Enhancing Secondary School Students' Mathematical Literacy through Wordwall-assisted Connecting, Organizing, Reflecting, Extending Model

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Abstract

Mathematical literacy helps to understand problems and develop mathematical knowledge to solve various complex problems. However, based on research conducted by the OECD through PISA in 2022, the mathematical literacy skills of Indonesian students are still far below the international average. Purpose of this study was to determine the mathematical literacy abilities of students who received the Connecting, Organizing, Reflecting, Extending (CORE) model with the help of Wordwall compared to students who received conventional learning models. The method used in this research is a quasi-Class with CORE model assisted by Wordwallal method with a nonequivalent Class with Expository modelgroup design. The subjects in this study were eight grader students of SMPN 40 Bandung, the research samples divided into two groups, VIII A as the Class with Expository modelgroup and VIII B as the Class with CORE model assisted by Wordwallal group. Samples taken by purposive technique. In this study, data taken by test of students' mathematical literacy skills conducted before the learning and after the learning treatment. The data obtained were then processed by carrying out a mean difference test with the help of IBM SPSS Statistics 26.0 for Windows. Based on the results of the study, it can be concluded that the mathematical literacy abilities of students who received the Wordwall-assisted CORE model were higher than the mathematical literacy abilities of students who received Expository model.

Keywords: CORE, PISA, Mathematical Literacy, Information Technology, Wordwall

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INTRODUCTION

Education plays a vital role in shaping the quality of future generations, especially amid current technological advancements. Mathematics is one of the subjects that influences technological development. Apart from being useful for technological developments, mathematics has an important role for students in overcoming various problems in various personal, professional, social and scientific aspects of their lives (Rusmana, 2019, p. 476). The Ministry of Education and Culture (2015) outlines that the objectives of mathematics education are to make learning meaningful by encouraging students to observe, inquire, reason, present, and create. The meaning of each mathematical material is very necessary so that students can understand the material being taught as well as the purpose and use of studying mathematical material.

Students' ability to use mathematical concepts in problems in daily life is mathematical literacy ability. Ojose (2011) "Mathematics literacy is the knowledge to know and apply basic mathematics in our everyday living." This statement shows that mathematical literacy is the knowledge to know and use basic mathematics in everyday life. After that, Anggiana et al. (2022, p. 159) explains that mathematical literacy ability is an individual's ability to design, use and interpret mathematics in various contexts. Therefore, mastering mathematical literacy can help understand problems and develop mathematical knowledge to solve various complex problems (Rum adan Junaidi, 2022, p. 117).

However, based on research conducted by the OECD through PISA in 2022, the mathematical literacy skills of Indonesian students are still far below the international average. PISA was designed to evaluate educational outcomes, namely the abilities of students aged 15 years in the areas of reading literacy, scientific literacy and mathematical literacy. The 2018 PISA survey was attended by 79 countries, Indonesia was ranked 73rd out of 79 countries with 379 points, while the OECD average was 489 points. These results indicate that students' mathematical literacy abilities in Indonesia are low or below average on an international scale.

At the West Java Province level, students' mathematical abilities seen from the results of the National Examination from 2017 to 2019 show an average score in mathematics, namely 56.90; 46.07; 43.95. These results show that students' National Examination scores in West Java experience a decline every year. The Ministry of Education and Culture issued a national policy, namely the National Assessment, which was carried out to improve the quality of learning and student learning outcomes. One of the three parts of the National Assessment is the Minimum Competency Assessment (AKM). AKM is designed to measure student achievement based on student cognitive achievement, namely literacy and numeracy.

One of the schools that took part in the National Assessment was SMPN 40 Bandung. Based on the results of AKM SMPN 40 Bandung's achievements, numeracy skills need encouragement in the applying category (L3), namely using their knowledge to solve real problems and find solutions to problems. In line with this, previous research conducted in West Java by Purwasih, et al. (2018, p.74), Nuurjannah, et al. (2018, p. 27), Widianti, et al. (2021, p. 31), specifically the City of Bandung, West Bandung Regency and Cirebon Regency, shows that junior high school students are good at carrying out mathematical calculations, but because students are not used to working on mathematical literacy questions, students have difficulty interpreting the information contained in the questions to create mathematical models and find mathematical solutions.

