The Influence of the RADEC Model with ESD (Education for Sustainable Development) Insight on Earth Sun Rotation and Revolution Material to Increase Student Metacognitive Awareness

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Abstract. The aim of this research is to describe and analyze the RADEC model based on ESD (Education for Sustainable Development) on the Concept of Rotation and Revolution of the Earth and Sun on students' metacognitive awareness. The research method uses quantitative - quasi experiment. The design is in the form of a Pretest-Posttest Control Group Design. The population is all students of the PGMI, FTK, UIN Raden Intan Lampung Study Program Class 2021/2022, totaling 317 people (Class A-J). The research sample was selected using simple random sampling technique. The research instrument used a metacognitive awareness questionnaire which was measured using the MAI. Data processing analysis was carried out using descriptive statistics and inference statistics by hypothesis testing using the t-test with a significance level of 5% (α = 0.05). Calculations assisted by the SPSS program. version 25. The results of the research are: (1) metacognitive awareness of students who study with the RADEC model with ESD insight in the good category, the mean value is 39.87, the median is 39, the mode is 37, and the variability is 3.8, and the Skewness is -0.112 or slope curve towards the left. (2) The criteria for increasing metacognitive awareness of students who receive lectures using the RADEC model with an ESD perspective is 0.4, so they are in the medium category (referring to Hake's criteria), (3) Differences in the influence of implementation the ESD-oriented RADEC model on students' metacognitive ability acquisition, the 2-tailed sig value is 0.00 and this value is smaller than 0.05 (α), so the conclusion is that there is a difference in achievement. (4) The difference in the effect of implementing the ESD-oriented RADEC model on increasing students' metacognitive awareness, it turns out that the 2-tailed sig value is 0.195 and this value is greater than 0.05 (α), so the conclusion is that there is no difference in improvement, and (5) Application of the model RADEC with ESD insight has a significant effect on students' acquisition of metacognitive awareness.

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1 Introduction

In the 21st century, science is a subject that students must master from elementary school (SD) to university (PT). For students, mastering science material is very beneficial so that they have a number of competencies needed to be able to adapt and survive in this era full of challenges, competition and uncertainty. Therefore, the learning philosophy must be integralistic [1], strengthen understanding of NoS [2], equip to choose various variations of ICT media [3], hone 4C skills [4] and support HOTS thinking [5]. Apart from that, student learning orientation is also directed at understanding various social issues related to nature and the surrounding environment, such as learning the concept of Rotation and Revolution of the Earth and Sun and studying the effects of these changes on the depletion of natural resources, climate change and reduced resilience. food and energy for living things. This aims to ensure that students have science insight that is oriented towards achieving Sustainable Development Goals (SDGs) [6] in order to realize Education for Sustainable Development (ESD).

The discussion above confirms that having good metacognitive awareness is something that is urgent for students to be able to achieve some of the learning activities above. Metacognitive awareness is an individual's awareness of using their thinking to plan, control and evaluate their cognitive processes and strategies [7]. Referring to the opinion of Schraw and Dennison (1994), indicators for assessing metacognitive awareness include metacognitive knowledge and metacognitive regulation. Metacognitive knowledge refers to knowledge about cognition such as knowledge about skills and good work strategies for students and how and when to use these skills and strategies. Meanwhile, metacognitive regulation refers to activities that control a person's thinking and learning, such as planning, monitoring understanding, and evaluating [8]. In essence, metacognitive awareness really helps students to plan, sequence and monitor their learning process so that they obtain better learning outcomes [9].

In the context of learning science, mastering metacognitive awareness will reduce mistakes made in solving problems and can help students identify good learning strategies. In other words, metacognitive awareness leads students to have insight into knowledge [10], to become critical thinkers, problem solvers, and wiser [11,12] and to become independent learners [13,14], especially social phenomena that need critical scientific review. However, what happens in the field is, in fact, students' metacognitive awareness is still low. The indications are that students do not use previous knowledge, organize the information obtained [15], know how and when to apply strategies, and how to regulate the effectiveness of strategies [16], do not know how to identify relevant information and use study guides. Not being challenged to solve difficult problems[17], especially contextual ones [18], as happens in the social environment of society. In conclusion, there are still many students who experience difficulty in using their metacognitive awareness when faced with problems [19].

