The WE-ARe model's potential to enhance digital literacy of preservice biology teachers

by Jurnal Jpbi

The WE-ARe model's potential to enhance digital literacy of preservice biology teachers

Astuti Muh. Amin, Fitriyah Karmila, Zainal A. Laode, E. Ermin, AdjarYusrandi Akbar, Mulkah Adebisi Ahmed

For correspondence:
astutimuhamin@iain-ternate.ac.id

Abstract: In the era of globalization, digital literacy has become one of the competencies that students must possess. Rarely can one find research that examines the effect of the WE-ARe model on digital literacy in biology education. WE-ARe is a constructivist-based active learning model consisting of Warm-up, Exploring, Argumentation, and Resume phases that emphasize students' collaborative and elaborative qualities. The objective of the study was to determine the impact of the WE-ARe model on the digital literacy of future biology teacher candidates. This is a quasi-experimental study using the Pretest-Posttest Control Group Design. The research population comprised all Tadris Biology students from IAIN Ternate and STKIP Kie Raha in the City of Ternate, North Maluku, Indonesia. The research sample contained 60 fourth-semester students from the Department of Tadris Biology. The validity score for the literacy digital instrument was 3.89 (very valid), while the correlation value (r-calculated) was 0.585. The Cronbach-Alpha analysis showed a score of 0.939, indicating that the literacy digital instrument was valid and reliable for use in data collection. This study was conducted during the even semester of the 2021/2022 academic year. The data were analyzed through ANACOVA using 5% level of significance. The results demonstrated that the WE-ARe model had an impact on the preservice biology teachers' digital literacy. The findings of this study provide an insight on the use of a new learning model that can be used to enhance students' 21st century skills.

Keywords: biology education; digital literacy; preservice biology teachers; WE-ARe model

Introduction

The quality of human resources is determined by the quality of higher education, which is integral to achieving sustainable development goals (Lembani et al., 2020). The paradigm shift in the teaching and learning process necessitates that educational institutions equip students and university graduates with digital skills to deal with global competencies and the complexity of the labour market (Amin et al., 2022). Presently, the field of education employs a variety of technological tools to facilitate classroom learning (Nancy et al., 2018). The purpose of education is to teach students how to collect valid evidence to prove a point, how to do something useful and produce a product, how to inspire others and benefit themselves, and how to live with others with mutual respect, courtesy, and observance of the rules. If the concepts of communication, collaboration, critical thinking, problem-solving, creativity and innovation, and digital literacy can be implemented in the classroom, Indonesian university graduates will be fully prepared to compete in the 21st century (Abduh & Istiqomah, 2021).

Digital literacy is an umbrella framework for developing digital world knowledge, skills, and ethics (Chan

et al., 2017). It refers to the ability to confidently, safely, and effectively use a computer and software such as word processing, electronic mail, and presentation, create and edit images, audio, and video, as well as use the web (Iman & Angraini, 2019). Moreover, it is a life skill that encompasses not only the ability to use technological devices but also to socialise, have attitudes, think critically and creatively, and inspire others in their interpretation of information obtained through technological devices (Gruszczynska & Pountney, 2013). Therefore, digital literacy involves the ability to analyse, synthesise, and compare information from different sources as well as present, evaluate, and use the information ethically (Dominggus et al., 2021).

In the era of globalisation, digital literacy has become one of the competencies that students must possess. It can enhance students' digital knowledge and motivation because it encourages them to seek information from a variety of reference sources. Educators must integrate technology into learning not only because students expect it but also because the education system must keep up with developments in online research, communication, and social media. The integration of technology in the classroom prepares students to enter the 21st-century workforce (Samson et al., 2021).

Digital literacy is more than having access to and knowing how to use the digital world. It involves the ability to collaborate, communicate effectively, and behave responsibly (Adeoye & Adeoye, 2017). The use of technology in education not only increases students' digital literacy but also their conceptual comprehension (Utama et al., 2019). Furthermore, the effects of implementing technology in the classroom will feel more tangible when students receive assistance from teachers and peers in using digital tools for learning (Watson et al., 2017). Learners are typically successful in online education when they possess high levels of digital literacy and autonomy (Pepito & Acledan, 2022).

Students currently live and learn in the digital age, which allows them to cultivate curiosity, creativity, and scientific literacy in addressing the fundamental problems of life and society (Bhatnagar, 2019). Integrating digital content into the classroom can enhance the learning experience and makes it easier for teachers to implement appropriate learning models for optimal learning (Lestari et al., 2020). Digital literacy can also influence students' learning outcomes or academic success (Purnamasari et al., 2021). A high level of digital literacy can help students face online risks (Helsper & Smahel, 2019). In 2019, 43.5% of the 270 million people in Indonesia had access to the internet (Statistik, 2020) and this number has continued to rise during the COVID-19 pandemic. The convenience of internet access has a significant impact on students' reading and writing activities. When educators have technological proficiency, they can assist their students with technical learning issues so that they are not distracted from pedagogical aspects and classroom learning (Waldrip B & Prain, 2016). Information and communication technology (ICT) helps students develop a stronger interest in learning according to most (91%) educators (Fraillon et al., 2019).

WE-ARe is a constructivist-based active learning model comprised of four phases: Warm-up, Exploring, Argumentation, and Resume (Amin, 2022a). This learning model emphasises collaborative and creative student activities and has been shown to increase preservice biology teachers' learning motivation, critical thinking skills, metacognitive skills, argumentation skills, and concept mastery (Amin & Corebima, 2016). However, this study involved students with more homogeneous social background and sufficient learning facilities, therefore, a more in-depth analysis was performed with students from Ternate, North Maluku, who have more diverse cultural backgrounds based on the digital literacy variables.

Overall, the WE-ARe stages are effective in fostering positive student perceptions and responses, as well as boosting student confidence in higher education. Self-efficacy increases students' interest in academic activities (Amin, 2022b). However, this study used a limited number of samples and research groups, so future research should include a substantial number of samples from the experimental, positive, and negative control classes. The findings of this study are expected to demonstrate how students' self-confidence in the WE-ARe classroom might contribute to improved digital literacy in the argumentation and elaboration phases.

Despite the widespread adoption of the WE-ARe model, studies evaluating its impact on students' acquisition of digital literacy skills in the context of biology education are rare. Students' scores on the ability to search for information were higher than their scores on the four indicators measuring their ability to use different sources of information, select relevant sources, evaluate information based on the credibility of the source, and consider relevant sources and consequences (Bahri et al., 2022). Previous research indicators were also employed by the present researchers but the learning models and study participants were different. Internet connections in eastern Indonesia frequently fail and become less stable when the weather is bad. The availability of the internet has a profound impact on student's ability to read and write, thus IT use can be maximised if students can read and then write to express their ideas (Makur, 2019), which is possible within the WE-ARe framework.

The above theoretical research highlights the significance of designing learning environments that support students' growth in digital literacy. An active, innovative, and 21st-century learning-based pedagogy can help solve the issues surrounding digital literacy by improving the standard of education. In this investigation, we asked, "Does the WE-ARe model have any impact on the digital literacy of students preparing to become biology teachers?" to determine how the WE-ARe model affected the

students' digital literacy as they prepared to become biology teachers. Lecturers today are expected to be creative problem solvers who can help students develop the life skills necessary to thrive in the modern world. The WE-ARe model can be used to encourage preservice biology instructors to actively develop knowledge and experiences in biological sciences through collaboration. The use of the WE-ARe learning syntax and digital literacy skills allows the more broad and in-depth study of biological subjects. Indeed, the WE-ARe model has the potential to increase preservice biology teachers' self-confidence, self-regulation, and ability to consistently develop biology and other knowledge in the digital globalisation era.

Method

This investigation used a quasi-experimental design with digital literacy as the dependent variable and the WE-ARe model as the independent variable. The learning syntax of the WE-ARe model consists of four phases, namely warm-up, exploring, argumentation, and resume. Table 1, shows the pre-test/post-test control group design.

Table 1. The pre-test/post-test control group design.

Group	Pre-test	Treatment	Post-test
Experimental	O_1	WE-ARe	O_2
Positive Control	O_3	STAD	O_4
Negative Control	O_5	Conventional	O_6

Notes:
O_1 = Pre-test score of the experimental group (implementing the WE-ARe model)
O_2 = Post-test score of the experimental group (implementing the WE-ARe model)
O_3 = Pre-test score of the positive control group (implementing the cooperative STAD model)
O_4 = Post-test score of the positive control group (implementing the cooperative STAD model)
O_5 = Pre-test score of the negative control group (implementing conventional learning)
O_6 = Post-test score of the negative control group (implementing conventional learning)
X = Treatment by implementing the WE-ARe model

The study involved 60 4th year Tadris Biology students from IAIN Ternate and STKIP Kie Raha in Ternate, North Maluku, Indonesia. Before determining the research sample, a test of equivalence was administered in which students were asked to answer questions from a placement test which had been subjected to expert and empirical validation and confirmed as valid and reliable. There were three treatment classes, each contained twenty students. Biology A from IAIN Ternate functioned as the experimental group, taught with the integrated WE-ARe. Biology B from IAIN Ternate was the positive control group, taught with STAD cooperative learning. Biology A from STIKIP Kie Raha Ternate served as the negative control group, taught with conventional models. The sample was determined after conducting an equivalence test to the students, through a placement test. The study was conducted during the even semester of the academic year 2021-2022.

The validity test was carried out by correlating each item score with the total score using the Product Moment Correlation technique. If the correlation coefficient rxy was greater than the Product Moment r_{table} then the instrument item was declared valid as a data collection tool. The validity test was performed at the significance level ($a = 0.05$) where the r_{table} was 0.433. The validity test showed a score of 0.585 for all the digital literacy test items and because the $r_{calculated}$ was greater than the r_{table}, the instrument was declared valid for data collection. Meanwhile, the expert validation of the test had a mean score of 3.89 (very high).

The questionnaire's reliability was tested using the Alpha-Cronbach formula. The item was declared reliable if the Alpha-Cronbach value was bigger than 0.6. The Alpha-Cronbach value for the digital literacy test was 0.939, thus it was considered reliable for data collection.

Data on students' digital literacy was obtained through a digital literacy questionnaire using a Likert scale. This questionnaire measures four dimensions of digital literacy, namely internet searching, hypertextual navigation, content evaluation, and knowledge assembly. Data related to digital literacy was also obtained through observation sheets that refer to the following dimensions: internet searching, hypertextual navigation, content evaluation, and knowledge assembly.

The data were analysed through analysis of covariance (ANCOVA) using a 5% significance level in SPSS after normality and homogeneity of variance tests were conducted. The data normality was examined using the One-Sample Kolmogrov-Smirnov test, while the homogeneity of the variance was assessed using Levene's Test of Equality of Error Variances.

Results and Discussion

Observation sheets and questionnaires were used to collect data on digital literacy ability in the WE-ARE experimental group, the STAD positive control group, and the conventional control group. There is a significant difference in the mean posttest scores in the three groups. Descriptive data analysis for the three groups can be found in Table 2.

Table 2. The treatment groups' minimum and maximum pre-test and post-test scores on digital literacy

Descriptive Statistics	Experimental Group WE-ARe		Positive Control Group STAD		Negative Control Group Conventional	
	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test
N	20	20	20	20	20	20
Minimum	37.25	80.67	39.04	66.38	37.71	44.21
Maximum	46	87.46	49.46	74	46.67	52.42
Mean	42.1945	84.2285	45.2225	70.625	40.989	48.4735
Std. Deviation	2.10107	2.05143	2.54107	2.22828	2.64194	2.17758

The normality of the data was examined using the *Kolmogorov-Smirnov* method with $\alpha=0.05$ serving as the decision criterion, confirming that the digital literacy pre-and post-test data were normally distributed as shown in Table 3.

Table 3. The results of the normality test

Score	Group	Kolmogorov-Smirnova	Sig.	Remarks
Pre-test Digital Literacy	Experimental Group WE-ARe	0.092	.200*	distributed normally
	Positive Control Group STAD	0.182	0.081	distributed normally
	Negative Control Group Conventional	0.177	0.099	distributed normally
Post-test Digital Literacy	Experimental Group WE-ARe	0.097	.200*	distributed normally
	Positive Control Group STAD	0.174	0.114	distributed normally
	Negative Control Group Conventional	0.16	0.195	distributed normally

Levene's test was then used to assess the homogeneity of the data indicating that the research data had homogeneous variance as shown in Table 4.

Table 4. The results of the homogeneity test on the research data

Variable	Levene Statistics	Sig.	Remarks
Pre-test Digital Literacy	0.372	0.691	Homogeneous variance
Post-test Digital Literacy	0.126	0.882	Homogeneous variance

The research hypothesis was tested using analysis of covariance (ANCOVA) to investigate the effect of the WE-ARe model on students' digital literacy, with pre-test score as the covariance as shown in Table 5. The ANCOVA results indicated that there was a difference between the experimental group and control groups in terms of digital literacy, that is, the WE-ARe model positively, and significantly impacted students' digital literacy.