An alternative learning model that can be used is the Model Connecting, Organizing, Reflecting, Extending (CORE). According to Ulfa, et al. (2019, hlm. 402) The CORE model is a model that guides students to actively form their understanding and self-confidence so they can explain, classify and conclude. Wahyuningtyas (2020, p. 88) explains that the CORE model has a role as a bridge for students so they can explore their abilities and overcome problems.

The CORE model is a model that guides students to actively form their understanding and self-confidence so they can explain, classify and conclude. Wahyuningtyas (2020, p. 88) explains that the CORE model has a role as a bridge for students so they can explore their abilities and overcome problems. The four things discussed in the CORE model according to Calfee, et al. (in Fisher, 2013, p. 15) First, discuss to determine the connection to learning (connecting). Second, discussion to organize knowledge (organizing). Third, discussions to improve reflective thinking (reflecting) and fourth, discussions to expand knowledge (extending). Rahmadhani et al. (2022, p. 32) states that the stages contained in the CORE model can make it easier for students to express opinions, get solutions and come up with their own ideas.

The CORE approach in mathematics education is closely related to everyday mathematical literacy skills. Through the CORE mathematical literacy model, students can be trained and their abilities explored when facing problems, starting from recognizing and identifying with mathematics, creating mathematical models, solving problems using formulas, finding solutions, and connecting these solutions to real-world contexts. In line with Jannah's research (2018, p. 60), the CORE model has been proven to improve students' mathematical literacy skills.

In the current era of globalization, many technologies can be used as learning media in the mathematics learning process (Yaniawati et al. 2020, p.1). Kandaga et al. (2021 p.2) also states that the use of technology can change complexity to be much easier and more enjoyable. Wordwall is website-based which can be used as an interactive learning medium between educators and students by creating quizzes in the form of games (Aribowo, 2018). The research results of Suwandi, et. al. (2022, p. 449) shows that students' mathematical literacy skills using Wordwall-based learning media have increased in the high category.

The author tries to describe students' mathematical literacy abilities after obtaining the Connecting, Organizing, Reflecting, Extending (CORE) model assisted by Wordwall in this paper. Testing research results are then discussed and compared with various supporting theories.

METHOD

This research employed a quantitative approach with a quasi-experimental design, using a non-equivalent control group. The subjects were eighth-grade students from SMPN 40 Bandung, selected through purposive sampling. Based on school considerations, Class VIII B was assigned as the experimental group, receiving the CORE model assisted by Wordwall, while Class VIII A served as the control group, using the Expository model. A mathematical literacy test was developed as the instrument for data collection, validated for content by two experts and a teacher from the school, and its reliability was confirmed through expert review.

A pretest was administered to both groups to assess students' initial mathematical literacy abilities. The pretest was given under similar conditions to ensure comparability. The experimental group (Class VIII B) followed the CORE model assisted by Wordwall for four sessions, with interactive, student-centered activities supported by the Wordwall platform. The control group (Class VIII A) participated in four sessions of teacher-centered lectures using the Expository model. After the intervention, both groups took the same posttest to measure the impact of the learning models on students' mathematical literacy. The data collected from the pretest and posttest were analyzed using SPSS software. A t-test was conducted to compare the mean scores of the two groups, determining whether there were statistically significant differences in the students' mathematical literacy abilities following the intervention.

RESULTS AND DISCUSSION

After testing the pretest and posttest of mathematical literacy skills in both classes, the data obtained was then processed using IBM SPSS Statistics 26.0 for Windows. Data testing was carried out by conducting descriptive statistical tests, normality, homogeneity and two means tests (t-test).

Table 1. Descriptive Statistics of Pretest Data on Students' Mathematical Literacy Ability

	Pretest Data				
	N	Min Score	Max Score	Mean	Std. Deviation
Class with CORE model assisted by Wordwall	31	13	46	30.32	8.780
Class with Expository model	31	10	40	26.48	7.995

Descriptive Statistics Test Results of pretest data in Table 1 show that the Class with CORE model assisted by Wordwall and Class with Expository model have different maximum, minimum, average and standard deviation values. The average pretest score obtained by the Class with CORE model assisted by Wordwall was 30.32, higher than the Class with Expository model which obtained an average score of 26.48. From the results of this descriptive statistical test, we then proceeded to carry out a test of equality of two means (t-test) on students' initial mathematical literacy abilities.

