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The Implementation of Research-Based Learning Model in the Basic Science Concepts Course in Improving Analytical Thinking Skills

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Abstract: This study aimed to analyze the Research-Based Learning (RBL) model implementation in the natural sciences in improving students' analytical thinking skills. This study employed a mixed-method with a sequential exploratory design. Data collection began with qualitative data and then continued with quantitative data. Qualitative data collection techniques used observation and interviews, while quantitative data collection used essay tests. Sampling was carried out before the research implementation. The samples were students of the PGMI IAIN Surakarta Study Program, Indonesia, which consisted of 34 pre-service elementary school teachers. The research was conducted in the odd semester of the 2019/2020 academic year. Quantitative data analysis techniques used a quasi-experimental design with one group pretest-posttest. Based on the results of four observations on the research treatments, the mean was 3.714, in which the values of preliminary activities were 3.625, core activities were 3.714, and closing activities were 3.75, used a rating scale (1-4) with the very good category. The RBL model implementation in the natural sciences in the concept of energy can improve the analytical thinking skills of students, as evidenced by the N-gain value was 56.57%in the medium category. This increase was obtained from the mean of the pretest score (46.84) and the post-test score (76.9), by using a rating scale (0-100). The research findings provide ideas to lecturers and researchers in improving the student's analytical thinking skills through the application of innovative learning models in the topic of the concept of energy.

Keywords: *Analytical thinking skills, concept of energy, mixed-method, natural sciences, research-based learning.*

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Introduction

Learners need analytical thinking skills in solving various problems (Ricco et al., 2020; Putri & Aznam, 2019; Putri et al., 2019). Analytical thinking skills direct students to become independent and quality thinkers (Anggraini et al., 2019; Nawawi & Nizkon, 2020). In addition, analytical thinking skills are one of the most basic higher-order thinking skills required for developing 21st-century skills, such as critical thinking, problem-solving, creativity, and decision making (Aksu & Eser, 2020).

Analytical thinking skills are important for students to optimize their ability to solve problems in everyday life (Aksu & Eser, 2020; Schumacher & Ifenthaler, 2018). However, the results showed that the students' analytical thinking skills were still low based on data with three indicators of analytical thinking skills: differentiating (16.6), organizing (46.6), and attributing (7.2), by using a rating scale (0-100) (Winarti, 2015). These data were strengthened by the results of tests conducted by the Program for International Students Assessment (PISA) for Indonesian students in the natural sciences, which ranked 62 out of 70 countries surveyed (Gurria, 2016).

One factor causing the low analytical thinking skills of students is the learning method. Traditional passive learning limits the opportunities for each student to develop analytical thinking skills, while active learning can produce students who think analytically (Puchumni et al., 2019). One learning model that can activate students is the Research-Based Learning (RBL) model because the stages in the RBL model require students to always learn through research (Haviz, 2020; Usmeldi, 2016). In addition, the RBL model promotes student-centered and integrates research into a meaningful learning process (Usmeldi et al., 2017). Therefore, the RBL model is a learning process that can construct students' knowledge by practicing through a series of observation and analysis activities (Nursofah et al., 2018).

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The RBL model can be implemented in science learning because the RBL model contains various methods that can reach science as a process, product, and attitude (Pebriawati, 2019). Science as a process is a way of investigation, which includes observation, measurement, data processing, and concluding. Besides, science is obtained through data collection with experiments and observations. It also tries to produce an explanation of the problem solved (Syofyan et al., 2019). Furthermore, analyze, criticize, assess, compare, and evaluate are the scopes that must be studied in science learning to improve analytical thinking skills (Taleb & Chadwick, 2016). In other words, analytical thinking skills are related to the science process skills used by students to solve complex and unstructured problems (Irwanto et al., 2017). In brief, the RBL model can activate student analytical thinking skills in science learning, including investigating, collecting data, and explaining the problem resolved.

