The effectiveness of the RADEC learning model on the numerical ability of madrasah tsanawiyah students

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Abstract: Numeracy skills are essential for junior high school students in the 21st century. The RADEC (Read, Answer, Discuss, Explain, Create) model is appropriate for implementation. This research aims to examine the effectiveness of the RADEC learning model in improving the numeracy skills of junior high school students. The research utilizes a quasi-experimental method with a nonequivalent control group design. The subjects of this research are male and female students in Madrasah Tsanawiyah Negeri (MTsN) 1 Pandeglang, with the population consisting of all seventh-grade students in MTsN 1 Pandeglang during the even semester of the academic year 2022/2023. The sample includes two classes determined purposely, with class VII A as the control group and class VII E as the experimental group. The instrument used in this research is a numeracy skills test. The research findings indicate that the improvement in numeracy skills of students using the RADEC model is considered better than that of students using the problem-based learning model. In conclusion, the RADEC learning model is more effective in enhancing students' numeracy skills than the problem-based learning model.

Keywords: Problem Based Learning; Numeracy skills; RADEC learning model


INTRODUCTION

In this increasingly fast-paced era, it has a significant impact on education in Indonesia. Education can guide individuals or groups to have the ability to achieve the nation's aspirations and become more useful individuals in the future (Maulaholo & Haryudo, 2015). A significant contribution of education is the creation and development of highly calibered human resources who are capable, have logical, creative, and critical thinking skills, as well as teamwork skills required in the current era of globalization. However, in reality, classroom learning directs students toward rote memorization skills and recalling a topic without guiding them to understand the topic and relate it to everyday life. Therefore, it is necessary to pay attention to a good curriculum that can develop high-quality human resources, so that the aspirations of the Indonesian nation can be realized.

The independent curriculum, known as the "Kurikulum Merdeka," is currently used in the learning process in Indonesia. The purpose of this curriculum is to create a pleasant atmosphere for teachers, students, and parents (Kusumaryono, 2020). Mathematics is an important subject to be taught at all levels of primary and secondary education. In the development of science education mathematics is an important foundation of science to be studied (Fitri et al., 2018). However, it is not excluded that many students who are not interested in mathematics because they find it difficult to understand and apply mathematical formulas into examples of subjects
that are taught to have a great impact on student learning outcomes (Asrika et al., 2020). The curriculum is implemented in various subjects, including mathematics. In mathematics learning, students are required to have mathematical literacy skills (Dinni, 2022). This is because mathematics learning is not only about understanding mathematics as a science, but in 21st-century mathematics learning, students are asked to develop their own abilities, such as critical thinking, logical thinking, rational thinking, high self-confidence, the ability to connect knowledge to real-life situations, proficiency in technology and information, good communication skills, and collaboration (Janah et al., 2019).

Numeration skills are important and must be possessed by students because students need to develop mathematical logical thinking, comprehensive understanding of concepts using learned knowledge, as well as the ability to carry out analysis by critically seeking information (Fitri & Effendi, 2023). This can help students face the challenges of mathematics learning in the 21st century and be beneficial in various fields of life as it can enhance social, economic, and individual or community well-being (Yunarti & Amanda, 2022). A "system comprising symbols and rules for using these symbols to write, represent, and name various numbers" is referred to as Numeration (Patnaude & Mathieu, 2019). Numeracy skills involve students being given problems related to daily life and asked to find solutions, making numeracy an important skill that students must master (Tyas & Pangesti, 2018).

The average mathematics score for Indonesian students is 379, according to the OECD’s 2018 Programme for International Student Assessment (PISA) results (2019), while the average mathematics score for OECD nations is 487. Based on these average scores, it can be seen that the numeracy skills of Indonesian students are still low. This is consistent with the research by Sudirman et al. (2020), which found that the majority of students have low numeracy skills, with only 34.04% of students having high proficiency, 14.89% with moderate proficiency, and 51.06% with low proficiency. This finding is also supported by the research of Holis et al., (2016), which revealed that students’ numeracy skills have not reached 60% in solving PISA problems at all levels, indicating that students' numeracy skills are still low.

This is further supported by the results of the National Madrasah Competency Assessment in Grade VIII for mathematics conducted in November 2021, with the following indicators: (1) the proportion of students with basic numeracy skills scored less than 50% (40% achievement); (2) the proportion of students requiring special interventions for numeracy skills (2.22% achievement); (3) the proportion of students with proficient numeracy skills (11.11% achievement); and (4) the proportion of students with competent numeracy skills (46.67% achievement).