Table 2. Parametric Statistics of Pretest Data on Students' Mathematical Literacy Ability

	Pretest		
	Normality	Homogeneity	Two samples t-test
	Shapiro-Wilk (Sig.)	Levene Statistic (Sig.)	Sig. (2-tailed)
Class with CORE model assisted by Wordwall	.587	.619	.077
Class with Expository model	.447		

Based on Table 2, it is shown that the significant value of the Shapiro-Wilk normality test for the Class with CORE model assisted by Wordwall is 0.587 and in the Class with Expository model it is 0.447. The significant value of the homogeneity test for both classes is 0.619. It can be concluded that which two classes in the population are normally distributed and have the same or homogeneous variance. Because the pretest data is normally distributed and homogeneous, you can then carry out a t-test. The significant value of the t-test was 0.077. This result shows that there is no difference in initial mathematical literacy abilities between Class with CORE model assisted by Wordwall and Class with Expository model students.

Table 3. Descriptive Statistics of Posttest Data on Students' Mathematical Literacy Ability

	Posttest Data				
	N	Min Score	Max Score	Mean	Std. Deviation
Class with CORE model assisted by Wordwall	31	52	100	78.13	13.308
Class with Expository model	31	50	93	71.58	11.129

Descriptive Statistics Test Results of posttest data contained in Table 3 show that the Class with CORE model assisted by Wordwall and Class with Expository model have different maximum, minimum, average and standard deviation values. The average pretest score obtained by the Class with CORE model assisted by Wordwall was 78.13, higher than the Class with Expository model which obtained an average score of 71.58. From the results of this descriptive statistical test, it was then continued to carry out a test of the difference between two means (t-test) on students' mathematical literacy abilities.

Table 4. Parametric Statistics of Posttest Data on Students' Mathematical Literacy Ability

	Posttest		
	Normality	Homogeneity	Two samples t-test
	Shapiro-Wilk (Sig.)	Levene Statistic (Sig.)	Sig. (2-tailed)
Class with CORE model assisted by Wordwall	.527	.201	.040
Class with Expository model	.328		

Table 4 shows that the significant value of the Shapiro-Wilk normality test for the Class with CORE model assisted by Wordwall is 0.527 and for the Class with Expository model it is 0.328. The significant value of the homogeneity test for both classes is 0.201. It can be concluded that which two classes in the population are normally distributed and have the same or homogeneous variance. Because the pretest data is normally distributed and homogeneous, you can then carry out a difference between two means or a t-test.

After carrying out one-party t-test processing in the Class with CORE model assisted by Wordwall and Class with Expository model, the significant value (Sig. 2-tailed) of the t-test was 0.040. Because SPSS 26.0 can only test two-party hypotheses, the significant value is divided by two and the value obtained is sig=0,040/2=0,02, the results of which show that it is smaller than 0.05, causing H_0 to be rejected and H_a to be accepted. It can be concluded that the mathematical literacy abilities of students who receive the CORE model assisted by Wordwall are higher than the mathematical literacy abilities of students who receive the conventional learning model.

This research began by conducting a pretest in the Class with CORE model assisted by Wordwall and Class with Expository model, to see students' initial mathematical literacy abilities. Then carry out the learning process for 4 meetings, discussing circle material. Where the Class with CORE model assisted by Wordwall was given the CORE model treatment assisted by Wordwall and the Class with Expository model was given the Expository model treatment. Next, after learning, students do a posttest to see differences in students' mathematical literacy abilities.

Based on the data analysis that has been carried out, show that the pretest and posttest data for the Class with CORE model assisted by Wordwall and Class with Expository model have data that is normally distributed and has homogeneous variance. The results of the equality test of two pretest means (t-test) in Table 2 show that there is no difference in students' initial mathematical literacy abilities. Table 4 shows the data from the test results of the difference between the two means in the posttest data, it shows that there is a difference in the mathematical literacy abilities of students who received the Wordwall-assisted CORE model which is higher than the mathematical literacy abilities of students who received the conventional learning model. In line with research conducted by Jannah (2018, p. 40) and Nasrulloh et al. (2023, p. 45) shows that the mathematical literacy abilities of students who receive the CORE model are higher than students who take conventional learning.