Based on the aforementioned problems, this study aims to analyze the application of the RBL model in science learning to improve the students' analytical thinking skills. The research findings are expected to provide ideas and encouragement to lecturers and researchers in improving the students' analytical thinking skills through implementing innovative learning models, such as the RBL model, in the concept of energy.

Literature Review

RBL Model

The RBL model is a learning model based on real-life problems, which is a context for students to learn about problem-solving techniques and skills and gain important knowledge and concepts from the subject (Hidayatul et al., 2020; Pratama et al., 2019). The RBL model has the characteristics of allowing students to practice searching, compiling hypotheses, collecting and processing data, and drawing conclusions, which ultimately can help them gain a better understanding and knowledge (Ramahwati, 2016). The instructional impact of the RBL model is to make students; 1) understand basic concepts and strong methodologies, 2) solve problems creatively, logically, and systematically, 3) have a scientific attitude that is always seeking the truth, open and honest (Hidayah, 2018). The RBL model application in learning refers to the syntax developed by Tremp (2010) as in Table 1.

Table 1. RBL model syntax

No	Stages	Activities
1	Stage 1	Formulate problems
2	Stage 2	Review the theoretical basis
3	Stage 3	Define the problem statement
4	Stage 4	Planning investigation activities
5	Stage 5	Carry out investigations and data analysis
6	Stage 6	Explain the research results
7	Stage 7	Create reports and presentations of results

Analytical Thinking Skills

Analytical thinking skills are skills to identify and connect between statements, concepts, descriptions, or other forms (Prawita & Prayitno, 2019). According to Winarti (2015), the ability to analyze is a process that includes breaking the material into small parts and connecting between parts and the overall structure (Dilekli, 2019). In conclusion, analytical thinking skills are the ability of students to describe a thing into its parts and be able to discover the relationship between these parts.

In this study, indicators of analytical thinking skills were developed by Anderson and Winarti: distinguishing, organizing, and attributing (Anderson, 2001). The details are in Table 2.

Table 2. Cognitive process dimension

Categories and Cognitive Process	Alternative Names	Definition
1. Differentiating	Discriminating, distinguishing, focusing	Distinguishing is relevant or important from irrelevant or unimportant parts of the presented material.
2. Organizing	Finding coherence, integrating, outlining	Determining how elements fit or function within a structure.
3. Attributing	Deconstructing	Determining a point of view, bias, values, or intent underlying presented material

Table 2, describes the indicators of analytical thinking skills and their definition. These indicators act as a reference in measuring students' analytical thinking skills.

Methodology

Research Objective

This study aimed to analyze the RBL model implementation in the natural sciences in improving students' analytical thinking skills. Besides, this study also was intended to train pre-service teachers to become elementary school teachers in science.

Research Design

The research method used exploratory sequential mixed methods adopted from Creswell (2014). First, this research used the qualitative method by collecting and analyzing data qualitatively. Second, it employed a quantitative method by collecting and analyzing data quantitatively based on the initial results of qualitative data, as seen in Figure 1.

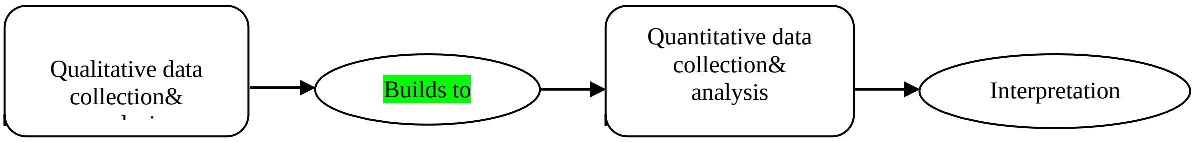


Figure 1. The mixed-method research: Qualitative-quantitative

Method priority was given to qualitative data, while quantitative methods played a role in supporting qualitative data. Qualitative methods were implemented to obtain data on implementing the RBL model in improving analytical thinking skills. Furthermore, quantitative methods were employed to receive data about students' analytical thinking skills through administering pretest and posttest in essays. The results of the pretest and posttest were student scores on essay tests of analytical thinking skills in the topic of the concept of energy.