Table 5. The ANCOVA results

Tests of Between-Subjects Effects

Dependent Variable: Post-test Digital Literacy

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	13044.062[a]	3	4348.021	981.444	.000
Intercept	629.322	1	629.322	142.052	.000
Pre-test_Digital_Literacy	16.301	1	16.301	3.679	.060
Group	12085.842	2	6042.921	1364.021	.000
Error	248.093	56	4.430		
Total	288904.614	60			
Corrected Total	13292.155	59			

a. R Squared = .981 (Adjusted R Squared = .980)

After the implementation of the WE-ARe model, the experimental group obtained a post-test mean score of 84.2285 which was higher than that achieved by the positive control (70.625) or the negative control (48.4735) groups. Thus, the WE-ARe model is more effective than STAD and conventional learning models in enhancing preservice biology teachers. However, differences in their sociocultural background (multicultural), cognitive ability, and level of IT knowledge impacted their post-test scores. The internet network in North Maluku remains fragile, especially during the rainy season. Also, students needed more time to adapt to the WE-ARe model syntax, particularly during the elaboration and argumentation phases, because they had been used to traditional teaching techniques, such as lectures and paper assignments. To circumvent these limitations, we offered participants additional time to acclimatise to the WE-ARe syntax, as well as provided them with e-book files and online links connected to the lesson. Furthermore, we aided participants in the elaboration phase and improved their confidence in the argumentation phase. Classroom learning becomes more dynamic and entertaining when students are digitally literate and digital literacy is critical for students' academic success, especially in meeting the predetermined learning objectives (Khan et al., 2022).

Indonesian students have low levels of digital literacy (Perdana et al., 2020), an essential predictor of success among today's youth (Asrizal et al., 2018). However, digital literacy is challenging to establish in the classroom since pupils are less interested in using digital platforms to learn. Many educators, particularly in developing countries, still require training to increase their knowledge and skills in using ICT and online learning platforms (Rini et al., 2022). Furthermore, because students in Indonesia are a digitally native generation, parents must join them as they study at home (Davidson, 2012).

Data analysis suggests that the We-ARe model can improve preservice biology teachers' digital literacy. As mentioned previously, digital literacy refers to the ability to receive information from various computer-based forms (Vodă et al., 2022) and along with study skills and life skills, is required in the 21st century. Radovan discovered that digital literacy has a favourable impact on academic attainment (Radovan, 2014), leading to more efficient task completion using software and computer programmes such as word processors and worksheets (Argentin et al., 2014). Other studies have found that using technology such as e-text and e-library has a positive impact on students, as they enable students to create good, creative, and current presentations (Kranzow & Hyland, 2011). Indeed, learners that utilise technology widely and intensively are more likely to adapt learning strategies from multiple sources to help the online learning process (Watson et al., 2017). Therefore, digital technology has a positive effect on students' self-directed learning through facilities and features to access online information (Curran et al., 2019).

The *Warm-up* phase in WE-ARe provides space for students to access the internet during the learning process. At this stage, students should be provided with website links that correspond to lecture materials to facilitate access to relevant learning materials. In addition, they should be provided with an e-book file related to the subject matter and be instructed on how to conduct web searches on their smartphones or laptops to access a variety of information pertinent to the topic discussed in class. These activities will pique students' interest and promote their literacy, particularly in terms of sorting pertinent information according to their learning needs. Students' digital literacy can be enhanced if they study biology by searching relevant websites for information (Ambarwati et al., 2019) and will encourage students to engage in more information analysis (Setiawan et al., 2021). Also, students can improve their digital literacy skills by motivating each other and working together to achieve a goal (Hazar, 2019; Mudra, 2020; Norte et al., 2017).

The *Exploring* phase in WE-ARe can stimulate students' problem-solving skills. At this stage, students are trained to analyse, synthesise, and compare information obtained from various sources. In addition, they are encouraged to use a web browser and internet search appropriately and effectively by entering keywords pertinent to their learning needs. The search for such information can facilitate the problem-solving process. Besides, at this stage, students are allowed to share information with their peers to develop personalised problem-solving analyses. Thus, this phase allows students to engage in

collaborative learning while using online media responsibly. Students' psychological conditions and independence in using ICT can also affect their digital literacy (Mnyanda & Mbelani, 2018).

The *Argumentation* phase of WE-ARe learning provides students with opportunities to analyse evidence and generate arguments based on information gleaned from diverse information media. Students can access websites, YouTube, electronic journals, and other resources to bolster their arguments. In this instance, students should be trained to use computers and other electronic devices responsibly, safely, and effectively for data processing, thereby becoming competent in using computers/laptops for presentations, presenting data, and creative in presenting comprehensible information effectively. To improve students' digital literacy, instructors must be digitally literate themselves as this will promote a more relaxed and enjoyable teaching process (Pratolo & Solikhati, 2021). Critical thinking abilities are vital for university students because they help them become critical consumers of information who can respond properly to scientific discoveries (Amin et al., 2022). In the classroom context, there is a link between students' critical thinking and digital literacy (Visser & Flynn, 2018) so implementing learning models that promote students' ability to generate logical and reasoned arguments and make reflective decisions will help them build critical thinking skills (Purwanti et al., 2022).

The *Resume* phase of WE-ARe learning gives students the option of using smartphone or laptop applications to record and summarise the gathered information. Students can utilise technological sophistication to review previously acquired information and learning experiences. In this instance, students should be trained to evaluate strategies and self-regulate their learning reflectively. By seeking out additional relevant learning resources, students can enhance their accessibility and digital literacy. The Resume stage has the potential to develop students' critical thinking skills which is not easy because students have poor metacognitive skills, fixed mindsets, and biased thinking is an effort (Persky et al., 2019). Other aspects that intervene in the representation of critical thinking skills are outside knowledge, intensive justification, and critical judgment. Research shows that assessment can show weaknesses in students' critical thinking dispositions (Beckmann & Weber, 2015; Sadaf et al., 2021).

Digital literacy is the information literacy required to access, analyse, and produce information from digital devices. However, the implementers of digital literacy (teachers/lecturers, schools/colleges, and students) face obstacles that impede the successful implementation of digital literacy. It is challenging to successfully practice digital literacy if the education system has limited funding capacity and technology and if students are not prepared to learn with technology (Pratolo & Solikhati, 2021). Digital self-efficacy can be defined as an individual's confidence in selecting technology tools according to their goals, as well as in organising, developing, and employing these tools. Those with a high level of digital self-efficacy are aware of which technological tools should be used for which purposes, and they try to identify and solve these technological issues (Aslan, 2021). To prepare for industrial revolution 4.0, university students need to increase their digital literacy (Arjaya et al., 2023; Saxena et al., 2018). A person with sufficient digital literacy abilities may examine and incorporate digital information into his accomplishments in addition to being proficient in using technology (Le et al., 2022). Technology in learning can be used as a driving force in achieving learning success (Haleem et al., 2022).

Several factors, including socioeconomic status, cultural/ethnic background, gender, and disciplinary specialisation, can influence students' ICT use (Scherer & Siddiq, 2019). In addition, the nature and frequency of internet use by students vary according to their ages and socioeconomic status (Acun, 2020; Harris et al., 2017). Also, age, educational background, gender, educational institution, and personal preferences can influence an individual's digital literacy (Karagul et al., 2021). Typically, high levels of digital literacy are found primarily in urban areas due to the convenience of having ready access to necessary network infrastructure and facilities (Rundel & Salemink, 2021).

Conclusion

The WE-ARe model positively impacted preservice biology teachers' digital literacy. The WE-ARe model was proven effective to increase student activity and collaboration in constructing scientific knowledge, providing opportunities for students to develop digital literacy, help strengthen their biological concepts, and strengthen their reasoning power regarding everyday biological problems. Further studies should determine the influence of the model on variables such as science process skills, problem-solving skills, creative thinking skills, metacognitive skills, and concept mastery, both in terms of academic ability and gender and multiethnic differences.

Acknowledgement

Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

Author Contributions

A. M. Amin: Data curation; Writing-original draft; Methodology and analysis; Writing — review and editing. **F. Karmila:** Analysis and review; Writing — review and editing. **Z. A. Laode:** Writing — review and editing. E. **Ermin:** Writing — review and editing. **E. S. Salimzyanova:** Writing — review and editing. **M. A. Ahmed:** Writing — review and editing.

References

Abduh, M., & Istiqomah, A. (2021). Analisis muatan hots dan kecakapan abad 21 pada buku siswa kelas V tema ekosistem di Sekolah Dasar. *Jurnal Basicedu*, *5*(4), 2069–2081. https://doi.org/10.31004/basicedu.v5i4.1124.

Acun, I. (2020). The relationship among university students' trust, self-esteem, satisfaction with life and social media use1. *International Journal of Instruction*, *13*(1), 35–52. https://doi.org/10.29333/iji.2020.1313a

Adeoye, A. A., & Adeoye, B. J. (2017). Digital literacy skills of undergraduate students in Nigeria Universities. *Library Philosophy and Practice (e-Journal)*, *1665*, 1–23. https://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=4736&context=libphilprac

Ambarwati, R., Faizah, U., & Rahayu, D. A. (2019). Enhancing the digital literacy of pre-service biology teacher through animal systematics course. *Advances in Computer Science Research*, *95*, 197–201. https://doi.org/10.2991/miseic-19.2019.46

Amin, A. M. (2022a). Self-Efficacy mahasiswa biologi setelah penerapan model WE-ARe (warm-up, exploring, argumentation, resume). *Jurnal AL-Nafis*, *2*(1), 117–128. http://journal.iain-ternate.ac.id/index.php/Al-Nafis/article/view/768

Amin, A M, Corebima, A. D., Zubaidah, S., & Mahanal, S. (2020). The correlation between metacognitive skills and critical thinking skills at the implementation of four different learning strategies in animal physiology lectures. *European Journal of Educational Research*, *9*(1), 143–163. https://doi.org/10.12973/eu-jer.9.1.143

Amin, A. M. (2022b). *Model WE-ARe dalam tantangan pembelajaran abad 21*. Akademia Pustaka. https://scholar.google.com/citations?view_op=view_citation&hl=en&user=02Z9EFQAAAAJ&sortby=pubdate&citation_for_view=02Z9EFQAAAAJ:OU6Ihb5iCvQC

Amin, A. M., & Corebima, A. D. (2016). Analisis persepsi dosen terhadap strategi pembelajaran reading questioning and answering (RQA) dan argument-driven inquiry (ADI). *Prosiding Seminar Nasional II Tahun 2016, Kerjasama Prodi Pendidikan Biologi FKIP Dengan Pusat Studi Lingkungan Dan Kependudukan (PSLK) Universitas Muhammadiyah Malang*, *November 2017*, 333–347. https://www.researchgate.net/publication/321144722_Analisis_Persepsi_Dosen_terhadap_Strategi_Pembelajaran_Reading_Questiong_and_Answering_RQA_dan_Argument-Driven_Inquiry_ADI_pada_Program_Studi_Pendidikan_Biologi_di_Kota_Makassar

Amin, H., Malik, M. A., & Akkaya, B. (2022). Development and validation of digital literacy scale (DLS) and its implication for higher education. *International Journal of Distance Education and E-Learning*, *7*(1), 24–43. https://doi.org/10.36261/ijdeel.v7i1.2224

Argentin, G., Pennisi, A., Vidoni, D., Abbiati, G., & Caputo, A. (2014). Trying to raise (low) math achievement and to promote (rigorous) policy evaluation in Italy: Evidence from a Large-scale randomized trial. *Evaluation Review*, *38*(2), 99–132. https://doi.org/10.1177/0193841X14529125.

