learning system in the Covid-19 era. In addition, the demands for various abilities that students must have must also be given even during the Covid-19 pandemic. One of the essential skills to be taught, especially in elementary schools, is scientific literacy. The following is a correlation test between online learning and students' scientific literacy in elementary schools.

Table 4. Pearson Correlation Test Between Online Learning and Scientific Literacy

		Online Learning (OL)	Scientific Literacy (SL)
OL	Correlation	1	0,239
	Sig. (2-tailed)		0,81
	N	54	54
SL	Correlation	0,239	1
	Sig. (2-tailed)	0,81	
	N	54	54

As shown in Table 4 above, the Sig value. (2-tailed) between online learning and elementary school students' scientific literacy was 0.81. From these results, it can be interpreted that there was no significant relationship between online learning and scientific literacy. Viewed from the Pearson correlation score of 0.239, the level of relationship between online learning and students' scientific literacy was low. It is reinforced from the descriptive statistical analysis of the students' scientific literacy skills below.

Table 5. Descriptive Statistics of Science Literacy Skills of Grade 5 Students

	N	Min	Max	Mean	Std. Dev
SL	54	16	89	54.94	17.68

Based on Table 5 above, the average score of 54 students who filled out science literacy skills was 54.94. Meanwhile, the lowest score was 16 and the highest score was 89. It shows that students' scientific literacy skills was still low. As revealed by Lestari et al (2017), the lowest scientific literacy competency indicators for elementary school students were in the aspects of understanding and interpreting basic statistics and problem solving. The statement above is in accordance with the results obtained in Table 6 below regarding the three literacy competency indicators obtained from the grade 5 ecosystem materials.

Table 6. Science Literacy Competence

Explaining Phenomena Scientifically	Evaluating and Designing Scientific Enquiry	Interpreting Data and Evidence Scientifically
64,5	50,26	44,13

Based on Table 6 above, the highest scientific literacy competence was explaining phenomena scientifically with the average score of 64.5. Meanwhile, the competence to interpreting data and evidence scientifically was the lowest competency with an average score of 44.13. The last competency was evaluating and designing scientific inquiry with an average score of 50.26. On the topic of ecosystems, students still had difficulty in interpreting data based on experimental results,

One of the causes of the low scientific literacy ability is due to the inability of students to analyze and apply concepts to solve problems; students also tend to memorize concepts more and rarely use their own knowledge (Jufrida et al, 2019). Such habits are caused by learning that focuses on memorization; it is what causes students to have difficulty in connecting the context of the materialy with real conditions in everyday life (Halrida & Lestari, 2014). In addition, environmental and classroom conditions are also not very supportive in the development of scientific literacy (Fakhriyah, 2017), students are also not actively involved in the process of learning science in class (Ibrahim & Lede, 2018).

The absence of a relationship between online learning and scientific literacy is also caused by the online learning system. The analysis of the online learning system is described below.

Table 7. Analysis of Negative Survey Statements

Survey statements	Percentage	Information
Difficulty in online learning	58 %	Enough
Difficulty in understanding the teacher's explanation	54 %	Enough
Feeling that online learning is not effective	67 %	Not good
Difficulty communicating when learning takes place	63 %	Not good
Troubled in the internet network	69 %	Not good

Students had difficulty in participating in online learning. It also caused difficulties for students in understanding the explanations given by the teacher. The students finally felt that online learning was not effective. This difficulty was not only felt by the students, but also by the teacher. Teachers consider online learning to be less effective when compared to regular face-to-face learning (Fauzi & Khusuma, 2020). The ineffectiveness of online learning above is caused by the following aspects: 1) the lack of facilities to support learning, 2) the difficulty in getting access to the network and internet, 3) the difficulty in carrying out all series of learning activities, and 4) the difficulty in cooperating with parents.

Teachers and students have a very important role in the implementation of online learning. Teachers act as facilitators of information and knowledge, and students act as learners seeking information and knowledge. Teachers collect information from various sources such as textbooks, personal notes, libraries, and others, then communicate it to students (Tamhankar et al, 2019).

Figure 3 below describes the process of knowledge transfer.

| Knowledge | ⟹ | Knowledge planned | ⟹ | Knowledge is |
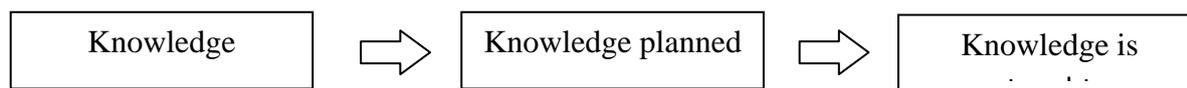
Figure 3. Didactic Transposition

In the figure above, the knowledge process should be well received by students. However, in online learning, the process does not run well. There are a lot of variables that could not be controlled either from the teacher's internal or external factors.