Based on the outlined problems, the solution is to implement an appropriate and suitable learning model that can enhance students’ numeracy skills in Indonesia. The suitable model to be used in Indonesia is the RADEC (Read, Answer, Discuss, Explain, and Create) learning model. This model focuses on competency and skills, making it suitable for the Indonesian education system (Setiawan et al., 2020). The RADEC model is considered innovative and tailored to the Indonesian education system, where students are required to grasp concepts and various information in a short period of time (Predi, 2022). According to Sopandi (2019), after training 97.2% of teachers are interested in applying the RADEC model in schools, because it is easy to understand and its application can help students in personality development, conceptual knowledge, motivation as well as developing skills of the 21st century, one of which is numeration.

Several researchers have already found positive results by implementing the RADEC learning model, such as its ability to foster critical thinking skills in thematic learning with an N-gain score of 0.513 in the moderate category (Yulianti et al., 2022), optimize students' critical thinking skills in understanding the properties of light with an N-gain score of 0.4 (Karlina et al., 2020), and develop communication and collaboration skills with a 65% improvement in the first cycle and a 90% improvement in the second cycle (Sukmawati et al., 2020). These studies have shown that the RADEC model is effective in enhancing creativity, critical thinking skills,
conceptual mastery, and collaboration among students. However, no research has been conducted on the effectiveness of the RADEC model in mathematics education. Therefore, the aim of this study is to examine the effectiveness of the RADEC learning model on students' numeracy skills”.

**METHOD**

**General Organization of the Paper**

This study is a quantitative research using the Quasi Experimental Design method. The experimental study was chosen to observe the effects of the treatment (independent variable) and the dependent variable, and it was conducted in a class by selecting a comparison class. The chosen design is the Nonequivalent Control Group Design, which includes two sample groups: one experimental group implementing the RADEC learning model and one control group using the problem-based learning model.

The entire students of class VII MTsN 1 Pandeglang in the academic year 2022-2023 constituted the population size used by the researcher. The population was selected based on interviews with subject teachers, which revealed that the numeracy skills of the students in class VII were relatively low. Since the assumption was made that the average skills of both sample groups would be the same, purposive sampling was used. Based on the results of the curriculum considerations and interviews with teachers of subjects, the class selected by the researchers as an experimental class is class VII E of 32 students while the control class is the class VII A with 32 students. These two classes were chosen because there was not a significant difference in the learning outcomes between them.

The researcher’s instrument was a test consisting of five essay questions with indicators of numeracy skills, specifically focusing on quadrilaterals. Prior to giving the student the ice instrument was validity test using moment product correlation and reliability test using Alpha Cronbach’s. After it was deemed valid and reliable, it was given to the students for both the pretest and posttest in both classes to observe the differences and improvements in students’ numeracy skills. Pre-test and post-test data are processed using the formula (1) and reduction guidelines presented in Table 1.

**Table 1. Guidelines for scoring numeracy ability test results**

<table>
<thead>
<tr>
<th>Explanation Score</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Not filled/not answered</td>
<td>0</td>
</tr>
<tr>
<td>2. Students write information from the question into the mathematical model with the learned concept</td>
<td>1</td>
</tr>
<tr>
<td>3. Students provide unclear steps in their calculations, resulting in incorrect answers</td>
<td>2</td>
</tr>
<tr>
<td>4. Students provide correct steps in their calculations and the correct answer</td>
<td>3</td>
</tr>
<tr>
<td>5. Students can interpret/conclude the results from the information in the given question</td>
<td>4</td>
</tr>
</tbody>
</table>

\[
N = \frac{\text{Achievement Score}}{\text{Maximum Score} = 20} \times 100\% \quad \text{...(1)}
\]

The research was conducted using two quantitative data analysis techniques using SPSS version 22 for windows, namely independent sample t-test and N-gain test. Independent sample T-test is used to see the difference between the learning model of RADEC and problem-based learning against the improvement of numeration capabilities. Meanwhile, the N-gain test is used to look at elevated numeration skills of students applied to the RADEC learning model with problem-based learning.
RESULTS AND DISCUSSION

**Results**

To assess the initial and final numeracy skills of students in both classes using quadrilaterals as the topic, an analysis of students' numeracy skills was conducted by utilizing the data from the pretest and posttest scores given to the experimental class, VII E, and the control class, VII A. The detailed results of this assessment are presented in Table 2, which provides a comprehensive overview of the students' performance across various aspects of numeracy.