The quantitative research design used a quasi-experiment with one group pretest-posttest without control group design (Fraenkel et al., 2007) (see Table 3).

Table 3. One group pretest-posttest design.

Pre-test	Treatment	Post-test
O	X	O

Note: X: Treatment by research-based learning model

The pretest was carried out before the implementation of the RBL model. Meanwhile, the posttest was conducted after the implementation of the RBL model. The time allocation for the pretest and posttest is the same, namely 90 minutes, because the weight of the questions between the pretest and posttest is the same even though the questions are different. Some examples of pretest and posttest questions are in Table 4.

Table 4. Some examples of pretest and posttest questions

No	Pretest Item	Posttest Item
1	In an experiment of combustion of a biomass stove using sawdust biomass, the data are; the mass of water (ma) = 0.6 kg, mass biomass (m_b) = 0.3 kg, initial temperature of water (T_a) = 30^{o}C, and final temperature of water (end) = 100^{o}C. Calculate the available heat and the heat used if it is known that the specific heat of water (Cp) = 4180 J/^{o}Ckg, and the calorific value of sawdust (L) = 15269,256 103 J/kg!	In the experiment of combustion of a biomass stove using sawdust biomass, the obtained data are; the mass of water (ma) = 1.2 kg, mass of biomass (m_b) = 0.6 kg, initial temperature of water (T_a) = 40^{o}C, and the final temperature of water (end) = 100^{o}C. Calculate the available heat and the heat used if it is known that the specific heat of water (Cp) = 4180 J/^{o}Ckg, and the calorific value of sawdust (L) = 15269,256 103 J/kg!
2	Calculate the efficiency of biomass stove combustion using sawdust in question number 1!	Calculate the efficiency of biomass stove combustion using sawdust in question number 1!

Research Sample

The research sample consisted of 34 students of the PGMI IAIN Surakarta Indonesia Study Program. The PGMI Study Program is under the Indonesian Ministry of Religious Affairs, which produces primary school teacher candidates. The sample has varied previous educational backgrounds, namely senior high school, Islamic senior high school, and vocational high school with various majors such as science, social sciences, electrical engineering, fashion, multimedia, administration, accounting, marketing, religion, and automotive. The research was conducted in the odd semester of the 2019/2020 academic year, for the third semester students who are between 19 and 20 years old.

Research Instruments

This study consisted of three instruments: critical thinking skills test, observation sheets, and interview sheets. The critical thinking skills test consisted of 10 questions. To examine the validity of the items, a trial was conducted with 85 students as respondents. The results of the trial were analyzed for validity with the QUES application, and all ten items were valid. Meanwhile, observation sheets and interview sheets were validated by five experts in evaluation. The results of the expert's assessment were analyzed by using Aiken's V analysis. The results of the observation sheet and the interview sheet were all valid.

RBL Model Procedure

The procedure of the RBL model consisted of 7 steps: 1) formulating the problem, this activity is begun by exploring existing natural phenomena and discussing them in groups to identify problems, 2) reviewing the theory, students read and analyze theories related to the theme to be carried out by the experiment, 3) defining problems formulation, students discussed in groups to formulate problems, 4) planning investigation activities, preparing the tools and materials used in the experiment, 5) investigating and analyzing data, carried out in groups and guided by the experimental steps in the Experiment Guide book, 6) explaining the research findings, based on the results of the analysis, 7) making reports and presenting results, each group presented their findings in front of the class.

The seven steps of the RBL model, which are the core of learning in the form of investigation, it is obtained through various empirical process discoveries by applying scientific methods. Investigation activities on energy change material were carried out by students with the equipment listed in Table 5.

