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The mastery of grade 4 of elementary school students' concepts on energy through the implementation of the RADEC learning model

F N Fuadi[*], **W Sopandi**[*], **and A Sujana**

Elementary Education Study Program, School of Postgraduate Studies, Indonesian University of Education, Jl. Dr. Setiabudi No. 229, Bandung 40154, Indonesia

[*]fitrinf@upi.edu, wsopandi@upi.com

Abstract. This study was aimed to determine students' concept mastery on energy topic before and after the implementation of Read-Answer-Discuss-Explain-and Create (RADEC) learning model. This study was carried out using pre-experimental method with one group pretest-posttest design. The participants of this study were eight elementary school students in which five of them from a public elementary school in Bandung, two students from a public elementary school in Tasikmalaya, and a student from a public elementary school in Ciamis. The instrument in this study was a four-tier test in the form of google form. The data were analyzed quantitatively and the result indicated that 50% of the students experienced misconceptions in learning energy topic. After the RADEC learning model was implemented, 77% of the students acquired scientific conception on the energy topic. Based on the Paired Sample T-Test result (p 0.015 <0.05), there was a difference in the concept mastery between pretest and posttest scores. The obtained N_{Gain} score of the pretest and the posttest in this study was 0.67 which was considered as moderate category. For further researchers, they were recommended to involve more participants so that the findings could be more useful.

1. Introduction

Conceptual change has been the focus of research for decades [1]. The results showed that difficulties in understanding scientific concepts are experienced by students at various levels [2]. Most reason is that they tend to build cognitive structures based on surface features [1]. Besides, the ability to master concepts is not transferred by their teacher so they must build them themselves [3]. There have been many different types of tests to measure the level of mastery of the concepts such as interviews, concept maps, open question tests, portfolios, and diagnostic tests [4]. One diagnostic test instrument that can measure the level of mastery of concepts is the four-tier test [5].

One topic of science that is considered difficult to understand is about energy [6]. Many abstract concepts make elementary school students experience misunderstandings related to the topic of energy, especially the subtopic of renewable and non-renewable energy sources [7], [8]. Energy is a universal interest that has a big impact on the economic and environmental fields [8]. On the other hand, with a lack of understanding of energy, students' awareness of the application and utilization of renewable energy is low [9]. Therefore, scientifically proper teaching about the concepts of energy is very important to carry out. In the practice of teaching concepts, teachers need to choose and implement a learning model that suits the objectives to be achieved. The selected learning model needs to equip students with various competencies holistically which does not just teach concepts.

One teaching model that is oriented towards mastering concepts and developing student competencies holistically is the RADEC model [10]–[14]. The RADEC model was first published by Sopandi in 2017 which involves Read, Answer, Discuss, Explain, and Create. This model was developed based on the objectives of national education, the condition of education in Indonesia, and based on the theory of constructivism [10]. Thus, RADEC can be a new alternative learning model that aims to help students to gain many useful competencies [10], including to help students understand many scientific concepts in limited time [15].

The Four-tier test that can measure students' conceptions has been widely used to uncover misconceptions in high school students [4], [16] and prospective teachers [5], [17], [18]. However, the use of the four-tier test is still quite rare in uncovering elementary students' conceptions. The purpose of this study was to determine the profile of students' mastery of concepts on the topic of energy before and after the implementation of the RADEC learning model. The importance of this research is because students' mastery of concepts is identified using the four-tier test that can simultaneously determine the students' reasoning.
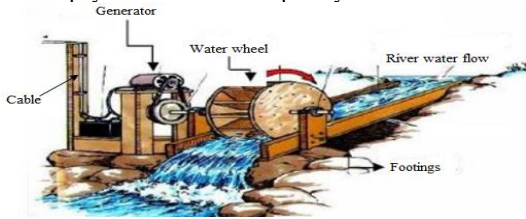
2. Methods

The method used was a pre-experimental design with a group of pretest-posttest [19]. This method is used to explore changes in the results of the pre-test before the intervention and changes in post-test results after the intervention [19]. The purpose of this study was to determine the profile of students' mastery of concepts on energy before and after the implementation of the RADEC learning model. The test instrument used was the four-tier test. This test can assess misunderstandings that are free of errors and lack of knowledge [17]. The four-level test consists of four questions; first is questions about the main concept, second is the level of trust connected to the first level, third is the reason for the selection of answers at the first level, and fourth is the level of trust connected with the third level. Illustration of the conception test in the four-tier test format is shown in Figure 1.

Consept:
Water is a natural resource that can be used as a source of energy production. To convert the energy in the flow of water into electrical energy a Hydroelectric Power Plant is needed.
Answer Choice (Tier I)
1.   Please pay attention on a simple Hydroelectric Power Plant below!