**Table 2.** Final numeracy skills of students

<table>
<thead>
<tr>
<th>Class</th>
<th>Data</th>
<th>Number of Data</th>
<th>$X_{max}$</th>
<th>$X_{min}$</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Varians</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Experiment</strong></td>
<td><strong>Pretest</strong></td>
<td>32</td>
<td>55</td>
<td>20</td>
<td>36.87</td>
<td>11.19</td>
<td>125,403</td>
</tr>
<tr>
<td></td>
<td><strong>Posttest</strong></td>
<td></td>
<td>100</td>
<td>70</td>
<td>87.34</td>
<td>8.97</td>
<td>80,620</td>
</tr>
<tr>
<td><strong>Control</strong></td>
<td><strong>Pretest</strong></td>
<td></td>
<td>55</td>
<td>20</td>
<td>35.46</td>
<td>10.87</td>
<td>118,322</td>
</tr>
<tr>
<td></td>
<td><strong>Posttest</strong></td>
<td></td>
<td>100</td>
<td>65</td>
<td>80.00</td>
<td>10.92</td>
<td>119,355</td>
</tr>
</tbody>
</table>

Based on Table 2, students in the experimental class had an average initial numeracy ability score of 36.87, compared to 35.46 in the control class. By this explanation, it is clear that there is no significant difference between the pretest results of students in both classes, indicating that the abilities of both classes are comparable.

Before conducting a test for the mean difference in final numeracy abilities to determine the difference between the RADEC model and the problem-based learning model, tests for normality and homogeneity will be performed first. According to the normality test, the data on the final numeracy abilities of students in both classes are normally distributed, with a normality value of 0.067 > 0.05 for the experimental class and 0.056 > 0.05 for the control class. Next, a test for homogeneity shows that the variances between the groups are homogenous, with a value of 0.732 > 0.05. The posttest data are shown to be regularly distributed and homogeneous. The mean difference in final numeracy abilities is then tested using an independent sample t-test. Table 3 are the results of the calculation for the test of mean difference in final numeracy abilities.

**Table 3.** Test the difference in the average final numeracy ability

<table>
<thead>
<tr>
<th>t-test for Equality of Means</th>
<th>T</th>
<th>df</th>
<th>Sig.(2-tailed)</th>
<th>Information</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>−2.489</td>
<td>62</td>
<td>.005</td>
<td>$H_0$ rejected</td>
</tr>
</tbody>
</table>

Based on Table 3, the obtained p-value (2-tailed) is 0.005 < $\alpha$ = 0.05. Based on this value, $H_0$ is rejected, indicating that the mathematical numeracy ability implemented using the RADEC teaching model is better than when the problem-based learning model is implemented. Based on the calculations, it can be concluded that mathematical numeration ability using the RADEC model is considered better than when using a problem-based learning model.

After that, the N-gain test was carried out to see the improvement in the numbering ability of students who applied the RADEC model and the problem based learning model. Based on the normality test of the two classes declared normal distribution with a value of 0.086 > 0.05 for the experimental class and 0.370 > 0.05 for the control class. Then a homogeneity test was performed that showed a variance between homogenous groups with a value of 0.263 > 0.05. The N-gain data ratio differential test was then carried out using the independent sample t-test, and the results are meticulously detailed in Table 4.
Based on Table 4, the obtained p-value or Sig. (2-tailed) is 0.020 < 0.05. From this value, we reject the null hypothesis \( H_0 \), which suggests that the increased numbering ability of students applied the RADEC model is considered superior to the Problem Based Learning model. As demonstrated by much higher final numeration scores and increased computing skills, it can be concluded that the student's numeration capabilities applied the RADEC learning model are more effective than the problem-based learning model.

**Table 4. N-gain Data Mean Difference Test**

<table>
<thead>
<tr>
<th>Information</th>
<th>t-test for Equality of Means</th>
</tr>
</thead>
<tbody>
<tr>
<td>( t )</td>
<td>2,395</td>
</tr>
<tr>
<td>( Df )</td>
<td>62</td>
</tr>
<tr>
<td>Sig.(2-tailed)</td>
<td>0,020</td>
</tr>
<tr>
<td>( H_0 ) rejected</td>
<td></td>
</tr>
</tbody>
</table>

**Discussion**

Based on the analysis of the data, the initial numeracy abilities of the experimental and control group students were not significantly different from each other, indicating that they had similar abilities. However, after implementing the respective learning models, it became clear that students using the RADEC learning model exhibited better numeracy skills compared to those using the problem-based learning model.

This can be seen from the numeracy test results of the class applying the RADEC model, with a score of 87.34, and the class applying the problem-based learning model, with a score of 80. Based on these test results, there is a difference in the numeracy abilities of students using the RADEC model, which is superior to those using the problem-based learning model.