Table 5.Tools and materials used in the investigation

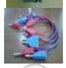
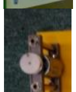
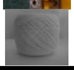
No	Tool's name	Total	Picture
1	Battery	two pieces	
2	Switch	one piece	
3	Cable	sufficiently	
4	lamp	two pieces	
5	Chain Board	one piece	
5	Electric motor	one piece	
6	Yarn	sufficiently	

Table 5, is the tools and materials used by students to carry out investigations of energy changes. An example of an investigation activity is demonstrated in Figure 2.

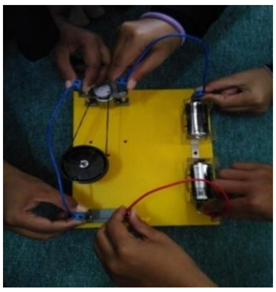


Figure 2. A group of students was investigating an energy conversion.

Figure 2, informs the RBL model implementation with group investigations, each group consists of 3 to 4 students.

Data Analysis

Analytical thinking skills scores were obtained after students worked on essay tests, consisting of pretest and posttest. Each test item was given an assessment criterion; if all aspects of the answer are met, then the value is four. If most aspects of the answer are met, the value is three. If a small part of the answer aspect is fulfilled, the value is two. If it is answered but, no aspect of the answer is met, the value is one. Data were from the pretest and posttest of students' analytical thinking skills, then the increase was calculated and expressed in the form of N-gain. The formula and category of N-gain values can be seen in Table 6 (Hake, 1998).

Table 6. The formula and category of N-gain values

Equation	**Value Gain**	**Category**
$(g) = \frac{S_{post} - S_{pre}}{S_{max} - S_{pre}}$	$(g) \geq 0.7$	High
	$0.7 > (g) \geq 0.3$	Medium
	$(g) < 0.30$	Low

S_{post} = mean score of posttest

S_{pre} = mean score of pretest

S_{max}= maximum score

In Table 6, the N-gain equation was used to determine the quality of the improvement in students' analytical thinking skills. To compare the pretest and posttest, the t-test was used, because the data were normally distributed based on the results of the normality test.

The normality test was assisted by SPSS Version 20. The results of the normality test were in Table 7. Based on the Kolmogorov-Smirnov and Shapiro Wilk tests, the level of significance taken is $\alpha = 0.05$ if the table is Sig. > α, the data is normally distributed, and Sig. < α; the data is normally undistributed.

Table 7. Tests of normality

	Kolmogorov-Smirnov			**Shapiro-Wilk**		
	Statistic	**df**	**Sig.**	**Statistic**	**df**	**Sig.**
Pretest	0.133	34	0.136	0.974	34	0.585
Posttest	0.108	34	0.200	0.973	34	0.540

Table 7, presents the interpretation of the results of the normality test and data on pretest and posttest of analytical thinking skills. The significance values respectively were 0.136 and 0.200; all are greater than $\alpha = 0.05$. It can be concluded that the analytical thinking skills data from the pretest and post-test results demonstrated a normal distribution.

Qualitative data were from observations and interviews and analyzed through three stages: data reduction, data display, and conclusions. Data reduction was conducted by sharpening, classifying, organizing, and removing unnecessary ones. Then, the data were presented in the narrative text to conclude.

Findings/Results

Observation Results of Learning Implementation

Observations were conducted on the learning process that implemented the RBL model in science learning with the concept of energy for four meetings. Each meeting began with an introduction, core, and closing activities. In preliminary activities, the lecturer explained the relationship between the previously studied material and the material to be studied at that time and also conveyed the learning objectives. The core activity focused on investigation activities, from planning to conclusion. In the closing activity, the lecturer asked students to collect reports of their investigations.

The results of observation are listed in Table 8.

