RESEARCH ARTICLE

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

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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 ($\propto = 0.05$) 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 α=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.

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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.

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