The implementation of research based learning and the effect to the student metacognition thinking skills in solving $H$-irregularity problem

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Abstract. This study aims to develop learning tools based on Learning Based Research and produce learning tools in the form of student worksheets (LKM), learning outcomes tests (THB) and monographs and describe the profile of students’ metacognitive skills. The procedure of this study refers to Thiagarajan’s 4D development model which consists of 4 stages, namely defining, designing, developing, and disseminating. This research is a type of mixed research method which is a multimethod approach. Data collection techniques using test methods, interviews, observation and documentation. Educational research data analysis techniques using quantitative research approaches, data collection techniques are usually carried out with test techniques. While data collection techniques in qualitative research generally use observation techniques, in-depth interviews and documentation. The results showed, after the application of research-based learning, 14% of students were categorized in low-level mathematical metacognition thinking skills, and 34% were categorized as medium-level mathematical metacognition thinking skills and 52% were categorized in high-level mathematical metacognitive thinking skills. The results revealed that the implementation of research-based learning can improve the ability of students' metacognitive thinking skills in solving H-Irregularity problems.

1. Introduction

The purpose of a learning process is to provide an effect or impact on one application phase in the form of problem solving, integration, separation, and preparation between concepts. According to Polya (1973) the problem-solving solution contains four steps of the completion phase, namely: understanding the problem, planning the solution, solving the problem according to the plan and re-checking all the steps that have been done. The development of the students’ skills needed is the existence of metacognition skills in the learning process. Metacognition according to Livingstone (1996), namely thinking about thinking or thinking about the thought process itself. Metacognition is related to monitoring and controlling the mind, so that someone consciously plans, monitors, and evaluates a learning process that is being carried out.

In principle, if related to the learning process, metacognition ability is the ability of a person to control the learning process, with several indicators starting from the planning stage, choosing the right strategy according to the problem at hand, then monitoring progress in learning and simultaneously correcting if there are errors that occur during understand the concept, and analyze the effectiveness of the chosen strategy [9]. An understanding of the abilities, strategies, and resources needed in a task; and the ability of how and when to use it to ensure that the task can be completed perfectly are two forms of ability of metacognition skills [11]. A knowledge someone based on their
operations or individual's ability to think is an explanation of cognitive awareness called metacognition. Where this process can affect the data stored or characteristics associated with information and stored in achieving goals. [2]. Metacognition thinking skills are influenced by three factors, where each indicator has several sub-indicators. The following table provides indicators and sub-indicators of metacognition thinking.

Table 1. Indicators of Metacognitive Thinking Ability

| No | Indicator | Sub Indicator |
|----|-----------|--------------|
| 1. | Planning  | Read and understand the questions given.   |
|    |           | Being able to predict the plan used to solve the problem |
|    |           | Being able to determine the plan used to solve the problem |
|    |           | Able to involve prior knowledge in problem solving |
|    |           | Believe the chosen settlement plan is correct |
|    |           | Take the right steps |
| 2. | Monitoring| Monitor the method used in the settlement |
|    |           | Able to manage the results |
|    |           | Re-check the process. |
|    |           | Decide that every step in the answer given is correct |
| 3. | Evaluating| Able to apply this method for other problems |
|    |           | Evaluate the methods used in solving problem. |

In solving a problem each student has different abilities. This is because every student has a different level or ability of metacognition. According to Swartz and Perkins [5] different levels of metacognition abilities in dealing with problems include Tacit use, Aware use, Strategic use and Reflective use.

One learning model that directs student metacognition skills is research-based learning (RBL). Dafik, et al [7] RBL is a learning method that uses contextual learning, authentic learning, problem solving, cooperative learning, hand on and mind on learning, and inquiry discovery approach. Sota, et al [12] The concept that refers to learning and teaching strategies related to research and learning is the understanding of the RBL. According to Tohir, et al [14] explained that research-based learning is a learning system that uses authentic-learning (learning by using real examples), problem solving (problem solving), cooperative learning (cooperative learning), contextual (hand on and mind on) and inquiry approaches based on the philosophy of constructivism. The syntax of the Research Based Learning (RBL) model according to Arifin [4], namely there are three main groupings of steps that must be present in the Research Based Research stage, namely: Exposure Stage, which is gathering information based on inquiry and searching literature on a particular topic (focused topic); Experience Stage, which is identifying and formulating problems based on literature studies and experimental experience; Capston stage, conveying plans or ideas in providing solutions to problems or methods of measurement or computing.