Table 8. Observation findings

No	**Lecturer Activities**	**Student Activities**
1	The lecturer directed students to find and formulate problems.	Students identified problems by discussing in groups and continuing to formulate problems.
2	The lecturer directed the process of investigation related to the course of the experiment.	Students communicated 2-way with the lecturer and other students in conducting experimental activities.
3	The lecturer guided students in analyzing experimental data.	The mentored students analyzed and inferred experimental data with their group members.
4	The lecturer directed students to make conclusions and report on experimental activities.	Students carried out group discussions in making experimental conclusions.
5	The lecturer facilitated establishing discussions and presentations in class.	The results of group discussions were presented in front of the class to get input from both lecturer and fellow students.

Table 8, describes the activities of the lecturer and students during learning, by applying the RBL model.

The observer gives a score of four if it is very good, a score of three if it is good, a score of two if it is enough, and a score of one if it is not good. The results of the observations were listed in Table 9.

Table 9. Observation results of the RBL model learning process

No	Activities	Assessment				Mean Score	Category value	Information
	Preliminary	I	II	III	IV			
1	Relate current learning material with previous learning.	3	4	4	4	3.75	3.625	Very good
2	Deliver learning objectives.	4	3	3	4	3.50		
	Core							
3	Formulate problems	3	4	4	3	3.50	3.714	Very good
4	Review the theoretical basis	3	4	4	3	3.50		
5	Define the problem statement	4	3	4	4	3.75		
6	Plan investigation activities	4	3	4	3	3.50		
7	Conduct investigation and data analysis	4	4	4	4	4.00		
8	Explain the research results	4	4	3	4	3.75		
9	Create reports and presentations of results	4	4	4	4	4.00		
	Closing							
10	Collect work	3	4	4	4	3.75	3.75	Very good

Table 9, roman I, II, III, IV shows the observer's assessment at the 1st, 2nd, 3rd, and 4th meetings in the implementation of the RBL model. The data obtain the mean score is categorized very good for the activities of the lecturer and students in teaching and learning. These activities were conducted for four meetings by applying the RBL model. The values of preliminary activities were 3.625, core activities were 3.714, and closing activities were 3.75 with a maximum score of 4.

Examples of data from observations and conclusions created by students are illustrated in Figures 3 and 4.

a) **F. Data percobaan:**

Energi listrik diperoleh dari 2 baterai yang dirangkai secara seri, lalu disambungkan ke motor listrik yang akan menghasilkan energi gerak, hal ini dapat dibuktikan dengan berputarnya baling-baling buatan, kemudian dari energi gerak akan menghasilkan energi listrik kembali dengan bukti menyalanya lampu secara terang. Jika saklar ditekan kebawah atau terjadi rangkaian tertutup, listrik akan mengalir dan baling-baling akan berputar sekaligus lampu akan menyala terang. Namun sebaliknya apabila saklar dinaikkan atau terjadi rangkaian terbuka, listrik tidak mengalir dan baling-baling tidak berputar sekaligus lampu tidak menyala.

b) **F. Experimental Data**

Electrical energy was obtained from two batteries connected in series, then connected to an electric motor which would produce kinetic energy. This could be proven by rotating the artificial propeller, then from the kinetic energy, it would generate electrical energy again with evidence of bright lights. If they pressed the switch down or a closed-circuit occurred, electricity would flow, and the propeller would spin, and the light would turn bright. On the other hand, if the switch was raised or an open circuit occurred, electricity did not flow and the propeller did not rotate, and the light did not turn on.

Figure 3. Examples of data on the results of student investigations (a- Original version was written in Indonesian b- English translation)

Based on the data from the results of the investigation, then the students conducted a qualitative analysis and created conclusions, as shown in Figure 4.

a) **G. Kesimpulan:**

Dari percobaan yang kami lakukan, dapat disimpulkan bahwa dari energi listrik dapat diubah menjadi energi gerak dengan dibuktikan berputarnya baling-baling, dan dari energi gerak dapat diubah menjadi energi listrik dengan dibuktikan menyalanya lampu dengan terang.

b) G. Conclusion

From the experiments we had conducted, it can be concluded that electrical energy can be converted into kinetic energy, as evidenced by the rotation of the propeller. In addition, from the kinetic energy, it can be converted into electrical energy by proving the light is bright.