Like tangled threads, there are many trigger factors. This includes choosing an inappropriate learning model [20,21]. It appears that lecture activities are rote learning, the cases/questions given are not non-routine problems, discussion topics are focused on textbooks or rarely deepen them with global issues regarding nature. Problem solving, observation and experiment activities do not directly train students to hone 4C skills and HOTS thinking. This situation as a whole has a big impact on increasing students' metacognitive awareness. An alternative solution can be done by applying the RADEC model [22]. In the first reading stage, students are guided in reading comprehension in a wider and more varied context. Second, answer, students are asked to find answers to pre-learning questions in order to practice the adversity quotient. Third, discuss, students are conditioned to be able to learn and teach each other (learning by teaching). Fourth, explain. Students are stimulated to convey reasonable explanations, emphasizing ZPD (Zone of proximal
development) and scaffolding towards other friends, and fifthly create, students create creative works in the form of ideas or products, in the form of scientific works or works of art.

Consequently, study by [23] Discovery offers a thorough comprehension of the precision and harmony of motivation, anxiety, and learning independence markers in research tools. The significance of this component in the context of raising students' metacognitive awareness is shown by the confirmatory factor analysis results, which provide a substantial contribution to our knowledge of learning independent factors.

Thus, this research aims to prove the application of the RADEC model with an ESD (Education for Sustainable Development) perspective on the material on Rotation and Revolution of the Earth and Sun to increase students' metacognitive awareness. For more details, it is described in the following research questions:

1. What is the description of the acquisition of metacognitive abilities for students who receive lectures using the RADEC model with an ESD perspective?
2. What are the criteria for improving the metacognitive abilities of students who receive lectures using the RADEC model with an ESD perspective?
3. Is there a difference in the effect of implementing the ESD-oriented RADEC model on students' acquisition of metacognitive abilities?
4. Is there a difference in the effect of implementing the ESD-oriented RADEC model on improving students' metacognitive abilities?
5. Does the application of the ESD-oriented RADEC model have a significant effect on students' acquisition of metacognitive abilities?

2 Research methodology

The research method uses quantitative research with a quasi-experiment type. The experimental design took the form of a Pretest-Posttest Control Group Design. In the design there are two groups selected randomly and given a pretest to determine the initial situation. Good results, if the pretest scores between the two groups are not significantly different, but in the posttest scores there is a significant difference with the experimental class. This indicates that the experimental results were successful.

<table>
<thead>
<tr>
<th>Group</th>
<th>Pretest</th>
<th>Treatment</th>
<th>Posttest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experiment</td>
<td>O1</td>
<td>X</td>
<td>O2</td>
</tr>
<tr>
<td>control</td>
<td>O3</td>
<td>-</td>
<td>O4</td>
</tr>
</tbody>
</table>

Information:
- X = Science learning with the RADEC model has an ESD perspective
- O1 / O3 = Pretest on both groups
- O2 / O4 = Posttest on both groups

The research population was students from the class of 2021/2022 of the PGMI, FTK, UIN Raden Intan Lampung study program, totaling 317 people spread from class A - class J. For the research sample, based on randomization results, class A was obtained with a total of 31 people as the experimental class and class B with 33 people as the control class. The sampling technique was carried out using simple random sampling. The research instrument uses a questionnaire to measure metacognitive awareness which is measured using the MAI (Metacognitive Awareness Inventory) modified by Schraw and Dennison (1994) [23] which
has been tested for validity and reliability. Indicators of metacognition awareness measured include knowledge about cognition consisting of sub-indicators of declarative knowledge, procedural knowledge, conditional knowledge, and indicators of regulation of cognition consisting of sub-indicators of planning, information management strategy, monitoring understanding, strategy prediction and evaluation. The questionnaire is in the form of a Likert scale (Very true, true, not true, and very untrue) with scoring guidelines for positive statements (4, 3, 2, and 1) and negative statements (1, 2, 3 and 4). In scoring the questionnaire results, calculations are carried out and categorized according to the existing criteria table. All questionnaire statement items were constructed based on theoretical analysis and have been validated by experts. Data processing analysis was carried out using descriptive statistics and inference statistics by hypothesis testing using the t test with a significance level of 5% ($\alpha = 0.05$). Calculations assisted by the SPSS version 25 program. For complete data analysis, data from science practicum/experiment results, observation notes and interviews related to the Implementation of Science Learning with the ESD-oriented RADEC Model, or documents (photos) of activities were also used. In this process, researchers collaborate with science lecturers to conduct brainstorming.