Furthermore, the N-gain test results indicate that the final numeracy abilities of the class implementing the RADEC model fall under the high category, with a score of 0.78, while the class implementing the problem-based learning model falls under the moderate category, with a score of 0.68. Based on these test results, it is evident that the improvement in numeracy abilities of students using the RADEC model is better than those using the problem-based learning model.

These findings align with the research conducted by Pratama et al. (2020), which found that the RADEC model had a positive impact on students' computational abilities, as evidenced by a 29.64-point increase between pretest and posttest scores. Additionally, it has been observed that the RADEC model has a significant impact on students' numerical abilities (Predi et al., 2022). This is attributed to the structured approach of the RADEC model, which aims to train and enhance students' numerical abilities. According to (Ismail et al., 2022), RADEC learning positively affects students' ability to calculate the area of triangles and engages them more actively in the learning process.

Apart from these factors, several reasons contribute to the effectiveness of the RADEC model. Firstly, the learning activities in the RADEC model are more varied. With the application of the RADEC model, students participate in learning processes such as reading, answering questions, discussing, delineating, and producing. Secondly, students are motivated to actively participate in class due to the RADEC model, which creates opportunities for asking questions, engaging in discussions, proposing investigations, and drawing conclusions about the material covered (Sopandi, 2019). Based on this, the RADEC model can be said to be more effective than the problem based learning model.

Additionally, the design and syntax of the RADEC model are suitable for the characteristics of Indonesian students. The first syntax is "read," where students are required to read the upcoming lesson's material from textbooks, the internet, or other sources. Reading helps foster numeracy literacy habits and development, which have a positive impact on students as it helps them acquire knowledge and understanding on their own (Yulianti et al., 2022). In this stage, students are also given pre-learning questions related to the upcoming material, which will be discussed in subsequent sessions to ensure better preparedness before the actual learning takes place.
The next syntax is "answer," which provides feedback to students based on their responses in the "read" stage. Teachers ask students to participate by answering pre-learning questions, and other students provide feedback on the accuracy and suitability of the answers. When students are able to solve the given problems, their numeracy skills are enhanced (Mulyadi et al., 2020).

The subsequent syntax, "discuss," involves providing students with problem-based worksheets that relate to daily life. This aligns with the basic principle of contextual numeracy literacy, where activities are connected to everyday life. The active discussion process encourages students to ask questions and use strategies to solve problems, thereby fostering higher-order thinking skills (Pratama et al., 2020). Once students can solve higher-order thinking problems, they can be considered to possess numeracy skills.

After the "discuss" syntax, the next syntax is "explain." In this stage, significant improvement in numeracy skills is evident as students develop their numeracy abilities by presenting results discussed students with groups in front of the class and interacting with other groups through questioning, objecting, or responding. This fosters critical thinking regarding the interaction with the answers given or received. When students are able to think critically, their numeracy skills improve.

The last syntax in the RADEC model is "create." This stage also develops students' numeracy skills as they are asked to come up with innovative ideas to create a product. In line with the research by Handayani (2019) and Maulaholo & Haryudo (2015), the RADEC learning model helps students develop their critical and creative thinking. Therefore, there is a connection between the RADEC model and numerical skills, as this stage cultivates students' critical and creative thinking abilities. The products created in this stage include various representations of quadrilateral shapes, such as miniatures and mind maps, which serve as visual reminders of the learned material.

Several researchers have utilized the RADEC model in mathematics education. (Yulianti et al., 2022) found that critical thinking skills of students significantly improved both before and after the intervention, with an N-gain value of 0.513 using the RADEC learning model. (Predi et al., 2022) found a relationship between the RADEC learning model, students’ IQ, and their numerical abilities. The research conducted by (Ismail et al., 2022) revealed that the use of the RADEC model, which actively involves students in their education, can enhance their ability to calculate the area of triangles. Based on these discussions, the RADEC model can be considered as an alternative to improve students’ numeracy skills in junior high school (SMP/MTs) and achieve the goals of mathematics education in the 21st century.

CONCLUSION

Based on the results of the research already carried out, it can be concluded that the numeration skills of students who applied the learning model RADEC are considered better than students that applied a problem-based learning model, as demonstrated by the result of the posttest ratio difference test with a significance of 0.005 > 0.05. Furthermore, the increased numeration skills of students who applied the RADEC learning model were better than students that applied a problem-based learning model, as demonstrated by the N-gain test averaged the difference with a significance value of 0.020 < 0.05.

Declarations

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