Figure 4. Examples of students' conclusions (a- Original version was written in Indonesian b- English translation)

In Figure 4, an example of the conclusion made by students is given: Electrical energy can be converted into kinetic energy by proving that the propeller is rotating, and the kinetic energy can be converted into electrical energy by proving that the light is on.

Results of Interviews with Students

Interviews were conducted after completing the implementation of the RBL learning model, on three students who were selected randomly. The results of the interview can be summarized in Table 10.

Table 10. Student responses to the implementation of the RBL model

Question	Answer
Was the learning conveyed by the lecturer fun? Why?	Yes, because it varied and did not make you sleepy
Is there any new experiences following this lesson? If so, what?	Yes, practice doing investigations, and analyzing data.
Were there any difficulties when taking part in learning activities? If there were any parts?	Actually, there were, but it could be resolved during discussions with friends. The part, analyze and lead to conclusions.
What was the most interesting part of learning? And which part was boring?	When investigating or experimenting, it was very interesting. Nothing was boring, but reporting took a lot of time.
Did you feel that there were new learning methods used in lecturing?	Yes, it was new and made students active in lecturing.

From the results of the interviews in Table 10, the researcher perceived that students were happy in taking classes with the RBL model because lecturing was varied and not monotonous. Students got new experiences in lecturing, researching, and analyzing data. According to students, this section was the most interesting, despite the difficulties, before discussing with their group of friends. However, when students answer the question "What are the shortcomings of the RBL model?". Students' answers were varied. For example, it takes a long time to prepare, costs money, and it is difficult to get the tools needed.

Results of Analytical Thinking Skills Test

Based on the results of the test analysis, it was found that the mean score of analytical thinking skills of students is categorized as high. Regarding the criteria used: $81,25 < X \leq 100$ (very high), $71,50 < X \leq 81,25$ (high), $62,50 < X \leq 71,50$ (medium), $43,75 < X \leq 62,50$ (low), dan $0 < X \leq 43,75$ (very low).

The results of each indicator of students' analytical thinking skills with a rating scale [0, 100], can be seen in Table 11.

Table 11. The results of data analysis on the indicators of analytical thinking skills

Indicator of Analytical Thinking Skills	Mean Score of Indicator	Indicator Category
Differentiate	79.58	High
Organize	76.96	High
Attribute	73.29	High
Mean Score	76.61	High

The results of the pretest and posttest data analysis, with the number of respondents 34 students, can be seen in Table 12.

Table 12. Recapitulation of the pretest-posttest results

Score	Total	Ideal	Minimum	Maximum	Mean
Pretest	34	100	32.50	60.00	46.84
Posttest	34	100	67.50	87.50	76. 91

The results of the analysis, the value (g) = 0.5657, is in the medium category. The mean score of pretest and posttest data can be seen in the bar chart in Figure 5.

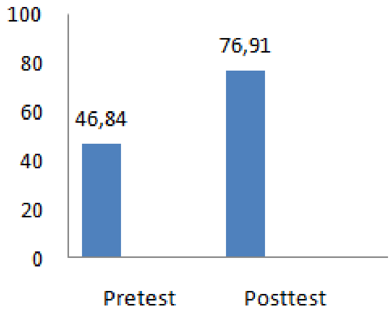


Figure 5. Mean of pretest and posttest scores

Based on Figure 5, overall, there is an increase in indicators of analytical thinking skills, as evidenced by an increase in the mean score from pretest to posttest.

The paired samples test using SPSS version 20 was in Table 13. Decision-making in paired samples test was based on the significant value of the SPSS output results. If the significance (2-tailed) value < 0.05, there is a significance difference between the pretest and posttest.