Arjaya, I. B. A., Hermawan, I. M. S., Ekayanti, N. W., & Paraniti, A. A. I. (2023). Metacognitive contribution to biology pre-service teacher's digital literacy and self-regulated learning during online learning. *International Journal of Instruction*, *16*(1), 455–468. https://doi.org/10.29333/iji.2023.16125a

Aslan, S. (2021). Analysis of digital literacy self-efficacy levels of pre-service teachers. *International Journal of Technology in Education*, *4*(1), 56–67. https://doi.org/doi.org/10.46328/ijte.47

Asrizal, A., Amran, A., Ananda, A., Festiyed, F., & Sumarmin, R. (2018). The development of integrated science instructional materials to improve students digital literacy in scientific approach. *Jurnal Pendidikan IPA Indonesia*, *7*(4), 442–450. https://doi.org/10.15294/jpii.v7i4.13613

Bahri, A., Jamaluddin, A., Novia, A. A., & Saparuddin. (2022). Students' and teachers' digital literacy skill: A comparative study between schools, classes, and genders in urban and rural areas. *International Journal of Science and Research*, *11*(2), 184–191.

https://doi.org/10.21275/SR22130101519

Beckmann, J., & Weber, P. (2015). Cognitive presence in virtual collaborative learning: Assessing and improving critical thinking in online discussion forums. *International Association for Development of the Information Society, 13*(1), 51–58. https://files.eric.ed.gov/fulltext/ED562486.pdf

Chan, B. S. K., Churchill, D., & Chiu, T. K. F. (2017). Digital literacy learning in higher education through digital storytelling approach. *Journal of International Education Research (JIER), 13*(1), 1–16. https://doi.org/10.19030/jier.v13i1.9907

Curran, V., Gustafson, D. L., Simmons, K., Lannon, H., Wang, C., Garmsiri, M., Fleet, L., & Wetsch, L. (2019). Adult learners' perceptions of self-directed learning and digital technology usage in continuing professional education: An update for the digital age. *Journal of Adult and Continuing Education, 25*(1), 74–93. https://doi.org/10.1177/1477971419827318

Davidson, C. (2012). Seeking the green basilisk lizard: Acquiring digital literacy practices in the home. *Journal of Early Childhood Literacy, 12*(1), 24–45. https://doi.org/10.1177/1468798411416788

Dominggus, R., Kristin, S., Martha M, B., Since Y, K., Vera V, K., & CorneliLatu, P. (2021). Resource based learning design thinking (RBLDT): A model to Improve students' creativez thinking skills, concept gaining, and digital literacy. *Cypriot Journal of Educational Sciences, 16*(1), 288–302. https://doi.org/10.18844/cjes.v16i1.5528

Fraillon, J., Ainley, J., Schulz, W., Friedman, T., & Duckworth, D. (2019). *Preparing for life in a digital world: The IEA international computer and information literacy study 2018 international report*. Australian Council for Educational Research (ACER). https://www.iea.nl/sites/default/files/2019-11/ICILS 2019 Digital final 04112019.pdf

Gruszczynska, A., & Pountney, R. (2013). Developing the concept of digital literacy in the context of schools and teacher education. *Enhancing Lerning in the Social Science, 5*(1), 25–36. https://doi.org/10.11120/elss.2013.05010025

Haleem, A., Javaid, M., Qadri, M. A., & Suman, R. (2022). Understanding the role of digital technologies in education: A review. *Sustainable Operations and Computers, 3*(February), 275–285. https://doi.org/10.1016/j.susoc.2022.05.004

Harris, C., Straker, L., & Pollock, C. (2017). A socioeconomic related "digital divide" exists in how, not if, young people use computers. *PLoS ONE, 12*(3), 1–13. https://doi.org/10.1371/journal.pone.0175011

Hazar, Z. (2019). An analysis of the relationship between digital game playing motivation and digital game addiction among children. *Asian Journal of Education and Training, 5*(1), 31–38. https://doi.org/10.20448/journal.522.2019.51.31.38

Helsper, E. J., & Smahel, D. (2019). Excessive internet use by young Europeans: Psychological vulnerability and digital literacy? *Information, Communication & Society, 23*(9), 1–19. https://doi.org/10.1080/1369118x.2018.1563203

Iman, J. N., & Angraini, N. (2019). Discussion task model in EFL classroom: EFL learners' perception, oral proficiency, and critical thinking achievements. *Pedagogika, 133*(1), 43–62. https://doi.org/https://doi.org/10.15823/p.2019.133.3

Karagul, B. I., Seker, M., & Aykut, C. (2021). Investigating students' digital literacy levels during online education due to COVID-19 pandemic. *Sustainability, 13*(11878). https://doi.org/10.3390/su132111878

Khan, N., Sarwar, A., Chen, T. ., & Khan, S. (2022). Connecting digital literacy in higher education to the 21st Century workforce. *Knowledge Management & E-Learning, 14*(1), 45–61. https://doi.org/10.34105/j.kmel.2022.14.004

Kranzow, J., & Hyland, N. (2011). Marketing climate: New considerations for target marketing in graduate student enrollment management. *Journal of College Admission, 211*, 22–25. https://files.eric.ed.gov/fulltext/EJ926820.pdf

Le, B., Lawrie, G. A., & Wang, J. T. H. (2022). Student self-perception on digital literacy in STEM blended learning environments. *Journal of Science Education and Technology, 31*(3), 303–321. https://doi.org/10.1007/s10956-022-09956-1

Lembani, R., Gunter, A., Breines, M., & Dalu, M. T. B. (2020). The same course, different access: The digital divide between urban and rural distance education students in South Africa. *Journal of Geography in Higher Education, 44*(1), 70–84. https://doi.org/10.1080/03098265.2019.1694876

Makur, A. P. (2019). The influence of PQ4R strategy and mathematical reasoning ability towards mathematical communication skills. *SJME (Supremum Journal of Mathematics Education), 3*(1), 18–31. https://doi.org/10.35706/sjme.v3i1.1467

Mnyanda, L., & Mbelani, M. (2018). Are we teaching critical digital literacy? grade 9 learners ' practices of digital communication. *Reading & Writing, 9*(1), 1–9. https://doi.org/10.4102/rw.v9i1.188

Mudra, H. (2020). Digital literacy among young learners: How do efl teachers and Learners view its benefits and barriers? *Teaching English with Technology, 20*(3), 3–24. http://cejsh.icm.edu.pl/cejsh/element/bwmeta1.element.desklight-b96ae22d-d0db-4654-8326-ff613391cb2a

Nancy, L., Woo, D., de la Torre, J., & Wong, G. (2018). A global framework of reference on digital

literacy skills for indicator 4.4.2. In *UNESCO Institute for Statistics*. https://uis.unesco.org/sites/default/files/documents/ip51-global-framework-reference-digital-literacy-skills-2018-en.pdf

Norte, P., Negreiros, J., & Correia, A. (2017). Cultivating students' reading literacy using digital lexile based reading in a Chinese Primary School. *International Conference on Cognition and Exploratory Learning in Digital Age (CELDA 2017)*, *2*, 51–59. https://files.eric.ed.gov/fulltext/ED579453.pdf

Pepito, M. J. T., & Acledan, M. Y. (2022). Influence of digital literacy and self-directed learning in the online learning success of STEM college students. *International Journal of Humanities Social Sciences and Education*, *9*(1), 88–100. https://doi.org/10.20431/2349-0381.0901007

Perdana, R., Jumadi, J., Rosana, D., & Riwayani, R. (2020). The online laboratory simulation with concept mapping and problem based learning (OLS-CMPBL): Is it effective in improving students' digital literacy skills? *Cakrawala Pendidikan*, *39*(2), 382–394. https://doi.org/10.21831/cp.v39i2.31491

Persky, A. M., Medina, M. S., & Castleberry, A. N. (2019). Developing critical thinking skills in pharmacy students. *American Journal of Pharmaceutical Education*, *83*(2), 7033–7042. https://doi.org/10.5688/ajpe7033

Pratolo, B. W., & Solikhati, H. A. (2021). Investigating teachers' attitude toward digital literacy in EFL classroom. *Journal of Education and Learning (EduLearn)*, *15*(1), 97–103. https://doi.org/10.11591/edulearn.v15i1.15747

Purnamasari, L., Herlina, K., Distrik, I. W., & Andra, D. (2021). Students' digital literacy and collaboration abilities: An analysis in Senior High School students. *Indonesian Journal of Science and Mathematics Education*, *4*(1), 48–57. https://doi.org/10.24042/ijsme.v4i1.8452

Purwanti, A., Hujjatusnaini, N., Septiana, N., Jasiah, J., & Amin, A. M. (2022). Analisis keterampilan berpikir Kritis mahasiswa melalui model blended-project based learning terintegrasi keterampilan abad 21 berdasarkan students skill. *JIPI (Jurnal IPA dan Pembelajaran IPA)*, *6*(3), 235–245. https://doi.org/10.24815/jipi.v6i3.25128

Radovan, V. (2014). Digital literacy as a prerequisite for achieving good academic performance. *Information Literacy. Lifelong Learning and Digital Citizenship in the 21st Century*, 160–169. https://doi.org/10.1007/978-3-319-14136-7_17

Rini, R., Mujiyati, Sukamto, I., & Hariri, H. (2022). The Effect of self-directed learning on students' digital literacy levels in online learning. *International Journal of Instruction*, *15*(3), 329–344. https://doi.org/10.29333/iji.2022.15318a

Rundel, C., & Salemink, K. (2021). Education sciences bridging digital Inequalities in rural schools in Germany: A geographical lottery? *Education Sciences*, *11*(181), 1–18. https://doi.org/10.18844/cjes.v16i1.5528

Sadaf, A., Wu, T., & Martin, F. (2021). Cognitive presence in online learning: A systematic review of empirical research from 2000 to 2019. *Computers and Education Open*, *2*, 100050. https://doi.org/10.1016/j.caeo.2021.100050

Samson, N. L., Boyles, L. Z., & Arnado, A. A. (2021). Spiral progression approach: digital literacy and competency in teaching science. *International Journal of Education and Research*, *9*(9), 111–120. https://www.ijern.com/journal/2021/September-2021/09.pdf

Saxena, P., Gupta, S. K., Mehrotra, D., Kamthan, S., Sabir, H., Katiyar, P., & Sai Prasad, S. V. (2018). Assessment of digital literacy and use of smart phones among Central Indian dental students. *Journal of Oral Biology and Craniofacial Research*, *8*(1), 40–43. https://doi.org/10.1016/j.jobcr.2017.10.001

Scherer, R., & Siddiq, F. (2019). The relation between students' socioeconomic status and ICT literacy: Findings from a meta-analysis. *Computers and Education*, *138*(0317), 13–32. https://doi.org/10.1016/j.compedu.2019.04.011

Selfa S. M., & Llovera M. L. (2016). Scientific studies on literacy and digital literacy indexed in scopus: A literature review (2000-2013). *Actualidades Pedagógicas*, *67*, 197. https://doi.org/10.19052/ap.3579

Setiawan, D., Mahanal, S., & Zubaidah, S. (2021). RICOSRE: Effect and potential to enhance biology students' digital literacy at Universitas Negeri Malang. *AIP Conference Proceedings*, *2330*(030041). https://doi.org/10.1063/5.0043139

Statistik, B. P. (2020). *Statistik telekomunikasi Indonesia 2019*. Badan Pusat Statistik. https://www.bps.go.id/publication/2020/12/02/be999725b7aeee62d84c6660/statistik-telekomunikasi-indonesia-2019.html

Utama, C., Sajidan, Nurkamto, J., & Wiranto. (2019). Investigating biology pre-service teacher perception of general biology and digital literacy. *IOP Conference Series: Earth and Environmental Science*, *243*(012046), 012046. https://doi.org/10.1088/1755-1315/243/1/012046

Visser, R., & Flynn, A. B. (2018). What are students' learning and experiences in an online learning tool designed for cognitive and metacognitive skill development? *Collected Essays on Learning and Teaching*, *11*(1), 129–140. https://doi.org/10.22329/celt.v11i0.5039

Vodă, A. I., Cautisanu, C., Grădinaru, C., Tănăsescu, C., & de Moraes, G. H. S. M. (2022). Exploring digital literacy skills in economics and social sciences and humanities students. *Sustainability (Switzerland)*, *14*(5), 1–31. https://doi.org/10.3390/su14052483

Waldrip B, & Prain, V. (2016). *Using multimodal representations to support learning in the science classroom.* Springer International Publishing. https://doi.org/10.1007/978-3-319-16450-2

Watson, F. F., Castano Bishop, M., & Ferdinand-James, D. (2017). Instructional strategies to help online students learn: Feedback from online students. *TechTrends*, *61*(5), 420–427. https://doi.org/10.1007/s11528-017-0216-y

The WE-ARe model's potential to enhance digital literacy of preservice biology teachers

9   Internet Source   1 %

10   www.koreascience.or.kr
     Internet Source   <1 %

11   Rohmani Nur Indah, Toyyibah, Ary Setya   <1 %
     Budhiningrum, Nur Afifi. "The Research
     Competence, Critical Thinking Skills and
     Digital Literacy of Indonesian EFL Students",
     Journal of Language Teaching and Research,
     2022
     Publication

12   Submitted to Universitas Brawijaya
     Student Paper   <1 %

13   ummaspul.e-journal.id
     Internet Source   <1 %

14   Submitted to Walden University
     Student Paper   <1 %

15   digilib.iain-palangkaraya.ac.id
     Internet Source   <1 %

16   dokumen.pub
     Internet Source   <1 %

17   www.un-pub.eu
     Internet Source   <1 %

18   Rahmat Rizal, Dadi Rusdiana, Wawan   <1 %
     Setiawan, Parsaoran Siahaan. "Development

of a Problem-Based Learning Management System-Supported Smartphone (PBLMS3) Application Using the ADDIE Model to Improve Digital Literacy", International Journal of Learning, Teaching and Educational Research, 2021
Publication

19   www.cips-indonesia.org
Internet Source   <1%

20   Cem Işık, Sümeyra Yılmaz. "E-learning in life long education: A computational approach to determining listening comprehension ability", Education and Information Technologies, 2010
Publication   <1%

21   I D T Putri, R Ambarwati. "An Effort in Teaching Invertebrates and Training Digital Literacy to the Students", Journal of Physics: Conference Series, 2019
Publication   <1%