3 Result

3.1 An overview of the acquisition of metacognitive awareness of students who receive lectures using the RADEC model with an ESD perspective.

The results of descriptive statistical calculations assisted by SPSS show that the metacognitive awareness of students who received lectures using the ESD-oriented RADEC model had a mean value of 39.87, a median (middle score) of 39, and a mode (highest score) of 37. Meanwhile for variability (distribution of scores) seen from the standard deviation calculation of 3.8. These results indicate that the score distribution deviates very far to the right of the mean point, which indicates that the diversity of students’ metacognitive awareness is very high (very variable) but in a positive direction. This finding can also be proven by looking at the Skewness curve of -0.112 which shows that the slope of the curve is on the left, meaning there are more high scores or indicating that students’ metacognitive awareness scores are in the “high” category. Based on interviews, the reason for this increase is because the implementation of science learning with the ESD-oriented RADEC model really stimulates students’ thinking abilities, they are trained and encouraged to solve problems by planning, controlling and assessing their cognitive processes and strategies. In the form of a histogram graph, it is expressed as follows:

![Histogram](image.png)

Fig. 1. metacognitive abilities of students
Based on the image above, a bell-shaped curve appears, indicating that the values are generally in the middle or in normal conditions and even if you look closely, the tendency for the values to be on the right, shows a distribution of high values.

3.2 Criteria for increasing the metacognitive abilities of students who receive lectures using the RADEC model with an ESD perspective.

\[ n \text{ Gain} = \frac{Skor \ Postest - Skor \ Pretest}{Skor \ Maks - Skor \ Pretes} \]

<table>
<thead>
<tr>
<th>Table 1. Independent Samples Test</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Levene's Test for Equality of Variances</strong></td>
</tr>
<tr>
<td>Skor Postest</td>
</tr>
<tr>
<td>F</td>
</tr>
<tr>
<td>.121</td>
</tr>
<tr>
<td>-5.675</td>
</tr>
</tbody>
</table>

\[ n \text{ Gain} \text{ RADEC model with an ESD perspective} = \frac{39.8 - 32.90}{52 - 32.90} = \frac{0.69}{19.1} = 0.36 = 0.4 \text{ (rounded)} \]

From the results of the calculations above, it is known that the n-Gain of RADEC with an ESD perspective is 0.4, so it can be concluded that the average gain (increase) in metacognitive awareness of students studying with RADEC with an ESD perspective is in the medium category (Referring to Hake's criteria)

3.3 Differences in the influence of implementing the ESD-oriented RADEC model on students' acquisition of metacognitive awareness.

With the help of SPSS version 26 software, the results of the Independent Sample T Test and the output are:

From the output above, it turns out that the 2 tailed sig value is 0.000 and this value is smaller than 0.05 (\( \alpha \)), so it means that it can be concluded that H0 is rejected and H1 is accepted. Then also, by looking at the t table, it turns out that the critical t at df = 62 with alpha (\( \alpha \)) = 5\% (0.025 due to 2 tails) is +/-1.980. When compared with the calculated t value (SPSS Independent Samples Test output results) above, it is known that the calculated t of -5.689 is located in the Ho rejection area, so it can also be concluded that Ho is rejected and H1 is accepted.

For more details, see the following normal curve image.
Fig. 2. normal curve

<table>
<thead>
<tr>
<th>Table 2. Independent Samples Test</th>
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<tbody>
<tr>
<td></td>
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<tr>
<td></td>
</tr>
<tr>
<td>Skor_Gain</td>
</tr>
<tr>
<td>Equal variances assumed</td>
</tr>
<tr>
<td>Equal variances not assumed</td>
</tr>
</tbody>
</table>

Thus, it can be concluded that there are differences in the influence of implementing the ESD-oriented RADEC model on students' acquisition of metacognitive awareness.

3.4 Differences in the influence of implementing the ESD-oriented RADEC model on increasing students' metacognitive awareness.