The implementation of the RBL aims to encourage the development of higher-order thinking skills among lecturers and students, LA Monalisa et al [10]. Yudha, et al [8] Increased learning motivation, increased ability to do important work, and increased problem solving skills, especially when dealing with complex problems are the benefits to students by using RBL. Based on the description above, the researcher aims to develop a learning tool based on RBL to analyze students' metacognitive thinking skills. Where the development of learning tools will be focused on discrete modeling with H-irregularity material, because discrete modeling requires students to use their creative abilities in modeling problems that are often encountered in daily life into mathematics.

Definition 1. Let $G$ be a graph with a set of vertices $V$ and set of sides $E$. From the labeling of total irregular sides it is known that for a graph $G = (V, E)$ can be defined as a function $f$: $V(G) \cup E(G) \rightarrow \{1, 2, 3, \ldots, \alpha\}$ is the value of total edge irregularity strength if for each of the two different sides $e_1$ and $e_2$ of $G$ each have $w(e_1) \neq w(e_2)$ where the weight of a side $e_1 = \{u, v\}$ on the function $f$ is $w$ $w(e_1) = f(u) + f(v) + f(e_1)$.
The total $H$-irregular $a$-labeling from the minimum where the graph $G$ is called the total $H$-irregularity strength of $G$, is denoted by $t_{Hs}(G)$. The minimum $k$ where $G$ has an edge labeled $k$ is an irregular total $k$ is the definition of the strength of the total irregularity, $tes(G)$. The strength of the irregularity of the edge $G$, denoted by $es(G)$ is a minimum $K$ where graph $G$ has an irregular labeled $k$ [13]. The total strength of Irregularity $G$, $t_{Hs}(G)$, is the minimum where graph $G$ has an irregular total labeling subgraph. The assignment of positive label integers 1, 2, ..., 1 for both of vertices and edges is called a label l number of irregular so that the weight is calculated on a different vertices [1].

This research is poured into a thesis entitled "Development of Mathematical Learning Devices Based on Research Based Learning in Improving Students’ Metacognition Thinking Skills on H-Irregularity Material”.

2. Research Methods
In this study, researchers used a mixed method that combines quantitative and qualitative research methods. Mixed methods are used to analyze student learning outcomes and metacognitive thinking skills. The convergent parallel research method is a mixed method design by the researcher to provide a comprehensive analysis by collecting data or combining quantitative and qualitative [6]. Quantitative methods are used to analyze student learning outcomes while qualitative methods are used to analyze the results of interviews of selected students [11]. The results of the analysis are conducted separately then a comparison is performed to see whether the findings inform or not between the two data [3]. The planning in this study is to divide the research class into two namely the control class and the experimental class. In the control class conventional learning is implemented using the lecture and question and answer method. While in the experimental class research-based learning is applied, namely RBL.

Table 2. Pre-test and post-test grouping designs

| Class                  | Pretest | Treatment | Posttests |
|------------------------|---------|-----------|-----------|
| Control (N = 35)       | R1      | Conventional | R2       |
| Experimental (N = 35) | R1      | X         | R2       |

2.1. Research Focus
This research focuses on analysis the students’ metacognition thinking skills in solving the H-Irregularity problem.

2.2. Sample
The subjects of this study were third semester students of Class A and B mathematics department of FKIP Jember University. The class used as a control class is class A with 35 students, while class B with 35 students as an experimental class.

2.3. Instrument
The instrument in this study used test results of learning and interviews. The results of the study in the form of students’ post-test and pre-test scores were obtained from the results of the study tests conducted by students. In this research using the an assessment in accordance with the criteria of metacognition thinking was given to students in the experimental class. The tasks used in this study are MFIs that are adapted to RBL learning and are based on metacognitive thinking criteria. The material provided in the assignment also corresponds to the H-irregularity material.