22   www.atlantis-press.com
Internet Source   <1%

23   Achmad Lutfi, Rusly Hidayah, Rusly Hidayah, Fitria Aftinia, Fitria Aftinia, Nurulita Ipmawati, Nurulita Ipmawati. "House of Chemistry as a Hydrocarbon Learning Media for High School Students", Educación Química, 2023
Publication   <1%

24 Submitted to University College London
Student Paper
<1%

25 ejournal.uin-malang.ac.id
Internet Source
<1%

26 www.ijsr.net
Internet Source
<1%

27 Submitted to Laguna State Polytechnic University
Student Paper
<1%

28 docksci.com
Internet Source
<1%

29 jppipa.unram.ac.id
Internet Source
<1%

30 www.hkr.se
Internet Source
<1%

31 Samsul Maarif, Nelly Fitriani. "MATHEMATICAL RESILIENCE, HABITS OF MIND, AND SOCIOMATHEMATICAL NORMS BY SENIOR HIGH SCHOOL STUDENTS IN LEARNING MATHEMATICS: A STRUCTURED EQUATION MODEL", Infinity Journal, 2023
Publication
<1%

32 arcjournals.org
Internet Source
<1%

33 jppe.ppe.or.kr
Internet Source

<1 %

34 repository.unej.ac.id
Internet Source

<1 %

35 Delia Hillmayr, Lisa Ziernwald, Frank Reinhold, Sarah I. Hofer, Kristina M. Reiss. "The potential of digital tools to enhance mathematics and science learning in secondary schools: A context-specific meta-analysis", Computers & Education, 2020
Publication

<1 %

36 journal.unnes.ac.id
Internet Source

<1 %

37 mingycomputersgh.files.wordpress.com
Internet Source

<1 %

38 uir.unisa.ac.za
Internet Source

<1 %

39 www.ejmste.com
Internet Source

<1 %

40 Poppy Sari Dewi, Heru Kuswanto. "The effectiveness of the use of augmented reality-assisted physics e-module based on pedicab to improve mathematical communication and critical thinking abilities", Journal of Technology and Science Education, 2023
Publication

<1 %

| 41 | academic-publishing.org
Internet Source | <1% |

| 42 | digitalcommons.liberty.edu
Internet Source | <1% |

| 43 | www.academypublication.com
Internet Source | <1% |

| 44 | Chengfei Zhao, Lina Wu, Xuewen Wang, Shaohuang Weng, Zhipeng Ruan, Qicai Liu, Liqing Lin, Xinhua Lin. "Quaternary ammonium carbon quantum dots as an antimicrobial agent against gram-positive bacteria for the treatment of MRSA-infected pneumonia in mice", Carbon, 2020
Publication | <1% |

| 45 | Muhammad Erwinto Imran, Wahyu Sopandi, Bachruddin Mustafa, Cepi Riyana. "Improving primary school teachers' competence in teaching multi-literacy through RADEC-based training programs", Cypriot Journal of Educational Sciences, 2021
Publication | <1% |

| 46 | Nanang Supriadi, Sunarto Sunarto, Putri Oktaviana, Fredi Ganda Putra. "MATHEMATICAL CONCEPT UNDERSTANDING ABILITY AND SELF-REGULATED LEARNING: THE EFFECT OF QUICK ON THE DRAW | <1% |

STRATEGY", AKSIOMA: Jurnal Program Studi Pendidikan Matematika, 2021
Publication

47 Submitted to School of Business and Management ITB
Student Paper   <1%

48 Shufang Cheng. "Exploring the role of translators' emotion regulation and critical thinking ability in translation performance", Frontiers in Psychology, 2022
Publication   <1%

49 dergipark.org.tr
Internet Source   <1%

50 digitalcommons.unl.edu
Internet Source   <1%

51 dspace.nwu.ac.za
Internet Source   <1%

52 egitimvebilim.ted.org.tr
Internet Source   <1%

53 id.123dok.com
Internet Source   <1%

54 ijonmes.net
Internet Source   <1%

55 ir.jkuat.ac.ke
Internet Source   <1%

56 repo.ppb.ac.id
Internet Source
<1%

57 worldwidescience.org
Internet Source
<1%

58 www.e-iji.net
Internet Source
<1%

59 "QASEE: A Potential Learning Model to Improve the Critical Thinking Skills of Pre-service Teachers with Different Academic Abilities", European Journal of Educational Research, 2020
Publication
<1%

60 MARK JOHN T. PEPITO, MICHELLE Y. ACLEDAN EdD. "Influence of Digital Literacy and Self-Directed Learning in the Online Learning Success of STEM College Students", International Journal of Humanities, Social Sciences and Education, 2022
Publication
<1%

61 Citra Ayu Dewi, Nurdianti Awaliyah, Nurin Fitriana, Satya Darmayani, Nasrullah, Jan Setiawan, Irwanto Irwanto. "Using Android-Based E-Module to Improve Students' Digital Literacy on Chemical Bonding", International Journal of Interactive Mobile Technologies (iJIM), 2022
Publication
<1%

Research Article/Article Review

The WE-ARe Model's Potential to Enhance Digital Literacy of Preservice Biology Teachers

ABSTRACT (10PT)

In the era of globalization, digital literacy has become one of the competencies that students must possess. Rarely can one find research that examines the effect of the WE-ARe model on digital literacy in biology education. WE-ARe is a constructivist-based active learning model consisting of Warm-up, Exploring, Argumentation, and Resume phases that emphasize students' collaborative and elaborative qualities. The objective of the study was to determine the impact of the WE-ARe model on the digital literacy of future biology teacher candidates. This is a quasi-experimental study using the Pretest-Posttest Control Group Design. The research population comprised all Tadris Biology students from IAIN Ternate and STKIP Kie Raha in the City of Ternate, North Maluku, Indonesia. The research sample contained 60 fourth-semester students from the Department of Tadris Biology. The research instruments consisted of valid and reliable survey and questionnaire sheets. This study was conducted during the even semester of the 2021/2022 academic year. The data were analyzed through ANACOVA using 5% level of significance. The results demonstrated that the WE-ARe model had an impact on the preservice biology teachers' digital literacy. The findings of this study provide an insight on the use of a new learning model that can be used to enhance students' 21st century skills.

Commented [WU1]: It will be better Add the score!

Akan lebih baik Tambahkan skor!

INTRODUCTION

The quality of human resources is determined by the quality of higher education, which is integral to achieving sustainable development goals (Lembani et al., 2020). The paradigm shift in the teaching and learning process necessitates that educational institutions equip students and university graduates with digital skills to deal with global competencies and the complexity of the labor market (Amin et al., 2022). Presently, the field of education employs a variety of technological tools to facilitate the classroom learning process (Nancy et al., 2018). The purpose of education should be to teach students how to collect valid evidence to prove a point, how to do something useful and produce a product, how to inspire others and benefit themselves, and how to live with others with mutual respect, courtesy, and observance of the rules. If the concepts of communication, collaboration, critical thinking, problem solving, creative and innovative, and digital literacy can be implemented in the classroom, Indonesian university graduates will be able and prepared to compete in the 21st century with qualified personalities and skills (Abduh & Istiqomah, 2021).

Digital literacy is an umbrella framework for developing digital world knowledge, skills, and ethics (Chan et al., 2017). Digital literacy refers to the ability to confidently, safely, and effectively use a computer, use software

such as word processing, electronic mail, and presentation software, create and edit images, audio, and video, as well as use the web (Iman & Angraini, 2019). Digital literacy is a life skill that encompasses not only the ability to use technological devices, but also the ability to socialize, to have attitudes, to think critically and creatively, and to inspire others in their interpretation of information obtained through technological devices (Gruszczynska & Pountney, 2013). Digital literacy includes the ability to analyze, synthesize, compare information from different sources as well as present, evaluate, and use the information ethically (Dominggus et al., 2021).

In the era of globalization, digital literacy has become one of the competencies that students must possess. Digital literacy can enhance students' digital knowledge and motivation because it encourages them to seek information from a variety of reference sources. Educators must integrate technology in learning, not only because students expect it, but also because the education system must keep up with developments in online research, communication, and social media. The integration of technology in the classroom prepares students to enter the twenty-first century workforce (Samson et al., 2021).

Digital literacy is more than having access to and knowing how to use the digital world. Digital literacy involves the ability to collaborate, communicate effectively, and behave responsibly (Adeoye & Adeoye, 2017). The use of technology in education not only increases students' digital literacy, but also their conceptual comprehension (Utama et al., 2019). The effects of implementing technology in the classroom will feel more tangible when students receive assistance from teachers and peers in using digital tools for learning (Hillmayr, 2020). Learners are typically successful in online education when they possess high levels of digital literacy and autonomy (Pepito & Acledan, 2022).

Students currently live and learn in the digital age, which affords them the opportunity to cultivate curiosity, creativity, and scientific literacy in addressing the fundamental problems of life and society (Bhatnagar, 2019). Integrating digital content into the classroom can enhance the learning experience. This practice also makes it easier for teachers to implement appropriate learning models in the classroom, allowing for optimal learning to occur (Lestari et al., 2020). Digital literacy can also influence the learning outcomes or academic success of students (Purnamasari et al., 2021).

A high level of digital literacy can help students face online risks (Helsper & Smahel, 2019). In 2019, 43.5% of the 270 million people in Indonesia had access to the internet (Statistik, 2020). This number continues to rise during the COVID-19 pandemic learning stage. The convenience of Internet access has a significant impact on the reading and writing activities of students. When educators have technological proficiency, they will be able to assist their students with technical learning issues so that they are not distracted from pedagogical aspects and classroom learning (Waldrip B & Prain, 2016). Information and communication technology (ICT) helps students develop a stronger interest in learning, according to ninety-one percent (91%) of educators (Fraillon et al., 2019).

WE-ARe is a constructivist-based active learning model comprised of four phases: Warm-up, Exploring, Argumentation, and Resume. This learning model emphasizes collaborative and creative student activities. This model has been shown to increase preservice biology teachers' learning motivation, critical thinking skills, metacognitive skills, argumentation skills, and concept mastery (A. M. Amin, 2020). Overall, the WE-ARe learning model's stages are effective in fostering positive student perceptions and responses, as well as boosting student confidence in higher education. Self-efficacy increase students' interest in academic activities (A. M. Amin, 2022)

Despite the widespread adoption of the WE-ARe model, studies evaluating its impact on students' acquisition of digital literacy skills in the context of biology education are still uncommon. Students' scores on the ability to search for information were higher than their scores on the four indicators measuring their ability to use different sources of information, select relevant sources, evaluate information based on the credibility of the source, and consider relevant sources and consequences (Bahri et al., 2022). The availability of the internet has a profound impact on students' ability to read and write. Advantage can be taken of the fact that students can read and then write to express their ideas, thus maximizing the use of IT (Makur, 2019). Researchers think this might be possible within the WE-ARe framework.

The above theoretical research highlights the significance of designing learning environments that support students' growth in digital literacy. An active, innovative, and 21st-century learning-based pedagogy can help solve the issues surrounding digital literacy by improving the standard of education. In this investigation, we asked, "Does the WE-ARe model have any impact on the digital literacy of students preparing to become biology teachers?" The research aimed to see how the WE-ARe model affected the students' digital literacy as they prepared to become biology teachers. Lecturers today are expected to be creative problem solvers who can help students develop the life skills necessary to thrive in the 21st century world.

Commented [WU2]: State of the art is not showing up…?

Suggestion; please analyze and find deficiencies/limitations of various related previous studies, so that the urgency of this research is more clearly visible. After that, convey the contribution of previous research in this research and the usefulness of your research in the future.

mohon dianalisis dan dicari kekurangan/keterbatasan dari berbagai penelitian sebelumnya yang terkait, agar urgensi penelitian ini lebih jelas terlihat. Setelah itu, sampaikan kontribusi penelitian sebelumnya dalam penelitian ini dan kegunaan penelitian Anda di masa mendatang.

METHOD

This investigation used a quasi-experimental design. In this study, digital literacy was the dependent variable, and the WE-ARe model was the independent variable. The learning syntax of the WE-ARe model consists of four phases, namely warm-up, exploring, argumentation, and resume.

Table 1. The Pretest-Posttst Control Group Design

Group	Prestest	Treatment	Posttest
Experimental	O_1	WE-ARe	O_2
Positive Control	O_3	STAD	O_4
Negative Control	O_5	Conventional	O_6

Notes:

O_1 = Pretest score of the experimental group (implementing the WE-ARe model)

O_2 = Posttest score of the experimental group (implementing the WE-ARe model)

O_3 = Pretest score of the positive control group (implementing the cooperative STAD model)

O_4 = Posttest score of the positive control group (implementing the cooperative STAD model)

O_5 = Pretest score of the negative control group (implementing conventional learning)

O_6 = Posttest score of the negative control group (implementing conventional learning)

X = *Treatment* by implementing the WE-ARe model

All Tadris Biology students from IAIN Ternate and STKIP Kie Raha in Ternate, North Maluku, Indonesia, constituted the study population. The research sample consisted of sixty fourth-year biology students from the Department of Tadris Biology. Before determining the research sample, a test of equivalence was administered in which students were asked to answer questions from a placement test. Before being implemented in the field, these questions were subjected to expert and empirical validation. The results of the validation indicated that all test questions were valid and reliable. The research was conducted during the even semester of the academic year 2021-2022.