From the picture above which objects can convert the energy of motion into electrical energy?
a. River water flow
b. Generator
c. Water wheel
d. Cable
 The first Confidence Rating Scale (Tier II)
2.   Are you sure with your answer?
    a.   Sure   b. Not sure
 Reasons (Tier III)
3.   Why did you choose that object?
    a.   The object converts the energy of motion from the waterwheel to electrical energy and the resulting electric current flows through the cable.
    b.   The flow of water that flows swiftly produces electricity then is distributed to the wheel.
    c.   It converts electrical energy into the energy of motion and then distributes electricity to the cable.
    d.   The object flows electrical energy from the wheel to the residents' houses

 The Second Rating Scale (Tier IV)
4.   Are you sure with your answer?
    a.   Sure   b. Not sure

Figure 1. An example of four-tier test on energy

The research participants consisted of five students from a public elementary school in Bandung students, two students from a public elementary school in Tasikmalaya, and a student from a public elementary school in Ciamis. All participants consisted of eight students, all of whom were Grade 4 students. The eight students were combined into one class and the learning process was carried out virtually using google classroom. The participants were selected from different schools with a small number due to several problems. First, the Covid-19 pandemic requires students to study online while there are not many elementary schools that use google classroom as a virtual learning media. The second was limited access of elementary school students to electronic devices.

The content validity of each test item was carried out by five experts consisting of four expert lecturers (three experts on learning models and one expert on assessment). Another validator was a teacher who teach grade 4 in two elementary schools. The results showed that the test instrument was valid for use since the value of its Content Validity Ratio (CVR) was 0,77. Meanwhile, the reliability of the test was calculated by Cronbach's Alpha with the acquisition of the coefficient was 0,762. The tests were given to the students through the google form feature distributed in google classroom. The categories of determining the students' conception level were based on table 1.

Table 1. The Students' conception level based on the patterns of answers [5]

Category	Choices Tier (1)	Confidence Tier (2)	Reason Tier (3)	Confidence Tier (4)
Understand the Concept (UC)	Correct	Sure	Correct	Sure
Has not Understood the Concept (HUC)	Correct	Sure	Correct	Not Sure
	Correct	Sure	Wrong	Not Sure
	Correct	Not Sure	Correct	Sure
	Correct	Not Sure	Correct	Not Sure
	Correct	Not Sure	Wrong	Not Sure
	Wrong	Sure	Correct	Not Sure
	Wrong	Sure	Wrong	Not Sure
	Wrong	Not Sure	Correct	Not Sure
	Wrong	Not Sure	Wrong	Not Sure
Misconception (M)	Correct	Sure	Wrong	Sure
	Correct	Not Sure	Wrong	Sure
	Wrong	Sure	Wrong	Sure
	Wrong	Not Sure	Wrong	Sure
Error (E)	Wrong	Sure	Correct	Sure
	Wrong	Not Sure	Correct	Sure

3. Result and Discussion

The result of this study is presented into three parts, namely students' pretest result, students' posttest result, and students' concept mastery improvement.

3.1 students' pretest result

The pretest was carried out before learning energy topic using RADEC learning model. Figure 2 describes students' concept mastery level on energy topic.
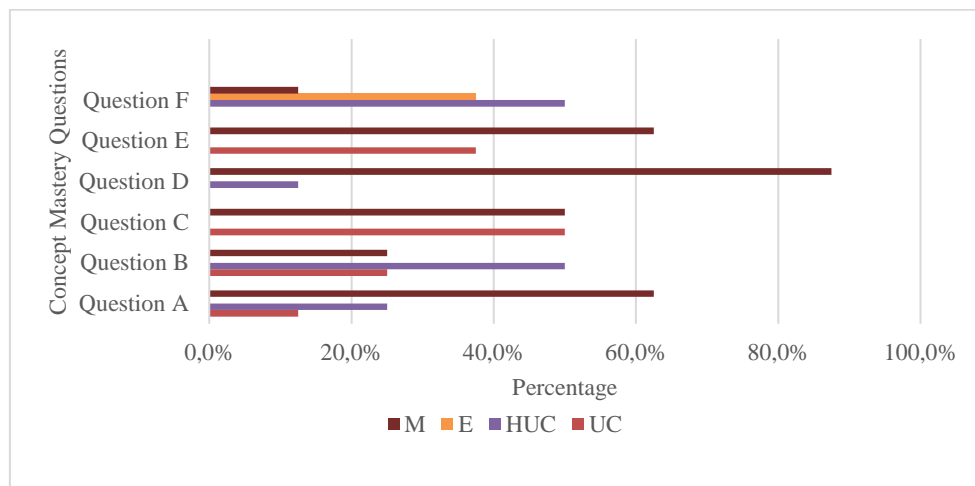
Figure 2. The Percentage of Students' Conception Level from Every Item in Pretest

In Figure 2 there was a misconception in each item. Furthermore, the misconceptions dominated question A, D, and E. This happened because students already held a concept before acquiring scientific theory [20]. Students' ideas and concepts were formed because they built their knowledge conceptions based on their daily activities [21], [22]. Thus, when students were studying in the classroom, they brought their own conceptions.