Actually, if looking at the survey, the pedagogical relationship between teachers and students tends to go well; even if it is seen from the learning system, teachers and students use various applications to implement an online learning system (Bakator & Radosav, 2020). However, the learning process is still conducted monotonously because it is only a one-way interaction. It is in contrast to the direct learning system that involves many directions. Online learning tends to be dominantly conducted through giving assignments via WhatsApp groups and YouTube learning video links.

In carrying out online learning, there are many applications that teachers can use to support the learning process, including Zoom, Google Meets, Whatsapp, Quizizz, Edmodo, and others. This learning focuses on the use of information technology as the main tool supported by the internet network. The video media provided is expected to be understood by students as a substitute for the teacher's explanation before daily assignments. In addition, the teacher uses a video call application using a WhatsApp group video or Zoom as a communication tool for distance teaching; the fact is that there are still many obstacles in the implementation of online learning, such as the lack of facilities, internet availability, learning systems, and collaborations between teachers and parents (Fauzi & Khusuma, 2020).

In the context of learning, when students are faced with the questions that they are not familiar with, they often experience obstacles and even confusion in solving problems. In fact, this often happens because they are faced with new information, or in Piaget's theory, this is called disequilibrium (Lovatt & Hedges, 2014). What the students can do when they experience confusion is to provide a little help so that they find a right way to overcome the problems. In Vygotsky's theory, it is called 'Scaffolding', but the teacher is not fully in control in providing the assistance. The teacher has to gradually release the assistance and give the students authority to complete it. The process of providing assistance to the students does not run well. At the end, the students still have difficulties that impact on the low score of scientific literacy.

Online learning can be implemented properly if several aspects are applied by teachers such as providing motivation and support, using various media and learning tools, conditioning students and so on (Gunawan et al., 2021). It aims to create fun and meaningful learning even in limited conditions. According Oducado et al. (2021), if fun learning can be created, it will reduce the stress level experienced by students due to boredom during online learning.

CONCLUSION

From the results of the study, it can be concluded that there was no significant relationship between online learning and scientific literacy of elementary school students. The students' lowest scientific literacy competence was in interpreting data and evidence scientifically. Online learning was considered not effective, especially in allowing the students to understand various materials. As a result, the scientific literacy ability of elementary school students was very low. It required improvement in terms of facilities and planning, implementing, and evaluating learning. This research could contribute to creating effective learning during the Covid-19 crisis. It also aimed to improve scientific literacy skills, especially in the elementary school settings.

REFERENCES

AlHamad, A. Q., Al Qawasmi, K. I., & AlHamad, A. Q. (2014). Key Factors in Determining Students' Satisfaction in Online Learning Based on'Web Programming'course within Zarqa University. *International Journal of Global Business, 7*(1), 1-7.

Almonacid-Fierro, A., Vargas-Vitoria, R., Carvalho, R. S. D., & Fierro, M. A. (2021). Impact on Teaching in Times of COVID-19 Pandemic: A Qualitative Study. *International Journal of Evaluation and Research in Education (IJERE), 10*(2), 432-440. https://doi.org/10.11591/ijere.v10i2.21129.

Bakator, M., & Radosav, D. (2020). Managing Education in the COVID-19 Era. International Conference on Information Technology and Development of Education – ITRO 2020, 1-5.

Breadmore, H. L., Vardy, E.J., Cunningham, A. J., Kwok, R. K. W., & Carroll, J. M. (2019). *Literacy Development: Evidence Review*. London: Education Endowment Foundation.

Cheng, X., Pellegrini, M., Zhou, L. & Cheung, A. C. K. (2020). Not Only Survival But Stronger: The Impact of Alarming Invader of SARS-CoV-2 on Global Education. *Science Insights Education Frontiers, 7*(2), 835-860. https://doi.org/10.15354/sief.20.or061.

Creswell J. W. (2012). *Educational Research Planning Conducting and Evaluating Quantitative and Qualitative Research. (4th edition)*. Pearson.

Dawes, J. (2008). Do Data Characteristics Change According to the Number of Scale Points Used? An Experiment Using 5-point, 7-point and 10-point Scales. *International Journal of Market Research, 50*(1), 61-77. https://doi.org/10.1177/147078530805000106.

Dwisetiarezi, D., & Fitria, Y. (2021). Analisis Kemampuan Literasi Sains Siswa pada Pembelajaran IPA Terintegrasi di Sekolah Dasar. *Jurnal Basicedu, 5*(4), 1958-1967. https://doi.org/10.31004/basicedu.v5i4.1136.