> **Commented [WU3]:** It will be better Add the score!
>
> Akan lebih baik Tambahkan skor!

Data on students' digital literacy was obtained through a digital literacy questionnaire using a Likert scale. This questionnaire measures four dimensions of digital literacy, namely internet searching, hypertextual navigation, content evaluation, and knowledge assembly. Data related to digital literacy was also obtained through observation sheets that refer to the following dimensions: internet searching, hypertextual navigation, content evaluation, and knowledge assembly.

Data analysis was performed through analysis of covariance (ANCOVA) using 5% significance level on SPSS. Prior to ANCOVA, tests of normality and homogeneity of variance were conducted. Normality of the data was examined using the One-Sample Kolmogrov-Smirnov test, while homogeneity of the variance was examined using the Levene's Test of Equality of Error Variances.

RESULTS AND DISCUSSION

Descriptive data analysis was performed to the pre- and post-test scores of the experimental, positive control, and negative control groups. Table 1 displays the minimum scsore, maximum score, mean score, and standard deviation reported by the experimental and control groups.

> **Commented [WU4]:** We recommend that in conveying opinions in discussions multiply more relevant citations and from research journal sources
> Suggestion: you should not only use one paragraph of one citation, and use references from journals equivalent to sinta 2 or above!
>
> Sebaiknya dalam menyampaikan pendapat dalam diskusi perbanyak kutipan yang relevan dan dari sumber jurnal penelitian
> Saran: sebaiknya tidak hanya menggunakan satu paragraf dari satu kutipan, dan gunakan referensi dari jurnal yang setara dengan sinta 2 atau lebih!

Table 1. The Treatment Groups' Minimum and Maximum Pretest and Posttests Scores on Digital Literacy

Descriptive Statistics	Experimental Group WE-ARe		Positive Control Group STAD		Negative Control Group Conventional	
	Pretest	*Posttest*	*Pretest*	*Posttest*	*Pretest*	*Posttest*
N	20	20	20	20	20	20
Minimum	37.25	80.67	39.04	66.38	37.71	44.21
Maximum	46	87.46	49.46	74	46.67	52.42
Mean	42.1945	84.2285	45.2225	70.625	40.989	48.4735
Std. Deviation	2.10107	2.05143	2.54107	2.22828	2.64194	2.17758

As shown in Table 1, the experimental group obtained a mean pretest score of 42.1945 with a standard deviation of 2.10107. The mean pre-test score of the positive control group was 45.2225, with a standard deviation of 2.54107. The mean pre-test score of the negati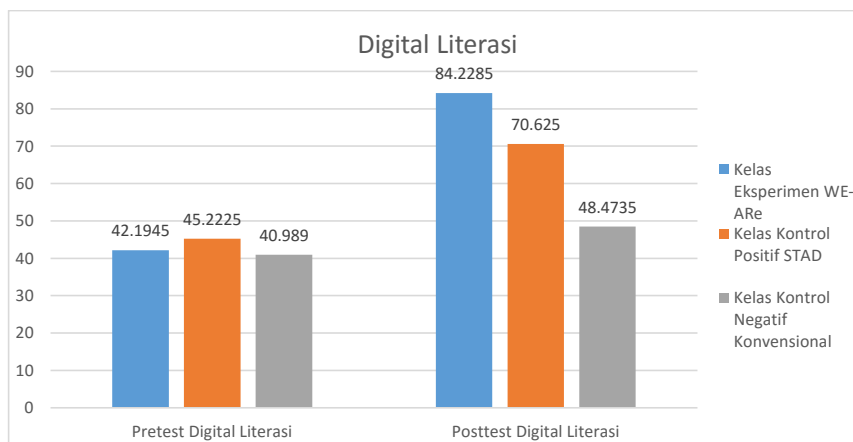ve control group was 40.989, with a standard deviation of 2.6419. As indicated by the mean pretest scores, the digital literacy of students in the three groups was comparable prior to treatment.

Meanwhile, following the treatment, the experimental group obtained a mean score of 84.2285 with a standard deviation of 2.05143. The mean pre-test score of the positive control group was 70.625, with a standard deviation of 2.2282. The mean pre-test score of the negative control group was 48.4735, with a standard deviation of 2.17758.

Figure 1. Participants' Pre- and Post-test Scores on Digital Literacy

Prior to conducting the analysis of covariance, data normality and homogeneity of variance were examined. The normality of the data was examined using the *Kolmogorov-Smirnov* method, with α=0.05 serving as the decision criterion. If the significance probability (p) is greater than 0.05, the data are normally distributed; if it is less than 0.05, the data are not normally distributed. If the research data are normally distributed, testing can be performed using parametric methods; if the data are not normally distributed, testing is performed using non-parametric methods. The homogeneity of variance was examined using the Levene's test. If the probability of significance or p> 0.05, then the data is considered homogeneous, whereas if p<0.05, the data is not homogeneous. Table 2 displays the results of the Kolmogrov-Smirnov test used to assess the normality of the data for the experimental group and the control group.

Table 2. The Results of the Normality Test on the Research Data

Score	Group	Kolmogorov-Smirnova	Sig.	Remarks
Digital Literacy-Pretest	Experimental Group WE-ARe	0.092	.200*	distributed normally
	Positive Control Group STAD	0.182	0.081	distributed normally
	Negative Control Group Konvensional	0.177	0.099	distributed normally
Digital Literacy-Posttest	Experimental Group WE-ARe	0.097	.200*	distributed normally
	Positive Control Group STAD	0.174	0.114	distributed normally
	Negative Control Group Konvensional	0.16	0.195	distributed normally

Based on Table 2, the p-value of the pretest and posttest scores reported by all treatment groups was bigger

than 0.05 (p>0.05), indicating that the research data were distributed normally. The results of the Levene's test of homogeneity are presented in Table 3.

Table 3. The Results of the Homogeneity Test on the Research Data

Variable	Levene Statistics	Sig.	Remarks
Digital Literacy-Pretest	0.372	0.691	Homogeneous variance
Digital Literacy-Posttest	0.126	0.882	Homogeneous variance

Based on Table 3, the p-value of the pretest and posttest scores reported by all treatment groups was bigger than 0.05 (p>0.05), indicating that the research data had homogeneous variance. The research hypothesis was tested using analysis of covariance (ANCOVA). The ANCOVA was performed to investigate the effect of the WE-ARe model on students' digital literacy, with pretest score as the covariance. Table 4 shows the results of the ANCOVA.

Table 4. The ANCOVA Results

Tests of Between-Subjects Effects

Dependent Variable: Posttest Digital Literacy

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	13044.062[a]	3	4348.021	981.444	.000
Intercept	629.322	1	629.322	142.052	.000
Pretest_Digital_Literacy	16.301	1	16.301	3.679	.060
Group	12085.842	2	6042.921	1364.021	.000
Error	248.093	56	4.430		
Total	288904.614	60			
Corrected Total	13292.155	59			

a. R Squared = .981 (Adjusted R Squared = .980)

Table 4 explains the difference in digital literacy between the experimental group and the control groups. F-calculated of 1364.021 and a significance level of 0.000 (which is smaller than alpha 5% or 0.05) indicated that there was a difference between the experimental group and control groups in terms of digital literacy. In other words, the WE-ARe model had a significant impact on students' digital literacy.

After the implementation of the WE-ARe model, the experimental group obtained a mean score of 84.2285 on the posttest. This score is higher than that achieved by the positive control group (70.625) or the negative control group (48.4735). Based on this finding, it can be explained that the WE-ARe model was more effective than STAD and conventional learning models in enhancing preservice biology teachers.

Data analysis suggests that the We-ARe model can stimulate the improvement of preservice biology teachers' digital literacy. The stages of the WE-ARe model have been shown to increase the digital literacy of the study's participants. Digital literacy refers to the ability to receive information from various computer-based forms (Gilster, 1997). Digital literacy, along with study skills and life skills, is required in the 21st century.

The *Warm-up* phase in WE-ARe provides space for students to access the internet during the learning process. At this stage, students should be provided with website links that corresponded to lecture materials to facilitate access to relevant learning materials. In addition, they should be provided with an e-book file related to the subject matter. The students need to be instructed on how to conduct web searches on their smartphones or laptops to access a variety of information pertinent to the topic discussed in class. These activities will be able to pique students' interest and promote their literacy, particularly in terms of sorting relevant and pertinent information according to their learning needs. Students' digital literacy can be enhanced if they study biology by searching relevant websites for information (Ambarwati et al., 2019). Digital literacy can encourage students to engage in more information analysis (Setiawan et al., 2021).

The *Exploring* phase in WE-ARe can stimulate students' problem-solving skills. At this stage, students are trained to analyze, synthesize, and compare information obtained from various sources. In addition, they are encouraged to use a web browser and internet search appropriately and effectively by entering keywords pertinent to their learning needs. The search for such information can facilitate the problem-solving process. Besides, at this stage, students are allowed to share information with their peers to develop personalized problem-solving analyses. Thus, this phase provides a space for students to engage in collaborative learning while using online media responsibly.

Commented [WU5]: Based on Figure 1. The data findings are very good, unfortunately the findings discussed are still around the positive findings, while the negative findings have not been discussed, for example why the posttest score only reached 84.2285, what about the deficiencies?? Why did that happen, what are the obstacles and solutions in the future, please multiply the discussion points of view!

Berdasarkan Gambar 1. Data temuan sangat bagus, sayangnya temuan yang dibahas masih berkisar pada temuan positif, sedangkan temuan negatif belum dibahas, misalnya skor posttest hanya mencapai 84,2285, bagaimana dengan kekurangannya?? Mengapa itu terjadi, apa kendala dan solusi ke depannya, tolong perbanyak sudut pandang diskusi!

The *Argumentation* phase of WE-ARe learning provides students with opportunities to analyze evidence and generate arguments based on information gleaned from diverse information media. Students can access websites, YouTube, electronic journals, and other resources to bolster their arguments. In this instance, students should be trained to use computers and other electronic devices responsibly, safely, and effectively for data processing. Thus, they become competent in using computers/laptops for presentations, presenting data, and creative in presenting comprehensible information effectively. To improve students' digital literacy, instructors must be digitally literate themselves. When educators are digitally literate, the teaching process is typically more relaxed and enjoyable (Pratolo & Solikhati, 2021).

The *Resume* phase of WE-ARe learning gives students the option of using smartphone or laptop applications to record and summarize the information they have gathered. Students can utilize technological sophistication to review previously acquired information and learning experiences. In this instance, students should be trained to evaluate strategies and self-regulate their learning reflectively. By seeking out additional relevant learning resources, students can enhance their accessibility and digital literacy.

Digital literacy is the information literacy required to access, analyze, and produce information from digital devices. However, the implementers of digital literacy (teachers/lecturers, schools/colleges, and students) face obstacles that impede the successful implementation of digital literacy. It is challenging to successfully practice digital literacy if the education system has limited funding capacity and technology, and if students are not prepared to learn with technology (Pratolo & Solikhati, 2021). Digital self-efficacy can be defined as an individual's confidence in selecting technology tools in accordance with their goals, as well as in organizing, developing, and employing these tools. Those with a high level of digital self-efficacy are aware of which technological tools should be used for which purposes, and they try to identify and solve these technological issues (Aslan, 2021).

Several factors, including socioeconomic status, cultural/ethnic background, gender, and disciplinary specialization, can influence students' ICT use (Kennedy et al., 2008). In addition, the nature and frequency of internet use by students vary according to their ages and socioeconomic status (Livingstone & Bober, 2004). Age, educational background, gender, educational institution, and personal preferences can influence an individual's digital literacy (Karagul et al., 2021). High levels of digital literacy are found primarily in urban areas due to the convenience of having ready access to necessary network infrastructure and facilities (Rundel & Salemink, 2021).

CONCLUSION

Based on the research findings and data analysis, it can be concluded that the WE-ARe model had a positive impact on preservice biology teachers' digital literacy. This finding is confirmed by the mean score achieved by the experimental group (84.2285), which is higher than that obtained by the positive control group (70.625) or the negative control group (48.4735). The results of this study can provide insights into the implementation of new learning models that can promote 21st-century skills in the classroom. The development of this model can also be investigated further to determine its influence on variables such as science process skills, problem-solving skills, creative thinking skills, metacognitive skills, and concept mastery, both in terms of academic ability and gender and multiethnic differences.