3.2 *students' posttest result*
The result of posttest was obtained after students finished learning energy topic using RADEC learning model. Students' conception level on energy topic can be seen in Figure 3.
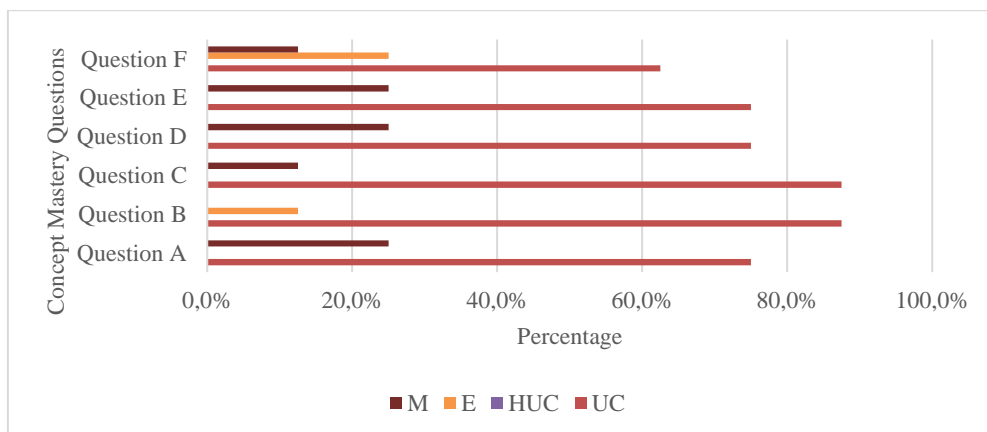

Figure 3. The Percentage of Students' Conception Level from Every Item in Post-test

Based on Figure 3, it can be identified that each item was dominated by understand the concept level. The average percentage of understand the concept level was 77%. This indicated that students' non-scientific understanding could be improved into scientific understanding through learning [23]. Students were able to master scientific concepts because they were actively participated during the learning process. In its implementation, RADEC learning model demanded students to actively think scientifically to understand a concept [24].

3.3 *students' concept mastery improvement*
Statistical tests were conducted to know whether there was students' concept mastery improvement after the implementation of RADEC learning model. The statistical tests included normality test, Shapiro-Wilk, test of homogeneity, and paired sample T-test was done by using SPSS version 24. The result of the tests is presented in Table 2.

Table 2. Pretest and Posttest's Mean Score Tests

Test	N	Mean	Std. Deviation	Normality Test	Homogenity Test	T-Test
Pretest	8	53.88	15.056	0.084	0.837	0.015
Postest	8	85.00	17.688	0.113		

Referring to the data in Table 2, the pretest score data was normally distributed with p $0.084 \geq 0.05$ and the posttest score data was also normally distributed with p $0.113 < 0.05$. Thus, to find out the mean difference of students' concept mastery, a paired sample t-test was performed with the research hypotheses are listed below:

H_0 : There is no mean score difference in students' concept mastery pre-test and posttest.

H_1 : There is mean score difference in students' concept mastery pretest and posttest.

If $p < 0.05$, H_0 was rejected.

Based on the test, the p value acquired was 0.015 which was smaller than 0.05. Therefore, H_0 was rejected. This signified that there was mean differences in students' concept mastery before and after the implementation of RADEC learning model. Furthermore, to find out the effectiveness of using RADEC learning model, the N_{Gain} value of the pretest and posttest scores was calculated. The overall N_{Gain} value from the pretest and post-test was 0.67 with moderate category. Therefore, it could be concluded that the implementation of RADEC learning model could improve elementary school students' concept mastery in energy topic. This was in line with some previous studies which stated that RADEC learning model could improve students' concept mastery [24], [25].

4. Conclusion

In conclusion, every student had their own conception before starting the lesson. This conception was formed by their experiences in daily lives. Based on the learning intervention using RADEC learning model, students could master scientific conceptions on energy topic. In addition, after the implementation of RADEC learning model, students could improve from has not understood the concept and misconception level into understand the concept level. Moreover, aside from improving students' conception level, the implementation of RADEC learning model could develop students' concept mastery in energy topic. In consequence, this study was expected to contribute in assisting elementary students to master energy topic concept through the implementation of RADEC learning model.

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