The average posttest score obtained in the Class with CORE model assisted by Wordwall was 78.13 while the Class with Expository model was 71.58. This difference in average score shows that the average score for the Class with CORE model assisted by Wordwall was higher than the Class with Expository model. The results of research conducted by Puspitarini (2019, p. 170), Niarti et al. (2021, p. 297) and Prasetya et al. (2020, p. 493) also shows that students who receive the CORE learning model have a higher average score compared to students who receive the conventional model. Apart from that, the posttest scores showed that more Class with CORE model assisted by Wordwall students passed the KKM score limit compared to Class with Expository model students. The good results shown were because the Class with CORE model assisted by Wordwall carried out learning using the CORE model assisted by Wordwall.

The learning process in the Class with CORE model assisted by Wordwall which applies the CORE model assisted by Wordwall, is carried out in groups of 5-6 students. Through group learning, students are trained to be actively involved in collaborating with groups and in finding understanding (Konita et al. 2019 p. 612). According to Hidayanti et al. (2023, p. 23) so that learning can be carried out optimally, it is necessary to use Student Worksheets (LKPD) that are in accordance with the CORE model learning steps. At the Connecting stage in the LKPD, students are asked questions about the circle material they have studied. The questions asked include the use of circles in everyday life and identifying the elements of circles.

Figure 1. Organizing Learning Stages

Figure 1 shows the Organizing stage where students discuss and organize the knowledge they have gained in the connecting stage by solving the problems contained in the Wordwall. As stated by Son & Ditasona (2020, p. 4), at the organizing stage, students discuss and build mathematical models of real life problems, so that they can connect non-formal mathematical models with formal mathematical models and develop more complex mathematical thinking. The third stage is Reflecting, presenting the results of group discussions regarding understanding of the information that has been obtained. This process is carried out so that students are trained to be able to explain again the information they have obtained (Fisher & Yaniawati 2017, p.25). The last stage is Extending, students expand their knowledge by practicing questions, then students present the results of their work.

Figure 2. Class with Expository model Learning Process

Figure 2. Learning in the Class with Expository model is carried out using an expository model, by making the teacher the center of learning (Wulandari et al. 2018, p.2). So that during the learning process teachers are more active than students (Sapuadi 2019, p. 5). The teacher explains the material to be studied at each meeting, and students just listen and write down the lessons delivered by the teacher. Followed by doing practice questions. Providing less varied practice questions makes students appear to have difficulty when they have to solve mathematical literacy questions.

The comparison of students' mathematical literacy abilities is shown through the posttest answers of Class with CORE model assisted by Wordwall students and the answers of Class with Expository model students.

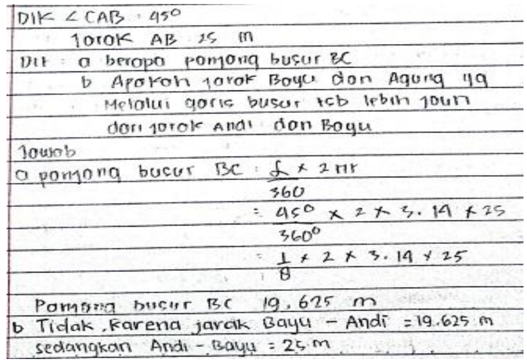

Figure 3. Class with CORE model assisted by Wordwall Students' Post-test Answers

Figure 3 shows that students have mastered 4 indicators of mathematical literacy abilities. The mathematical literacy indicators in this research have been used in research conducted by Saputri, et. al. (2021, p. 15). The first indicator is formulating real problems into problem solving, it shows that students have been able to write down the information contained in the problem correctly, formulate the problem and determine the use of formulas that are appropriate to the problem. The second indicator is using mathematics in solving problems. In this indicator, students carry out calculations using mathematical operations correctly.

An indicator of students' mathematical literacy skills achieved is interpreting solutions to problems, from the results of mathematical calculations students can draw conclusions about the values they have found. The fourth indicator achieved by students in answering posttest questions is evaluating solutions in solving problems. Through student answers, students are able to compare the information in the problem with the solution obtained from the calculation results and assess that the statement contained in the problem is incorrect because it does not match the solution obtained through the calculation process. This is supported by the statement mentioned by Murtiyasa and Perwita (2020, p. 3171) that students with high abilities can meet all indicators of mathematical literacy abilities.