2.4. Task
In this study, students are given assignments based on metacognition thinking criteria. Assignments given to students consist of LKM that are adapted to learning based on metacognition thinking. The following are tasks based on metacognition thinking, namely students who are able to determine plans after reading questions and completing answers according to plans made. In addition, students can label edges and vertex and calculate the
value of $tHs$ from the graph. The assignment is also in accordance with the $H$-Irregularity strength material as follows:

![Graph Example](image)

**Figure 1.** Example H-Irregularity Strength of diamond graph

Students label vertex and edge in each subgraph, and then determine the weight value and calculate the cardinality and calculate the value of $tHs$ when it's expanded and was added.

2.5. **Data collection and analysis**

Before looking at the results, we tested the reliability and validity of the instruments used in the study. The initial research conducted was to use a quantitative method that was applied to all research students. Quantitative methods are used to determine the value of student learning outcomes. Namely by doing pre-tests in both control and experiment classes. After conducting pre-tests in both classes, the next step is to apply conventional learning models in the control class and RBL learning models in the experimental class. Next is giving a post-test to see whether there is a change in the value of student learning outcomes. After getting the value of learning outcomes, further research uses qualitative methods. The results of the guided interviews conducted on several students' then observed to get a portrait of the metacognitive thinking phase.

![Data Collection Diagram](image)

The analysis of student metacognition thinking skills
Solving under the implementation of RBL.
To test the research hypothesis formulated, an independent sample t-test was used with a significance level of 5% or 0.05.

$H_0$ = The ability to think metacognition students who use problem-based learning is lower than or equal to the ability to think metacognition students who do not use problem-based learning.

$H_1$ = The ability to think metacognition students who use RBL is higher than the ability to think metacognition students who do not use RBL.

Information:
- If the value of $p < 0.05$ then reject $H_0$ and accept $H_1$
- If the value of $p \geq 0.05$, accept $H_0$ and reject $H_1$

3. Research Findings

3.1 Instrument validation

Before showing the results, the researchers conducted a validity and reliability test on the instrument used in the study. The following table shows the results of the validity and reliability test:

| Table 3. Results of question validity |
|---------------------------------------|
| **Item** | **Correlations** | **Skor_Total** |
|          | **Item_1** | **Item_2** | **Item_3** | **Item_4** | **Item_5** |
| Pearson Correlation | 1 | .268 | .067 | .248 | .012 | .507** |
| Sig. (2-tailed) | .120 | .004 | .293 | .151 | .943 | .002 |
| N | 35 | 35 | 35 | 35 | 35 | 35 |
| Pearson Correlation | .268 | 1 | .475** | -.002 | .166 | .598** |
| Sig. (2-tailed) | .120 | .004 | .293 | .151 | .943 | .002 |
| N | 35 | 35 | 35 | 35 | 35 | 35 |
| Pearson Correlation | .067 | .475** | 1 | .204 | .272 | .654** |
| Sig. (2-tailed) | .703 | .004 | .293 | .151 | .943 | .002 |
| N | 35 | 35 | 35 | 35 | 35 | 35 |
| Pearson Correlation | .248 | -.002 | .204 | 1 | .197 | .558** |
| Sig. (2-tailed) | .151 | .991 | .239 | .113 | .004 | .000 |
| N | 35 | 35 | 35 | 35 | 35 | 35 |
| Pearson Correlation | .012 | .166 | .272 | .197 | 1 | .636** |
| Sig. (2-tailed) | .943 | .342 | .113 | .256 | .000 | .000 |
| N | 35 | 35 | 35 | 35 | 35 | 35 |
| Pearson Correlation | .507** | .598** | .654** | .558** | .636** | 1 |
| Sig. (2-tailed) | .002 | .000 | .000 | .000 | .000 | .000 |
| N | 35 | 35 | 35 | 35 | 35 | 35 |

**. Correlation is significant at the 0.01 level (2-tailed).

Based on Table 3, it is found that the value for validation of question number 1 is 0.507, question number 2 is 0.598, question number 3 is 0.654, question number 4 is 0.558 and question number 5 is 0.636. And from the five question items all values are valid because they meet the criteria $> \frac{N}{5}$ with $N = 35$.

| Table 4. The results of the reliability test question |
|-----------------------------------------------|
| **Reliability Statistics** | **Cronbach’s Alpha** | **N of Items** |
|-------------------------------|----------------------|----------------|
|                               |                      | 0.523 | 5 |

From Table 4 above, it is obtained that the reliability value is 0.523 and a significant 5% level with $\alpha = 0.2826$, therefore $> \alpha$ it can be concluded that the question instrument can be used.