Fakhriyah, F. (2017). Student's Science Literacy in the Aspect of Content?. *Jurnal Pendidikan IPA Indonesia, 6*(1), 81-87.

Fatimah, A. S., & Santiana. (2017). Teaching in 21st Century: Students-Teachers' Perceptions of Technology Use in the Classroom. *Script Journal: Journal of Linguistic and English Teaching, 2*(2), 125-135. http://dx.doi.org/10.24903/sj.v2i2.132.

Fauzi, I., & Khusuma, I. (2020). Teachers' Elementary School in Online Learning of COVID-19 Pandemic Condition. *Jurnal Iqra': Kajian Ilmu Pendidikan, 5*(1). 58-70. https://doi.org/10.25217/ji.v5i1.914

Fauzi, I., Salim, H., & Syafrudin,. U. (2021). Online Learning Paradigm in Elementary Schools: An Evaluation by Teachers in Indonesia during COVID-19 Pandemic.

Jurnal Iqra': Kajian Ilmu Pendidikan, 6(2). 166-183. https://doi.org/10.25217/ji.v6i2.1610.

Gravemeijer, K., Stephan, M., Julie, C., Lin, F. L., & Ohtani, M. (2017). What Mathematics Education May Prepare Students for the Society of the Future? *International Journal of Science and Mathematics Education, 15*, 105–123. https://doi.org/10.1007/s10763-017-9814-6.

Gunawan, G., Kristiawan, M., Risdianto, E., & Monicha, R. E. (2021). Application of the Zoom Meeting Application in Online Learning during the Pandemic. *Education Quarterly Reviews, 4*(2), 26−32. https://doi.org/10.31014/aior.1993.04.02.193

Halrida, W.F., & Lestari, I. (2014). The Description of Science Literacy on Inquiry Model in Subect Reaction Rate. *Jurnal Pendidikan dan Pembelajaran, 3*(1), 1-13.

Hernawati, D., Amin, M., Henie, M., Nuhdhar, I., Endah, S. & Indriwati. Science literacy skills through the experience of project actVities with assisted local potential based learning materials. *Jurnal Pendidikan Biologi Indonesia. 5*(1), 159-168.

Ibrahim, M. S. & Lede, N. S. (2018). Process Skills Approach to Develop Primary Students' Scientific Literacy: A Case Study with Low Achieving Students on Water Cycle. *IOP Conf. Series: Materials Science and Engineering*, 296(2018) 012030, 1-6. https://doi.org/10.1088/1757-899X/296/1/012030.

Jufrida., Basuki, F. R., Kurniawan, W., & Pangestu, M. D. (2019). Scientific Literacy and Science Learning Achievement at Junior High School. *International Journal of Evaluation and Research in Education (IJERE), 8*(4), 630-636. http://dx.doi.org/10.11591/ijere.v8i4.20312

Kadaritna, N., Rosidin, U., Sari, N. N., & Rakhmawati, I. (2020) Identification of Scientific Literacy of Elementary School Students in Central Lampung District. *Jurnal Pendidikan Progresif, 10*(1), 133-145. https://doi.org/10.23960/jpp.v10.i1.202014.

Klimova, B., & Kacet, J. (2017). Efficacy of Computer Games on Language Learning. *TOJET: The Turkish Online Journal of Educational Technology, 16*(4), 19-26.

Koehler, M. J., & Mishra, P. (2005). Teachers Learning Technology by Design. *Journal of Computing in Teacher Education, 21*(3), 94-102.

Lestari, H., Setiawan, W., & Sikandar, R. (2020). Science Literacy Ability of Elementary Students Through Nature of Science-based Learning with the Utilization of the Ministry of Education and Culture's "Learning house". *Jurnal Penelitian Pendidikan IPA (JPPIPA), 6*(2), 215-220.https://doi.org/10.29303/jppipa.v6i2.410.

Lovatt, D., & Hedges, H. (2014). Children's Working Theories: Invoking Disequilibrium. *Early Child Development and Care, 185*(6), 909–925. https://doi.org/10.1080/03004430.2014.967688.

Marpaung, R. R. T., Yolida, B., & Putri, F. R. (2021). Student's Scientific Literacy on Environmental Pollution Material based on SETS Learning Approach Combined with Vee Diagram. *JPBI (Jurnal Pendidikan Biologi Indonesia), 7*(2), 117-125. https://doi.org/10.22219/jpbi.v7i2.15718

Mielgo-Conde, I., Seijas-Santos, S., & Grande-de-Prado, M. (2021). Review about Online Educational Guidance during the COVID-19 Pandemic. *Educational Science. 11*, 1-17. https://doi.org/10.3390/educsci11080411.