> **Commented [WU6]:** Conclusions should no longer discuss research data anymore, convey various research findings that answer research objectives
>
> Kesimpulan seharusnya tidak lagi membahas data penelitian, menyampaikan berbagai temuan penelitian yang menjawab tujuan penelitian

ACKNOWLEDGMENT

REFERENCES

> **Commented [WU7]:**

Abduh, M., & Istiqomah, A. (2021). Analisis Muatan Hots dan Kecakapan Abad 21 pada Buku Siswa Kelas V

Tema Ekosistem di Sekolah Dasar. *Jurnal Basicedu*, *5*(4), 2069–2081. https://doi.org/10.31004/basicedu.v5i4.1124.

Adeoye, A. A., & Adeoye, B. J. (2017). Digital Literacy Skills of Undergraduate Students in Nigeria Universities. *Library Philosophy and Practice (e-Journal)*, *1665*, 1–23. https://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=4736&context=libphilprac.

Ambarwati, R., Faizah, U., & Rahayu, D. A. (2019). Enhancing the Digital Literacy of Pre-Service Biology Teacher through Animal Systematics Course. *Advances in Computer Science Research*, *95*, 197–201. https://doi.org/10.2991/miseic-19.2019.46

Amin, A. M. (2020). *Pengaruh Model Reading, Questioning, and Answering (RQA) Dipadu Argument-Driven Inquiry (ADI) pada Kemampuan Akademik Berbeda terhadap Motivasi, Keterampilan Berpikir Kritis, Keterampilan Metakognitif, Keterampilan Argumentasi, Penguasaan Konsep*. Disertasi Tidak Diterbitkan. Malang: Universitas Negeri Malang.

Amin, A. M. (2022). Self-Efficacy Mahasiswa Biologi Setelah Penerapan Model WE-ARe (Warm-up, Exploring, Argumentation, Resume). *Jurnal AL-Nafis*, *2*(1), 117–128. http://journal.iain-ternate.ac.id/index.php/Al-Nafis/issue/view/85/showToc

Amin, H., Malik, M. A., & Akkaya, B. (2022). Development and Validation of Digital Literacy Scale (DLS) and its Implication for Higher Education. *International Journal of Distance Education and E-Learning*, *7*(1), 24–43. https://doi.org/10.36261/ijdeel.v7i1.2224

Aslan, S. (2021). Analysis of Digital Literacy Self-Efficacy Levels of Pre-service Teachers. *International Journal of Technology in Education*, *4*(1), 56–67. https://doi.org/doi.org/10.46328/ijte.47.

Bahri, A., Jamaluddin, A., Novia, A. A., & Saparuddin. (2022). Students' and Teachers' Digital Literacy Skill: A Comparative Study between Schools, Classes, and Genders in Urban and Rural Areas. *International Journal of Science and Research*, *11*(2), 184–191. https://doi.org/10.21275/SR22130101519

Chan, B. S. K., Churchill, D., & Chiu, T. K. F. (2017). Digital Literacy Learning In Higher Education Through Digital Storytelling Approach. *Journal of International Education Research (JIER)*, *13*(1), 1–16. https://doi.org/10.19030/jier.v13i1.9907

Dominggus, R., Kristin, S., Martha M B., Since Y, K., Vera V, K., & CorneliLatu, P. (2021). Resource Based Learning Design Thinking (RBLDT): A Model to Improve Students ' Creative Thinking Skills , Concept Gaining, and Digital Literacy. *Cypriot Journal of Educational Sciences*, *16*(1), 288–302. https://un-pub.eu/ojs/index.php/cjes/article/view/5528

Fraillon, J., Ainley, J., Schulz, W., Friedman, T., & Duckworth, D. (2019). *Preparing for Life in a Digital World: The IEA International Computer And Information Literacy Study 2018 International Report*. Australian Council for Educational Research (ACER). https://www.iea.nl/sites/default/files/2019-11/ICILS 2019 Digital final 04112019.pdf.

Gilster, P. (1997). *Digital Literacy*. Wiley Computer Publications.

Gruszczynska, A., & Pountney, R. (2013). Developing the Concept of Digital Literacy in the Context of Schools and Teacher Education. *Enhancing Lerning in the Social Science*, *5*(1), 25–36. https://doi.org/10.11120/elss.2013.05010025.

Helsper, E. J., & Smahel, D. (2019). Excessive Internet Use by Young Europeans: Psychological Vulnerability and Digital Literacy? *Information, Communication & Society*, 1–19. https://doi.org/10.1080/1369118x.2018.1563203.

Iman, J. N., & Angraini, N. (2019). Discussion Task Model in EFL Classroom: EFL Learners' Perception, Oral Proficiency, and Critical Thinking Achievements. *Pedagogika*, *133*(1), 43–62. https://doi.org/https://doi.org/10.15823/p.2019.133.3

Karagul, B. I., Seker, M., & Aykut, C. (2021). Investigating Students' Digital Literacy Levels during Online Education Due to COVID-19 Pandemic. *Sustainability*, *13*(11878). https://doi.org/10.3390/su132111878

Kennedy, G., Krause, K.-L., Judd, T., Churchward, A., & Gray, K. (2008). First-Year Students' Experiences with Technology: Are They Really Digital Natives? *Australasian Journal of Educational Technology*, *24*(1), 108–122. https://doi.org/10.14742/ajet.1233.

Lembani, R., Gunter, A., Breines, M., & Dalu, M. T. B. (2020). The Same Course, Different Access: the Digital Divide between Urban and Rural Distance Education Students in South Africa. *Journal of Geography in Higher Education*, *44*(1), 70–84. https://doi.org/10.1080/03098265.2019.1694876

Livingstone, S., & Bober, M. (2004). Taking Up Online Opportunities? Children's use of the Internet for Education, Communications, and Participation. *E-Learning*, *1*(3), 395–419.

Makur, A. P. (2019). The Influence of PQ4R Strategy And Mathematical Reasoning Ability Towards

7

Mathematical Communication Skills. *SJME (Supremum Journal of Mathematics Education)*, *3*(1), 18–31. https://doi.org/10.35706/sjme.v3i1.1467

Nancy, L., Woo, D., de la Torre, J., & Wong, G. (2018). A Global Framework of Reference on Digital Literacy. *UNESCO Institute for Statistics*. https://www.researchgate.net/publication/326223206_A_Global_Framework_of_Reference_on_Digital_Literacy_Skills_for_Indicator_442

Pepito, M. J. T., & Acledan, M. Y. (2022). Influence of Digital Literacy and Self-Directed Learning in the Online Learning Success of STEM College Students. *International Journal of Humanities Social Sciences and Education*, *9*(1), 88–100. https://doi.org/10.20431/2349-0381.0901007

Pratolo, B. W., & Solikhati, H. A. (2021). Investigating Teachers' Attitude toward Digital Literacy in EFL Classroom. *Journal of Education and Learning (EduLearn)*, *15*(1), 97–103. https://doi.org/10.11591/edulearn.v15i1.15747.

Purnamasari, L., Herlina, K., Distrik, I. W., & Andra, D. (2021). Students' Digital Literacy and Collaboration Abilities: An Analysis in Senior High School Students. *Indonesian Journal of Science and Mathematics Education*, *4*(1), 48–57. https://doi.org/10.24042/ijsme.v4i1.8452.

Rundel, C., & Salemink, K. (2021). Education Sciences Bridging Digital Inequalities in Rural Schools in Germany : A Geographical Lottery ? *Education Sciences*, *11*(181), 1–18. https://doi.org/10.18844/cjes.v16i1.5528.

Samson, N. L., Boyles, L. Z., & Arnado, A. A. (2021). Spiral Progression Approach: Digital Literacy and Competency in Teaching Science. *International Journal of Education and Research*, *9*(9), 111–120. https://www.ijern.com/journal/2021/September-2021/09.pdf.

Setiawan, D., Mahanal, S., & Zubaidah, S. (2021). RICOSRE: Effect and Potential to Enhance Biology Students' Digital Literacy at Universitas Negeri Malang. *AIP Conference Proceedings, 2330*(030041). https://doi.org/10.1063/5.0043139.

Statistik, B. P. (2020). *Statistik Telekomunikasi Indonesia 2019*. Badan Pusat Statistik. https://www.bps.go.id/publication/2021/10/11/e03aca1e6ae93396ee660328/statistik-telekomunikasi-indonesia-2020.html.

Utama, C., Sajidan, Nurkamto, J., & Wiranto. (2019). Investigating Biology Pre-service Teacher Perception of General Biology and Digital Literacy. *IOP Conference Series: Earth and Environmental Science*, *243*(012046). https://doi.org/10.1088/1755-1315/243/1/012046.

Waldrip B, & Prain, V. (2016). *Using Multimodal Representations to Support Learning in the Science Classroom.* Springer International Publishing. https://doi.org/10.1007/978-3-319-16450-2

Research Article/Article Review

Commented [J1]: delete

The WE-ARe Model's Potential to Enhance Digital Literacy of Preservice Biology Teachers

ABSTRACT (10PT)

In the era of globalization, digital literacy has become one of the competencies that students must possess. Rarely can one find research that examines the effect of the WE-ARe model on digital literacy in biology education. WE-ARe is a constructivist-based active learning model consisting of Warm-up, Exploring, Argumentation, and Resume phases that emphasize students' collaborative and elaborative qualities. The objective of the study was to determine the impact of the WE-ARe model on the digital literacy of future biology teacher candidates. This is a quasi-experimental study using the Pretest-Posttest Control Group Design. The research population comprised all Tadris Biology students from IAIN Ternate and STKIP Kie Raha in the City of Ternate, North Maluku, Indonesia. The research sample contained 60 fourth-semester students from the Department of Tadris Biology. The research instruments consisted of valid and reliable survey and questionnaire sheets. This study was conducted during the even semester of the 2021/2022 academic year. The data were analyzed through ANACOVA using 5% level of significance. The results demonstrated that the WE-ARe model had an impact on the preservice biology teachers' digital literacy. The findings of this study provide an insight on the use of a new learning model that can be used to enhance students' 21st century skills.

INTRODUCTION

The quality of human resources is determined by the quality of higher education, which is integral to achieving sustainable development goals (Lembani et al., 2020). The paradigm shift in the teaching and learning process necessitates that educational institutions equip students and university graduates with digital skills to deal with global competencies and the complexity of the labor market (Amin et al., 2022). Presently, the field of education employs a variety of technological tools to facilitate the classroom learning process (Nancy et al., 2018). The purpose of education should be to teach students how to collect valid evidence to prove a point, how to do something useful and produce a product, how to inspire others and benefit themselves, and how to live with others with mutual respect, courtesy, and observance of the rules. If the concepts of communication, collaboration, critical thinking, problem solving, creative and innovative, and digital literacy can be implemented in the classroom, Indonesian university graduates will be able and prepared to compete in the 21st century with qualified personalities and skills (Abduh & Istiqomah, 2021).

Digital literacy is an umbrella framework for developing digital world knowledge, skills, and ethics (Chan et al., 2017). Digital literacy refers to the ability to confidently, safely, and effectively use a computer, use software

such as word processing, electronic mail, and presentation software, create and edit images, audio, and video, as well as use the web (Iman & Angraini, 2019). Digital literacy is a life skill that encompasses not only the ability to use technological devices, but also the ability to socialize, to have attitudes, to think critically and creatively, and to inspire others in their interpretation of information obtained through technological devices (Gruszczynska & Pountney, 2013). Digital literacy includes the ability to analyze, synthesize, compare information from different sources as well as present, evaluate, and use the information ethically (Dominggus et al., 2021).

In the era of globalization, digital literacy has become one of the competencies that students must possess. Digital literacy can enhance students' digital knowledge and motivation because it encourages them to seek information from a variety of reference sources. Educators must integrate technology in learning, not only because students expect it, but also because the education system must keep up with developments in online research, communication, and social media. The integration of technology in the classroom prepares students to enter the twenty-first century workforce (Samson et al., 2021).

Digital literacy is more than having access to and knowing how to use the digital world. Digital literacy involves the ability to collaborate, communicate effectively, and behave responsibly (Adeoye & Adeoye, 2017). The use of technology in education not only increases students' digital literacy, but also their conceptual comprehension (Utama et al., 2019). The effects of implementing technology in the classroom will feel more tangible when students receive assistance from teachers and peers in using digital tools for learning (Hillmayr, 2020). Learners are typically successful in online education when they possess high levels of digital literacy and autonomy (Pepito & Acledan, 2022).

Students currently live and learn in the digital age, which affords them the opportunity to cultivate curiosity, creativity, and scientific literacy in addressing the fundamental problems of life and society (Bhatnagar, 2019). Integrating digital content into the classroom can enhance the learning experience. This practice also makes it easier for teachers to implement appropriate learning models in the classroom, allowing for optimal learning to occur (Lestari et al., 2020). Digital literacy can also influence the learning outcomes or academic success of students (Purnamasari et al., 2021).

A high level of digital literacy can help students face online risks (Helsper & Smahel, 2019). In 2019, 43.5% of the 270 million people in Indonesia had access to the internet (Statistik, 2020). This number continues to rise during the COVID-19 pandemic learning stage. The convenience of Internet access has a significant impact on the reading and writing activities of students. When educators have technological proficiency, they will be able to assist their students with technical learning issues so that they are not distracted from pedagogical aspects and classroom learning (Waldrip B & Prain, 2016). Information and communication technology (ICT) helps students develop a stronger interest in learning, according to ninety-one percent (91%) of educators (Fraillon et al., 2019).