3.2 Results on test work on questions

In this study using 2 groups, namely the experimental group using research-based learning consisting of 35 students and the control group with conventional learning consisting of 35 students. Before learning is done in the experimental group and the control group pre-test it first. The pre-test results of the two groups can be seen in the following figure:
The study was conducted on 35 students in the control class (figure 1) to determine the level of metacognitive thinking. 35 subjects were tested using pre-tests and found 20% of students were at the level of aware use, 34% of students were at the level of strategic use and 46% of students were at the level of reflective use. Then the pre-test in the experimental class (figure 2) resulted in 29% of students being in the level of aware use, 31% of students in the level of strategic use and 40% of students in the level of reflective use.

The next step is to analyze the data obtained from the pre-test and post-test using the SPSS application. Data analysis performed using SPSS is a quantitative method. Pre-test data from both classes were tested using homogeneity test. Homogeneity test is performed to determine whether the variance of the population is the same or not. Homogeneity test results of the pre-test data of the control class and the experimental class can be seen in the following table 5:

| Test of Homogeneity of Variances | Pretest | Levene |
|----------------------------------|---------|--------|
|                                 | df1     | df2    | Sig.  |
|                                 | 1       | 71     | .105  |

In Table 5, the homogeneity test results obtained a significant value of 0.105. Based on SPSS calculation, it is known that the significance value of the homogeneity test results is 0.105> 0.05 which shows that between the control class and the experimental class has a homogeneous variance.

Then the normality test is performed. Normality test is used to determine know the distribution of research data is normal or not. The results of the normality test data of the control and the experimental class can be seen in the following table 6:
In Table 6, the normality test results obtained significant values in the control class 0.188 and 0.200 in the experimental class. Based on the results of SPSS calculations, it is known that the significance value of the two classes > 0.05 which means that both classes are normally distributed. Then an independent sample test is carried out which aims to find out whether the research data is independent or not. The independent test results can be seen in table 7 below:

### Table 6. Pre-test data normality test

| Tests of Normality | Kolmogorov-Smirnov<sup>a</sup> | Shapiro-Wilk |
|--------------------|-------------------------------|--------------|
|                    | Statistic | df | Sig. | Statistic | df | Sig. |
| pre-test           |           |    |      |           |    |      |
| Control Class      | .124      | 35 | .188 | .941      | 35 | .059 |
| Experiment Class   | .112      | 35 | .200 | .961      | 35 | .237 |

* This is a lower bound of the true significance.

a. Lilliefors Significance Correction

In Table 6, the normality test results obtained significant values in the control class 0.188 and 0.200 in the experimental class. Based on the results of SPSS calculations, it is known that the significance value of the two classes > 0.05 which means that both classes are normally distributed.

Then an independent sample test is carried out which aims to find out whether the research data is independent or not. The independent test results can be seen in table 7 below:

### Table 7. Independent Sample Test

| Independent Samples Test |
|--------------------------|
| Levene's Test for Equality of Variances |
| t-test for Equality of Means |

|                  | F    | Sig. | t    | df | Sig. (2-tailed) | Mean Difference | Std. Error Difference | 95% Confidence Interval of the Difference | Lower | Upper |
|------------------|------|------|------|----|-----------------|-----------------|----------------------|------------------------------------------|-------|-------|
| pre-test         | 1.263 | .265 | - .806 | 68 | .423            | -1.45714        | 1.80828              | -5.06550 - 2.15122                       |       |       |
| Equal variances assumed | |    |      |    |                 |                 |                     |                                          |       |       |
| Equal variances not assumed | |    |      |    |                 |                 |                     |                                          |       |       |

Table 7 is the results of pre-test independent tests of both classes. The independent test results obtained significance value (2-tailed) 0.423. Based on the SPSS calculation results, it is known that the significance value is 0.423 > 0.05 which means that it is not significant. The meaning that the pre-test of the two classes is not different.