Moshinski, V., Pozniakovska, N., Mikluha, O., & Voitko, M. (2021). Modern Education Technologies: 21st Century Trends and Challenges. SHS Web of Conferences 104, 03009 (2021), 1-7.

Murati, R., & Ceka, A. (2017). The Use of Technology in Educational Teaching. *Journal of Education and Practice, 8*(6), 197-199.

Nainggolan, V. A., Situmorang, R. P., and Hastuti, S. P. (2021). Learning Bryophyta: Improving Students' Scientific Literacy through Problem-Based Learning. *JPBI*

(Jurnal Pendidikan Biologi Indonesia), *7*(1), 71-80. https://doi.org/10.22219/jpbi.v7i1.15220

Narut, Y. F., & Supardi, K. (2019). Literasi Sains Peserta Didik dalam Pembelajaran IPA di Indonesia. *Jurnal Inovasi Pendidikan Dasar, 3*(1), 61-69.

Nguyen, H. T. T. (2021). Boosting Motivation to Help Students to Overcome Online Learning Barriers in Covid-19 Pandemic: A Case Study. *International Journal of Interactive Mobile Technologies,* *15*(10), 4–20. https://doi.org/10.3991/ijim.v15i10.20319.

Oducado, R. M., Rabacal, J. S., Moralista, R. B., & Tamdang, K. A. (2021). Estrés Percibido Debido a La Pandemia de COVID-19 Entre Los Profesores Profesionales Empleados. *International Journal of Educational Research and Innovation (IJERI), 15*, 305−316. https://doi.org/10.46661/ijeri.5284

OECD (2019). *PISA 2018 Assessment and Analytical Framework*. Paris: OECD Publishing.

Selwyn, N. (2020). What's the Problem with Learning Analytics?. *Journal of Learning Analytics, 6*(3), 11–19. https://doi.org/10.18608/jla.2019.63.3.

Setiawan, D., Hartati, T., & Sopandi, W. (2019). Kemampuan Menulis Teks Eksplanasi Siswa Kelas 5 Sekolah Dasar Melalui Model Read, Answer, Disscuss, Explain, And Create. *Jurnal Ilmiah Pendidikan Dasar, 4*(1), 1-16 http://dx.doi.org/10.23969/jp.v4i1.1575

Susetyo, B. (2017). *Statistika untuk Analisis Data Penelitian*. Bandung: Refika Aditama.

Tamhankar, T. K., Pujari, V. I., & Pati, R. B. (2019). Role of Technology In Education : A 21st Century Approach. *International Journal of Scientific Research in Computer Science, Engineering and Information Technology, 5*(2), 2456-3307. https://doi.org/10.32628/CSEIT1952270.

Teräs, M., Suoranta, J., Teräs H., & Curcher, M. (2020). Post-Covid-19 Education and Education Technology 'Solutionism': A Seller's Market. *Postdigital Science and Education, 2*, 863-878.

Tümen-Akyıldız, S., Çelik, V., & Ahmed, K. H. (2021). The Impact of Covid-19 Pandemic on EFL Classes through the Lenses of Secondary Learners. *Shanlax International Journal of Education, 9*(4), 389–406. https://doi.org/10.34293/education.v9i4.4210.

Voogt, J. & Pareja, R. N. (2010). *21st Century Skills*. Enschede, the Netherlands: UnVersiteit Twente.

Widodo, A., Jumanto., Adi, Y. K., & Imran., M. E. (2019). Pemahaman Nature of Science (NOS) oleh Siswa dan Guru Sekolah Dasar. *Jurnal Inovasi Pendidikan IPA, 5*(2), 237-247. https://doi.org/10.21831/jipi.v5i2.27294.

Widodo, E., Sudibyo, E., Suryanti., Sari, D. A. P., Inzanah., & Setiawan, B. (2020). The Effectiveness of Gadget-Based Interactive Multimedia in Improving Generation Z's Scientific Literacy. *Jurnal Pendidikan IPA Indonesia, 9*(2), 248-256. https://doi.org/10.15294/jpii.v9i2.23208.

Winarni, E. W., Hambali, D., & Purwandari, E. P. (2020). Analysis of Language and Scientific Literacy Skills for 4th Grade Elementary School Students through Discovery Learning and ICT Media. *International Journal of Instruction, 13*(2), 213-222. https://doi.org/10.29333/iji.2020.13215a.

Yuliana, I., Cahyono, M. E., Widodo, W., & Irwanto. (2021). The Effect of Ethnoscience-Themed Picture Books Embedded Within ContextBased Learning on Students' Scientific Literacy. *Eurasian Journal of Educational Research, 92*(2021), 317-334.