With the help of SPSS version 26 software, the results of the Independent Sample T Test and the output are:

From the output above, it turns out that the 2 tailed sig value is 0.195 and this value is greater than 0.05 (α), so it means that it can be concluded that H0 is accepted and H1 is rejected. Then also, by looking at the t table, it turns out that the critical t at df = 62 with alpha (α) = 5% (0.025 due to 2 tails) is +-1.980. When compared with the calculated t value (SPSS Independent Samples Test output results) above, it is known that the calculated t of 1.311 is located in the Ho acceptance area, so it can also be concluded that Ho is accepted and H1 is rejected.

For more details, see the following normal curve image.
Thus, it can be concluded that there is no difference in the effect of implementing the ESD-oriented RADEC model on increasing students' metacognitive awareness.

### 3.5 The application of the ESD-oriented RADEC model has a significant effect on students' acquisition of metacognitive abilities.

#### Table 3. Paired sample test

<table>
<thead>
<tr>
<th>Paired Samples Test</th>
<th></th>
<th>Paired Differences</th>
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<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Std. Deviation</td>
<td>Mean</td>
<td>Std. Error</td>
<td>95% Confidence Interval</td>
<td>T</td>
<td>Df</td>
<td>Sig. (2-tailed)</td>
<td></td>
</tr>
<tr>
<td>Pair 1</td>
<td>-6.968</td>
<td>3.799</td>
<td>.682</td>
<td>-8.361</td>
<td>-5.574</td>
<td>-10.212</td>
<td>30</td>
<td>.000</td>
<td></td>
</tr>
</tbody>
</table>

With the help of SPSS version 26 software, the results of the Independent Sample T Test and the output are:

From the output above, it is known that the 2 tailed sig value is 0.00 and this value is smaller than 0.05(α) which means that H0 is rejected and H1 is accepted. Then also, by looking at the t table, it turns out that the critical t at df = 30 with alpha (α) = 5% (0.025 due to 2 tails) is +2.042. When compared with the calculated t value (see SPSS Paired Samples Test output results) above, it is known that the calculated t of -10.212 is located in the H0 rejection area, so it can be concluded that H0 is rejected and H1 is accepted.

For more details, see the following normal curve image.

![Figure 3. normal curve](image)

Based on the results above, the conclusion is that the application of the ESD-oriented RADEC model has a significant effect on students' acquisition of metacognitive awareness. Furthermore, because H0 is rejected, we want to know whether the pre-test and post-test metacognitive awareness of students studying with the ESD-oriented RADEC model has a connection (correlation) which can be read in the following table:
Table 4. Paired sample correlation

<table>
<thead>
<tr>
<th>Paired Samples Correlations</th>
<th>N</th>
<th>Correlation</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pair 1 Pretes Model RADEC &amp; Posttest Model RADEC</td>
<td>31</td>
<td>.619</td>
<td>.000</td>
</tr>
</tbody>
</table>

Because the sig value for the paired samples correlation score is 0.000 and this value is smaller than 0.05 (α), it can be concluded that the metacognitive awareness pretest and posttest scores of students studying with the ESD-oriented RADEC model are significantly correlated.

4 Conclusion

Based on the research results above, it proves that in general the application of the RADEC model in studying SD/MI science material, which in its study is oriented with insight into achieving Sustainable Development Goals (SDGs) in order to realize Education for Sustainable Development (ESD) has proven successful in improving student learning outcomes in cognitive domain, especially in developing metacognitive awareness in solving social problems related to nature and the surrounding environment, such as learning the concept of Rotation and Revolution of the Earth and Sun and examining the effects of these changes on the depletion of natural resources, climate change, and reduced food security and energy for living things.

The indicators can be seen from descriptive statistical calculations showing the average value and standard deviation value of students in the good value category. Likewise the calculation of N-Gain, obtained the medium category. Furthermore, from hypothetical calculations, it is proven that in the classes that were tested or the groups that were given treatment there was significant progress in terms of gaining metacognitive awareness, although in terms of increasing metacognitive awareness this has not been proven and the causes of this need to be analyzed further. However, for research on whether the application of the ESD-oriented RADEC model has a significant effect on the acquisition of students' metacognitive abilities, the results were proven to be significantly effective, even after more in-depth research it turned out that the metacognitive awareness pre-test and post-test scores of students studying with the RADEC-oriented model ESD is significantly correlated. This finding is an extraordinary educational innovation to contribute to advancing science education, especially in elementary education.

References

Through Inquiry-Based Learning (2000)