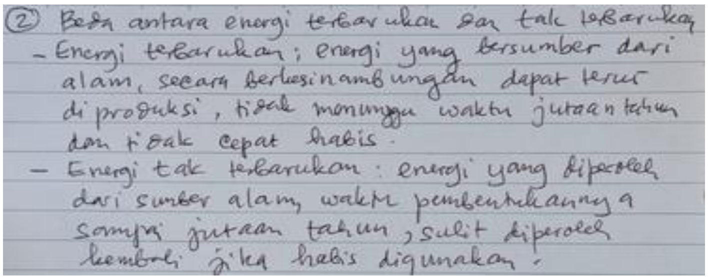
Table 13. Paired sample test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Pretest - Posttest	-11.29412	2.88706	0.49513	-12.30146	-10.28677	-22.811	33	0.000

Based on Table 13, the output of paired samples test had the significance (2-tailed) value of 0.000 < 0.05. So, there is a difference in the mean score of analytical thinking skills between the pretest and posttest. This means there is an effect of the application of the RBL model in improving students' analytical thinking skills on energy concepts.

For example, a student's answer for question number 2 was presented, differentiating indicators in Figure 6.

a)



② Beda antara energi terbarukan dan tak terbarukan
- Energi terbarukan : energi yang bersumber dari alam, secara berkesinambungan dapat terus diproduksi, tidak menunggu waktu jutaan tahun dan tidak cepat habis.
- Energi tak terbarukan : energi yang diperoleh dari sumber alam, waktu pembentukannya sampai jutaan tahun, sulit diperoleh kembali jika habis digunakan.

b)

The difference between renewable and non-renewable energy:

Renewable energy: energy that comes from nature, can continually be produced, does not wait millions of years, and does not run out briskly.

Non-renewable energy: energy is obtained from natural sources, the time of its formation to millions of years, is difficult to recover if it is consumed out.

Figure 6. Examples of students' answers to item 2 on differentiating indicators (a- Original version was written in Indonesian b- English translation)

In Figure 6, students have been able to answer well, distinguishing between renewable and non-renewable energy.

Discussion

Based on the data analysis, applying the RBL model in science learning was running very well, as evidenced by the results of the four observations with the mean score is 3.714. The learning activities referred to the steps in the RBL model suggested by Tremp: (1) formulating a general question; (2) over-viewing of research literature; (3) defining the question; (4) planning research activities, clarifying methods or methodologies; (5) investigating, analyzing data; (6) interpreting and considering the results; and (7) reporting and presenting the results (Tremp, 2010).

In the implementation of the RBL model, students can explore and conduct investigations. This activity can train students on how to acquire and construct new knowledge on their own (Srikoon et al., 2014). Therefore, the RBL model can be an alternative to the applied learning model, because, through this model, students can explore, obtain learning outcomes, including knowledge, skills, and scientific attitudes. Investigation activities were carried out in groups consisting of three to four students, because according to Poonpan and Siriphan (2001) that the RBL model uses a cooperative classroom setting and learning through discovery.

The RBL model developed student understanding, learning that involved a process of social interaction, and meaningful learning achieved through real-world experiences (Susiani et al., 2018). In addition, the RBL model was useful for 1) encouraging the role of students in the learning process, 2) students were familiar with the thinking process with a scientific approach, 3) students were independent, logical, critical, and creative, 4) students were trained in ethics (Yulhendri, 2019).

The RBL model encouraged students to carry out research activities. The RBL model can train students to think critically and conduct research activities such as conducting searches, compiling hypotheses, collecting data and processing data, and drawing conclusions (Ramahwati, 2016). The RBL model is a learning process able to build their knowledge by practicing through a series of observation and analysis activities (Nursofah et al., 2018), such as the process of concluding the analysis of experimental data carried out by students.