WE-ARe is a constructivist-based active learning model comprised of four phases: Warm-up, Exploring, Argumentation, and Resume. This learning model emphasizes collaborative and creative student activities. This model has been shown to increase preservice biology teachers' learning motivation, critical thinking skills, metacognitive skills, argumentation skills, and concept mastery (A. M. Amin, 2020). Overall, the WE-ARe learning model's stages are effective in fostering positive student perceptions and responses, as well as boosting student confidence in higher education. Self-efficacy increase students' interest in academic activities (A. M. Amin, 2022)

Despite the widespread adoption of the WE-ARe model, studies evaluating its impact on students' acquisition of digital literacy skills in the context of biology education are still uncommon. Students' scores on the ability to search for information were higher than their scores on the four indicators measuring their ability to use different sources of information, select relevant sources, evaluate information based on the credibility of the source, and consider relevant sources and consequences (Bahri et al., 2022). The availability of the internet has a profound impact on students' ability to read and write. Advantage can be taken of the fact that students can read and then write to express their ideas, thus maximizing the use of IT (Makur, 2019). Researchers think this might be possible within the WE-ARe framework.

The above theoretical research highlights the significance of designing learning environments that support students' growth in digital literacy. An active, innovative, and 21st-century learning-based pedagogy can help solve the issues surrounding digital literacy by improving the standard of education. In this investigation, we asked, "Does the WE-ARe model have any impact on the digital literacy of students preparing to become biology teachers?" The research aimed to see how the WE-ARe model affected the students' digital literacy as they prepared to become biology teachers. Lecturers today are expected to be creative problem solvers who can help students develop the life skills necessary to thrive in the 21st century world.

Commented [J2]: apa kontribusi penelitian ini? Khususnya bagi pengembangan pendidikan biologi. Jelaskan!

METHOD

This investigation used a quasi-experimental design. In this study, digital literacy was the dependent variable, and the WE-ARe model was the independent variable. The learning syntax of the WE-ARe model consists of four phases, namely warm-up, exploring, argumentation, and resume.

Table 1. The Pretest-Posttst Control Group Design

Group	Prestest	Treatment	Posttest
Experimental	O_1	WE-ARe	O_2
Positive Control	O_3	STAD	O_4
Negative Control	O_5	Conventional	O_6

Notes:
O_1 = Pretest score of the experimental group (implementing the WE-ARe model)
O_2 = Posttest score of the experimental group (implementing the WE-ARe model)
O_3 = Pretest score of the positive control group (implementing the cooperative STAD model)
O_4 = Posttest score of the positive control group (implementing the cooperative STAD model)
O_5 = Pretest score of the negative control group (implementing conventional learning)
O_6 = Posttest score of the negative control group (implementing conventional learning)
X = *Treatment* by implementing the WE-ARe model

All Tadris Biology students from IAIN Ternate and STKIP Kie Raha in Ternate, North Maluku, Indonesia, constituted the study population. The research sample consisted of sixty fourth-year biology students from the Department of Tadris Biology. Before determining the research sample, a test of equivalence was administered in which students were asked to answer questions from a placement test. Before being implemented in the field, these questions were subjected to expert and empirical validation. The results of the validation indicated that all test questions were valid and reliable. The research was conducted during the even semester of the academic year 2021-2022.

Data on students' digital literacy was obtained through a digital literacy questionnaire using a Likert scale. This questionnaire measures four dimensions of digital literacy, namely internet searching, hypertextual navigation, content evaluation, and knowledge assembly. Data related to digital literacy was also obtained through observation sheets that refer to the following dimensions: internet searching, hypertextual navigation, content evaluation, and knowledge assembly.

Data analysis was performed through analysis of covariance (ANCOVA) using 5% significance level on SPSS. Prior to ANCOVA, tests of normality and homogeneity of variance were conducted. Normality of the data was examined using the One-Sample Kolmogrov-Smirnov test, while homogeneity of the variance was examined using the Levene's Test of Equality of Error Variances.

RESULTS AND DISCUSSION

Descriptive data analysis was performed to the pre- and post-test scores of the experimental, positive control, and negative control groups. Table 1 displays the minimum scsore, maximum score, mean score, and standard deviation reported by the experimental and control groups.

Table 1. The Treatment Groups' Minimum and Maximum Pretest and Posttests Scores on Digital Literacy

Descriptive Statistics	Experimental Group WE-ARe		Positive Control Group STAD		Negative Control Group Conventional	
	Pretest	*Posttest*	*Pretest*	*Posttest*	*Pretest*	*Posttest*
N	20	20	20	20	20	20
Minimum	37.25	80.67	39.04	66.38	37.71	44.21
Maximum	46	87.46	49.46	74	46.67	52.42
Mean	42.1945	84.2285	45.2225	70.625	40.989	48.4735
Std. Deviation	2.10107	2.05143	2.54107	2.22828	2.64194	2.17758

Commented [J3]: Tabel harus disebutkan di paragraph.

Commented [J4]: score

Commented [J5]: Tabel harus disebutkan di paragraph.

Commented [J6]: Table 2

As shown in Table 1, the experimental group obtained a mean pretest score of 42.1945 with a standard deviation of 2.10107. The mean pre-test score of the positive control group was 45.2225, with a standard deviation of 2.54107. The mean pre-test score of the negati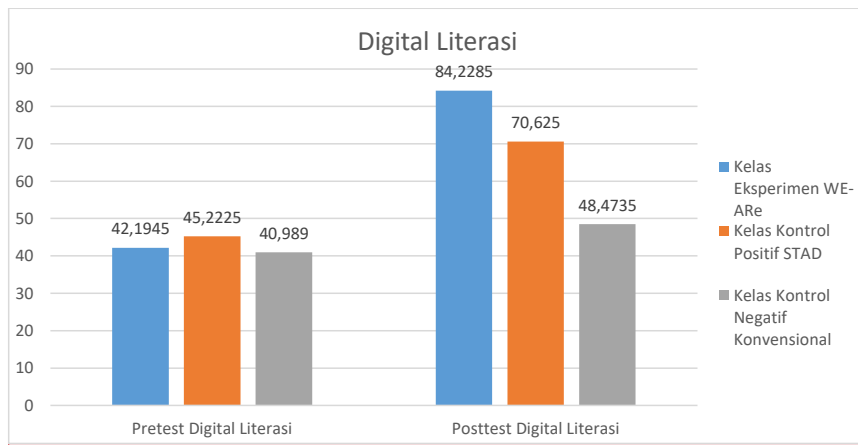ve control group was 40.989, with a standard deviation of 2.6419. As indicated by the mean pretest scores, the digital literacy of students in the three groups was comparable prior to treatment.

Meanwhile, following the treatment, the experimental group obtained a mean score of 84.2285 with a standard deviation of 2.05143. The mean pre-test score of the positive control group was 70.625, with a standard deviation of 2.2282. The mean pre-test score of the negative control group was 48.4735, with a standard deviation of 2.17758.

> **Commented [J7]:** Gambar harus disebutkan di paragraph.

> **Commented [J8]:** Gambar harus dalam Bahasa Inggris

Figure 1. Participants' Pre- and Post-test Scores on Digital Literacy

Prior to conducting the analysis of covariance, data normality and homogeneity of variance were examined. The normality of the data was examined using the *Kolmogorov-Smirnov* method, with α=0.05 serving as the decision criterion. If the significance probability (p) is greater than 0.05, the data are normally distributed; if it is less than 0.05, the data are not normally distributed. If the research data are normally distributed, testing can be performed using parametric methods; if the data are not normally distributed, testing is performed using non-parametric methods. The homogeneity of variance was examined using the Levene's test. If the probability of significance or p> 0.05, then the data is considered homogeneous, whereas if p<0.05, the data is not homogeneous. Table 2 displays the results of the Kolmogrov-Smirnov test used to assess the normality of the data for the experimental group and the control group.

Table 2. The Results of the Normality Test on the Research Data

Score	Group	Kolmogorov-Smirnova	Sig.	Remarks
Digital Literacy-Pretest	Experimental Group WE-ARe	0.092	.200*	distributed normally
	Positive Control Group STAD	0.182	0.081	distributed normally
	Negative Control Group Konvensional	0.177	0.099	distributed normally
Digital Literacy-Posttest	Experimental Group WE-ARe	0.097	.200*	distributed normally
	Positive Control Group STAD	0.174	0.114	distributed normally
	Negative Control Group Konvensional	0.16	0.195	distributed normally

Based on Table 2, the p-value of the pretest and posttest scores reported by all treatment groups was bigger

than 0.05 (p>0.05), indicating that the research data were distributed normally. The results of the Levene's test of homogeneity are presented in Table 3.

Table 3. The Results of the Homogeneity Test on the Research Data

Variable	Levene Statistics	Sig.	Remarks
Digital Literacy-Pretest	0.372	0.691	Homogeneous variance
Digital Literacy-Posttest	0.126	0.882	Homogeneous variance

Based on Table 3, the p-value of the pretest and posttest scores reported by all treatment groups was bigger than 0.05 (p>0.05), indicating that the research data had homogeneous variance. The research hypothesis was tested using analysis of covariance (ANCOVA). The ANCOVA was performed to investigate the effect of the WE-ARe model on students' digital literacy, with pretest score as the covariance. Table 4 shows the results of the ANCOVA.

Table 4. The ANCOVA Results

Tests of Between-Subjects Effects

Dependent Variable: Posttest Digital Literacy

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	13044.062ᵃ	3	4348.021	981.444	.000
Intercept	629.322	1	629.322	142.052	.000
Pretest_Digital_Literacy	16.301	1	16.301	3.679	.060
Group	12085.842	2	6042.921	1364.021	.000
Error	248.093	56	4.430		
Total	288904.614	60			
Corrected Total	13292.155	59			

a. R Squared = .981 (Adjusted R Squared = .980)

Table 4 explains the difference in digital literacy between the experimental group and the control groups. F-calculated of 1364.021 and a significance level of 0.000 (which is smaller than alpha 5% or 0.05) indicated that there was a difference between the experimental group and control groups in terms of digital literacy. In other words, the WE-ARe model had a significant impact on students' digital literacy.

After the implementation of the WE-ARe model, the experimental group obtained a mean score of 84.2285 on the posttest. This score is higher than that achieved by the positive control group (70.625) or the negative control group (48.4735). Based on this finding, it can be explained that the WE-ARe model was more effective than STAD and conventional learning models in enhancing preservice biology teachers.

Data analysis suggests that the We-ARe model can stimulate the improvement of preservice biology teachers' digital literacy. The stages of the WE-ARe model have been shown to increase the digital literacy of the study's participants. Digital literacy refers to the ability to receive information from various computer-based forms (Gilster, 1997). Digital literacy, along with study skills and life skills, is required in the 21st century.

The *Warm-up* phase in WE-ARe provides space for students to access the internet during the learning process. At this stage, students should be provided with website links that corresponded to lecture materials to facilitate access to relevant learning materials. In addition, they should be provided with an e-book file related to the subject matter. The students need to be instructed on how to conduct web searches on their smartphones or laptops to access a variety of information pertinent to the topic discussed in class. These activities will be able to pique students' interest and promote their literacy, particularly in terms of sorting relevant and pertinent information according to their learning needs. Students' digital literacy can be enhanced if they study biology by searching relevant websites for information (Ambarwati et al., 2019). Digital literacy can encourage students to engage in more information analysis (Setiawan et al., 2021).

The *Exploring* phase in WE-ARe can stimulate students' problem-solving skills. At this stage, students are trained to analyze, synthesize, and compare information obtained from various sources. In addition, they are encouraged to use a web browser and internet search appropriately and effectively by entering keywords pertinent to their learning needs. The search for such information can facilitate the problem-solving process. Besides, at this stage, students are allowed to share information with their peers to develop personalized problem-solving analyses. Thus, this phase provides a space for students to engage in collaborative learning while using online media responsibly.

The *Argumentation* phase of WE-ARe learning provides students with opportunities to analyze evidence and generate arguments based on information gleaned from diverse information media. Students can access websites, YouTube, electronic journals, and other resources to bolster their arguments. In this instance, students should be trained to use computers and other electronic devices responsibly, safely, and effectively for data processing. Thus, they become competent in using computers/laptops for presentations, presenting data, and creative in presenting comprehensible information effectively. To improve students' digital literacy, instructors must be digitally literate themselves. When educators are digitally literate, the teaching process is typically more relaxed and enjoyable (Pratolo & Solikhati, 2021).

The *Resume* phase of WE-ARe learning gives students the option of using smartphone or laptop applications to record and summarize the information they have gathered. Students can utilize technological sophistication to review previously acquired information and learning experiences. In this instance, students should be trained to evaluate strategies and self-regulate their learning reflectively. By seeking out additional relevant learning resources, students can enhance their accessibility and digital literacy.