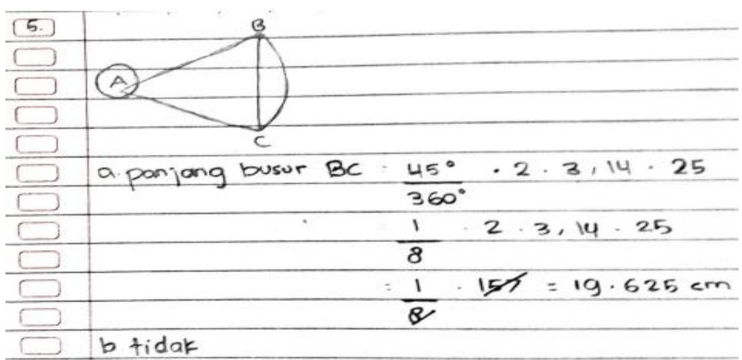

Figure 4. Class with Expository model students' post-test answers

Figure 4 shows the answer sheet for Class with Expository model students. Students do not formulate real problems in the questions into the form of problem-solving effectively. Because they don't write down the information contained in the problem, they directly use mathematics to find solutions to mathematical problems. When the problem in the question asks students to evaluate the problem, the students seem to already know that the statement in the question is wrong, but they do not explain the reasons to support that the statement in the question is wrong by comparing the information in the question with the solution that has been obtained through the calculation process (Steen, 2001; OECD, 2019).

The achievement of indicators of students' mathematical literacy abilities in this Class with CORE model assisted by Wordwall was due to the use of the CORE model assisted by Wordwall. Sari & Karyati (2020, p. 237) mention the factor that makes the CORE Model superior to other models is because students are actively involved during the learning process, which is also supported by findings from Hiebert et al. (1996) and Schoenfeld (2002), highlighting the importance of active learning in enhancing mathematical understanding. There is a relationship between indicators of students' mathematical literacy abilities and the learning stages of the CORE model assisted by Wordwall used. The Connecting stage involves linking old information with new information and applying it to everyday life, as emphasized by Resnick (1987) in promoting meaningful learning connections. The Organizing stage in this research uses Wordwall, where students formulate their knowledge to assess the suitability of the statements displayed, a method supported by Zohar & Dori (2003), who underline the role of metacognitive activities in learning. In the Reflecting Stage, students conclude and then evaluate to check the correctness and suitability of their understanding. In the Extending Stage, students use mathematics to solve problems, further substantiated by Boaler (1997), who found that such problem-solving approaches enhance student engagement and learning outcomes.

The teacher-centered learning process particularly in the Class with Expository model, leads students to be highly dependent on the information conveyed by the teacher. When students encounter unfamiliar or more complex problems, such as mathematical literacy tasks, they are unable to fully explore their abilities. This may be attributed to the fact that students are not accustomed to such tasks and have not been adequately trained to communicate their ideas (Sirait et al., 2016, p. 8). Fisher et al. (2019, p. 149) explain that conventional mathematics learning poses a significant obstacle to fostering student independence and active engagement.

Throughout the course of this research, several challenges were encountered. One of the primary obstacles was the students' limited ability to engage with higher-order thinking tasks, such as solving mathematical literacy problems, due to their prior exposure to teacher-centered instructional methods. Furthermore, some students demonstrated reluctance to actively participate in activities that required them to express their ideas and collaborate with peers. The researcher also faced difficulties in managing classroom dynamics, particularly in balancing the need for structured guidance with providing opportunities for student exploration. These challenges underscore the importance of integrating problem-solving activities into the learning process and fostering greater student autonomy in their learning journeys.

CONCLUSIONS

Based on the research results, it can be concluded that students' mathematical literacy abilities are higher when using the CORE model assisted by Wordwall compared to conventional learning models. In light of these findings, several suggestions are offered for future research. When implementing game-based learning media, such as the Wordwall application, teachers should carefully manage the classroom environment and maintain an expository approach to ensure students stay focused on educational content during the organizing stage, rather than becoming overly engaged in the gaming aspects. Additionally, future research should explore other cognitive abilities, such as mathematical connection skills, within the CORE model framework to better understand its broader impact on students' learning outcomes.

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