The atmosphere of implementing the PBL model based on the results of interviews with students; students were happy to participate in learning with the RBL model because learning was varied and not monotonous. The RBL model can develop critical inquiry attitudes, multiple ideas, and creative solutions. In addition, the RBL model can improve academic achievement, train learning on how to learn, and build new knowledge by students' self (Camacho et al., 2017; Srikoon et al., 2014). Students get new experiences in learning, investigating, and analyzing data. According to students, this section was the most interesting even though there were difficulties, in making conclusions, before discussing with their peers. The RBL model provides opportunities for students to develop critical attitudes, get used to scientific thinking, and practice ethics (Yulhendri, 2019), including conveying ideas to lecturers and peers in polite language.

The RBL model application in science learning can improve analytical thinking skills, and as evidenced by the N-gain value of 56.57% in the medium category, which means the greater the N-gain value, the greater the improvement in student's analytical skills. This increase can also be seen from the mean score of the pretest of 46.84 and posttest 76.91. The results of the mean score of student analytical thinking skills were 76.91 with a high category. This showed that students had mastered the concept of energy well. The indicators: distinguish, organize, and attribute were all high categories with sequential values: 79.58, 76.96, and 73.29. The results of the paired t-test revealed that there is an effect of the application of the RBL model in improving students' analytical thinking skills on the concept of energy.

Furthermore, the RBL model can influence analytical thinking skills because the skills trained to students are differentiating, classifying, and attributing. These skills are acquired during the learning process by applying the RBL model. Every step of the RBL model trains the aspects of analytical thinking skills. These results showed that applying the RBL model can improve academic achievement, train learning on how to learn, and build new knowledge by yourself (Camacho et al., 2017; Srikoon et al., 2014). In conclusion, the RBL model can be an alternative model applied to learn, because, through this model, students can explore, interpret, and synthesize information to get various learning outcomes, including knowledge, skills, and attitudes.

Conclusion

Based on the data analysis and discussion, it can be concluded that; 1) The RBL model in science learning with the concept of energy runs very well, as indicated by the score of preliminary activities is 3.625, the score of core activities is 3.714, and the score of closing activities is 3.75 with a maximum score of 4, 2) The activities of lecturer during learning, by applying the RBL model, can encourage students to carry out research activities, based on the positive response of students when being interviewed, 3) The RBL model application in science lectures on energy materials can improve students' analytical thinking skills, as evidenced by the N-gain value of 0.5657 in the medium category and strengthened by the results of the paired sample test which has a significance value (2-tailed) of 0.000 < 0.05, 4) The results of this study provided general information to lecturers and researchers about implementing RBL model lectures in tertiary institutions in science learning in energy material.

Recommendations

It is expected that the following researchers, who want to measure analytical thinking skills, should select another and more effective learning model than the learning model studied by the researcher. This aims to investigate the level of effectiveness of other learning models in improving analytical thinking skills. Another model referred to by the researcher is an inquiry-based learning model, such as a problem-based learning model. Problem-based learning and research-based learning require adequate laboratories and equipment to support investigations.

Limitations

This research is limited to the concept of 'Energy' for students in Indonesia. The results provide an overview to lecturers and researchers about the condition of students' analytical thinking skills in science learning, especially in the concept of 'Energy'. Another limitation in this study, the absence of a control group as a comparison to the experimental group, as well as the few students who were interviewed, only 3 people. Future researchers are expected to improve this research by expanding the topic discussion, employing a control group as a comparison of an experimental group, and interviewing more respondents to receive an objective response on the learning process.

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Authorship Contribution Statement

Suyatman: Conceptualizing and designing, collecting and analyzing data, and compiling manuscripts. Saputro S.: Collecting and analyzing data, and revising the manuscript. Sunarno W.: Providing technical support, supervising, and providing final approval. Sukarmin: Collecting and analyzing data, compiling manuscripts, and interpreting data

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