Digital literacy is the information literacy required to access, analyze, and produce information from digital devices. However, the implementers of digital literacy (teachers/lecturers, schools/colleges, and students) face obstacles that impede the successful implementation of digital literacy. It is challenging to successfully practice digital literacy if the education system has limited funding capacity and technology, and if students are not prepared to learn with technology (Pratolo & Solikhati, 2021). Digital self-efficacy can be defined as an individual's confidence in selecting technology tools in accordance with their goals, as well as in organizing, developing, and employing these tools. Those with a high level of digital self-efficacy are aware of which technological tools should be used for which purposes, and they try to identify and solve these technological issues (Aslan, 2021).

Several factors, including socioeconomic status, cultural/ethnic background, gender, and disciplinary specialization, can influence students' ICT use (Kennedy et al., 2008). In addition, the nature and frequency of internet use by students vary according to their ages and socioeconomic status (Livingstone & Bober, 2004). Age, educational background, gender, educational institution, and personal preferences can influence an individual's digital literacy (Karagul et al., 2021). High levels of digital literacy are found primarily in urban areas due to the convenience of having ready access to necessary network infrastructure and facilities (Rundel & Salemink, 2021).

CONCLUSION

Based on the research findings and data analysis, it can be concluded that the WE-ARe model had a positive impact on preservice biology teachers' digital literacy. This finding is confirmed by the mean score achieved by the experimental group (84.2285), which is higher than that obtained by the positive control group (70.625) or the negative control group (48.4735). The results of this study can provide insights into the implementation of new learning models that can promote 21st-century skills in the classroom. The development of this model can also be investigated further to determine its influence on variables such as science process skills, problem-solving skills, creative thinking skills, metacognitive skills, and concept mastery, both in terms of academic ability and gender and multiethnic differences.

> **Commented [J9]:** Apa implikasi penelitian ini??

ACKNOWLEDGMENT

REFERENCES

> **Commented [J10]:** Tambahkan referensi dari Scopus (di dalam naskah)

Abduh, M., & Istiqomah, A. (2021). Analisis Muatan Hots dan Kecakapan Abad 21 pada Buku Siswa Kelas V

Tema Ekosistem di Sekolah Dasar. *Jurnal Basicedu*, *5*(4), 2069–2081. https://doi.org/10.31004/basicedu.v5i4.1124.

Adeoye, A. A., & Adeoye, B. J. (2017). Digital Literacy Skills of Undergraduate Students in Nigeria Universities. *Library Philosophy and Practice (e-Journal)*, *1665*, 1–23. https://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=4736&context=libphilprac.

Ambarwati, R., Faizah, U., & Rahayu, D. A. (2019). Enhancing the Digital Literacy of Pre-Service Biology Teacher through Animal Systematics Course. *Advances in Computer Science Research*, *95*, 197–201. https://doi.org/10.2991/miseic-19.2019.46

Amin, A. M. (2020). *Pengaruh Model Reading, Questioning, and Answering (RQA) Dipadu Argument-Driven Inquiry (ADI) pada Kemampuan Akademik Berbeda terhadap Motivasi, Keterampilan Berpikir Kritis, Keterampilan Metakognitif, Keterampilan Argumentasi, Penguasaan Konsep*. Disertasi Tidak Diterbitkan. Malang: Universitas Negeri Malang.

Amin, A. M. (2022). Self-Efficacy Mahasiswa Biologi Setelah Penerapan Model WE-ARe (Warm-up, Exploring, Argumentation, Resume). *Jurnal AL-Nafis*, *2*(1), 117–128. http://journal.iain-ternate.ac.id/index.php/Al-Nafis/issue/view/85/showToc

Amin, H., Malik, M. A., & Akkaya, B. (2022). Development and Validation of Digital Literacy Scale (DLS) and its Implication for Higher Education. *International Journal of Distance Education and E-Learning*, *7*(1), 24–43. https://doi.org/10.36261/ijdeel.v7i1.2224

Aslan, S. (2021). Analysis of Digital Literacy Self-Efficacy Levels of Pre-service Teachers. *International Journal of Technology in Education*, *4*(1), 56–67. https://doi.org/doi.org/10.46328/ijte.47.

Bahri, A., Jamaluddin, A., Novia, A. A., & Saparuddin. (2022). Students' and Teachers' Digital Literacy Skill: A Comparative Study between Schools, Classes, and Genders in Urban and Rural Areas. *International Journal of Science and Research*, *11*(2), 184–191. https://doi.org/10.21275/SR22130101519

Chan, B. S. K., Churchill, D., & Chiu, T. K. F. (2017). Digital Literacy Learning In Higher Education Through Digital Storytelling Approach. *Journal of International Education Research (JIER)*, *13*(1), 1–16. https://doi.org/10.19030/jier.v13i1.9907

Dominggus, R., Kristin, S., Martha M, B., Since Y, K., Vera V, K., & CorneliLatu, P. (2021). Resource Based Learning Design Thinking (RBLDT): A Model to Improve Students ' Creative Thinking Skills , Concept Gaining, and Digital Literacy. *Cypriot Journal of Educational Sciences*, *16*(1), 288–302. https://un-pub.eu/ojs/index.php/cjes/article/view/5528

Fraillon, J., Ainley, J., Schulz, W., Friedman, T., & Duckworth, D. (2019). *Preparing for Life in a Digital World: The IEA International Computer And Information Literacy Study 2018 International Report*. Australian Council for Educational Research (ACER). https://www.iea.nl/sites/default/files/2019-11/ICILS 2019 Digital final 04112019.pdf.

Gilster, P. (1997). *Digital Literacy*. Wiley Computer Publications.

Gruszczynska, A., & Pountney, R. (2013). Developing the Concept of Digital Literacy in the Context of Schools and Teacher Education. *Enhancing Lerning in the Social Science*, *5*(1), 25–36. https://doi.org/10.11120/elss.2013.05010025.

Helsper, E. J., & Smahel, D. (2019). Excessive Internet Use by Young Europeans: Psychological Vulnerability and Digital Literacy? *Information, Communication & Society*, 1–19. https://doi.org/10.1080/1369118x.2018.1563203.

Iman, J. N., & Angraini, N. (2019). Discussion Task Model in EFL Classroom: EFL Learners' Perception, Oral Proficiency, and Critical Thinking Achievements. *Pedagogika*, *133*(1), 43–62. https://doi.org/https://doi.org/10.15823/p.2019.133.3

Karagul, B. I., Seker, M., & Aykut, C. (2021). Investigating Students' Digital Literacy Levels during Online Education Due to COVID-19 Pandemic. *Sustainability*, *13*(11878). https://doi.org/10.3390/su132111878

Kennedy, G., Krause, K.-L., Judd, T., Churchward, A., & Gray, K. (2008). First-Year Students' Experiences with Technology: Are They Really Digital Natives? *Australasian Journal of Educational Technology*, *24*(1), 108–122. https://doi.org/10.14742/ajet.1233.

Lembani, R., Gunter, A., Breines, M., & Dalu, M. T. B. (2020). The Same Course, Different Access: the Digital Divide between Urban and Rural Distance Education Students in South Africa. *Journal of Geography in Higher Education*, *44*(1), 70–84. https://doi.org/10.1080/03098265.2019.1694876

Livingstone, S., & Bober, M. (2004). Taking Up Online Opportunities? Children's use of the Internet for Education, Communications, and Participation. *E-Learning*, *1*(3), 395–419.

Makur, A. P. (2019). The Influence of PQ4R Strategy And Mathematical Reasoning Ability Towards

7

Mathematical Communication Skills. *SJME (Supremum Journal of Mathematics Education)*, *3*(1), 18–31. https://doi.org/10.35706/sjme.v3i1.1467

Nancy, L., Woo, D., de la Torre, J., & Wong, G. (2018). A Global Framework of Reference on Digital Literacy. *UNESCO Institute for Statistics*. https://www.researchgate.net/publication/326223206_A_Global_Framework_of_Reference_on_Digital_Literacy_Skills_for_Indicator_442

Pepito, M. J. T., & Acledan, M. Y. (2022). Influence of Digital Literacy and Self-Directed Learning in the Online Learning Success of STEM College Students. *International Journal of Humanities Social Sciences and Education*, *9*(1), 88–100. https://doi.org/10.20431/2349-0381.0901007

Pratolo, B. W., & Solikhati, H. A. (2021). Investigating Teachers' Attitude toward Digital Literacy in EFL Classroom. *Journal of Education and Learning (EduLearn)*, *15*(1), 97–103. https://doi.org/10.11591/edulearn.v15i1.15747.

Purnamasari, L., Herlina, K., Distrik, I. W., & Andra, D. (2021). Students' Digital Literacy and Collaboration Abilities: An Analysis in Senior High School Students. *Indonesian Journal of Science and Mathematics Education*, *4*(1), 48–57. https://doi.org/10.24042/ijsme.v4i1.8452.

Rundel, C., & Salemink, K. (2021). Education Sciences Bridging Digital Inequalities in Rural Schools in Germany : A Geographical Lottery ? *Education Sciences*, *11*(181), 1–18. https://doi.org/10.18844/cjes.v16i1.5528.

Samson, N. L., Boyles, L. Z., & Arnado, A. A. (2021). Spiral Progression Approach: Digital Literacy and Competency in Teaching Science. *International Journal of Education and Research*, *9*(9), 111–120. https://www.ijern.com/journal/2021/September-2021/09.pdf.

Setiawan, D., Mahanal, S., & Zubaidah, S. (2021). RICOSRE: Effect and Potential to Enhance Biology Students' Digital Literacy at Universitas Negeri Malang. *AIP Conference Proceedings, 2330*(030041). https://doi.org/10.1063/5.0043139.

Statistik, B. P. (2020). *Statistik Telekomunikasi Indonesia 2019*. Badan Pusat Statistik. https://www.bps.go.id/publication/2021/10/11/e03aca1e6ae93396ee660328/statistik-telekomunikasi-indonesia-2020.html.

Utama, C., Sajidan, Nurkamto, J., & Wiranto. (2019). Investigating Biology Pre-service Teacher Perception of General Biology and Digital Literacy. *IOP Conference Series: Earth and Environmental Science*, *243*(012046). https://doi.org/10.1088/1755-1315/243/1/012046.

Waldrip B, & Prain, V. (2016). *Using Multimodal Representations to Support Learning in the Science Classroom*. Springer International Publishing. https://doi.org/10.1007/978-3-319-16450-2

BUKTI CORRESPONDENCE

ejournal.umm.ac.id/index.php/jpbi/authorDashboard/submission/23061

WhatsApp Web   Kotak Masuk (27) -...   Selamat Datang   THE 3rd ICoSMEE   Sci-Hub: removing...   European Journal o...   Login   Journal of Educatio...   Google Terjemahan

JPBI (Jurnal Pendidikan Biologi Indonesia)

? Back to Submissions

23061 / **Amin et al.** / The WE-ARe model's potential to enhance digital literacy of preservice biology teachers

Library

Workflow   Publication

Submission   **Review**   Copyediting   Production

Round 1

Round 1 Status
Submission accepted.

https://ejournal.umm.ac.id/index.php/jpbi/$$$call$$$/tab/author-dashboard/author-dashboard-tab/fetch-tab?submissionId=23061&stageId=3

Activate Windows

---

ejournal.umm.ac.id/index.php/jpbi/authorDashboard/submission/23061

WhatsApp Web   Kotak Masuk (27) -...   Selamat Datang   THE 3rd ICoSMEE   Sci-Hub: removing...   European Journal o...   Login   Journal of Educatio...   Google Terjemahan

JPBI (Jurnal Pendidikan Biologi Indonesia)

? Back to Submissions

Notifications

[JPBI] Editor Decision	2023-02-04 01:56 PM
[JPBI] Editor Decision	2023-02-07 10:55 PM
[JPBI] Editor Decision	2023-02-16 12:42 PM

Reviewer's Attachments   Q Search

| 81998 | Review Manuskrip_JPBI-UMM_sebagai Sukarsono.docx | February 4, 2023 |
| 82000 | Review Manuskrip_JPBI-UMM.pdf | February 4, 2023 |

Activate Windows

2

📄 81998   Review Manuskrip_JPBI-UMM_sebagai Sukarsono.docx   February 4, 2023

📄 82000   Review Manuskrip_JPBI-UMM.pdf   February 4, 2023

Revisions

🔍 **Search**   **Upload File**

▶ 📄 82292   07. JPBI-Astuti 07022023 - Rev-Mendeley.docx   February 7, 2023   Article Text

Review Discussions

Add discussion

Name	From	Last Reply	Replies	Closed
No Items				

Workflow   **Publication**

Status: Published   **Version:** 2   **All Versions**

This version has been published and can not be edited.

▪ Title & Abstract

Contributors

Metadata

References

Galleys

Prefix
Examples: A, The

Title

The WE-ARe model's potential to enhance digital literacy of preservice biology teachers

Subtitle

Activate Windows

3

5