After that a t-test was conducted on the pre-test value to see the average of the two classes. T-test was conducted to see the average comparison between pre-test and post-test. The results of the t-test can be seen in Table 8 below:

### Table 8. T-Test Test

| Statistics Group |
|------------------|
| Group            | N   | Mean  | Std. Deviation | Std. Error Mean |
| pre-test         |     |       |                |                |
| Control Class    | 35  | 60.1714 | 6.54166       | 1.10574       |
| Experiment Class | 35  | 61.6286 | 8.46476       | 1.43080       |

From the t-test results obtained an average (mean) 60.1714 control class and 61.6286 experimental class.

The study continued with conventional learning in the control class and RBL learning in the experimental class. After being given effect, a post-test was conducted to determine the level of metacognitive thinking.
The study was conducted on 35 students in the control class (figure 1) to determine the level of metacognitive thinking. 35 subjects were tested using pre-tests and found 9% of students were at the level of aware use, 34% of students were at the level of strategic use and 57% of students were at the level of reflective use. Then the pre-test in the experimental class (figure 2) resulted in 14% of students being in the level of aware use, 34% of students in the level of strategic use and 52% of students in the level of reflective use.

Then an independent sample test is carried out which aims to find out whether the research data is independent or not. The independent test results can be seen in the following table 9:

| Table 9. Independent Sample Test |
|----------------------------------|
| Independent Samples Test         |
| Levene’s Test for                |
| Equality of Variances            |
| F                                |
| Sig.                             |
| t                                |
| df                               |
| Sig. (2-tailed)                  |
| Mean Difference                  |
| Std. Error Difference            |
| 95% Confidence Interval of the Difference |
| Lower                             |
| Upper                             |
| Posttest                         |
| Equal variances assumed          |
| 2.694                            |
| .105                             |
| 5.856                            |
| 71                               |
| .000                             |
| -11.00301                        |
| 1.8798                           |
| -14.74959                        |
| -7.25642                         |
| Equal variances not assumed      |
| -5.930                           |
| 67.673                           |
| .000                             |
| -11.00301                        |
| 1.85551                          |
| -14.70595                        |
| -7.30006                         |

In Table 9, the independent test results obtained significant (2-tailed) 0.000. Based on SPSS calculation results, the value of 0.000 <0.05, which means that it is significant. In the average between
the post-test scores of the control class and the pre-test scores of the experimental class there are differences. The value of the experimental class is higher than the value of the control class. This shows that the application of research-based learning has an effect in improving students' learning abilities.

After that a t-test was conducted on the pre-test value to see the mean (mean) of the two classes. The results of the t-test can be seen in Table 10 below:

| Group         | N  | Mean   | Std. Deviation | Std. Error Mean |
|---------------|----|--------|----------------|-----------------|
| Post test     | 35 | 62.6286| 6.66018        | 1.12578         |
| Control class | 38 | 73.6316| 9.09238        | 1.47498         |

From the t-test results obtained an average (mean) control class 6.66018 and experimental class 9.09238. From the results above, it can be seen the difference between the average control and experimental class in the t-test pre-test data and post-test data.

3.3 Results in guided interviews

Researchers conducted guided interviews to find out in depth the process of thinking metacognition when the process of working on test questions. From the results of the guided interview produced a potential phase that describes the process of thinking metacognition by re-entering the implementation of RBL. The researcher selected 3 students who represented low, medium and high levels of metacognition to be interviewed.
The interview process with student A on his metacognition skills.

R : What do you know after reading the problem?
S : I was asked to develop a graph that is different from the others.
R : Try to explain, what kind of answer is asked by that question?
S : I must determine the cardinality, determine the labeling of points and their sides, calculate the weight and value of the Hs from the graph.
R : What steps will you take to solve the problem?
S : First I made a graph and developed it. Then calculate cardinality, determine the labeling of points and sides, and calculate weights. The last one calculates the value of the Hs from the graph. (Write steps to be taken on paper)
R : Do you understand about the sealing of points and their sides on graphs that you have developed?
S : Yes, mother, I understand, as you explained earlier, each point and neighboring side are labeled differently.
R : Are the steps you are doing right?
S : Yes ma'am, I have compiled it (checked the steps that have been written).
R : Have you calculated the cardinalities?
S : No ma'am, I counted the cardinality after labeling points and sides to make it easier to count.
R : Do you work according to the steps that have been arranged?
S : Yes, I have done it (students check more thoroughly).
R : Do you find difficulty in solving problems?
S : Yes ma'am, I have difficulty labeling points and sides (observing workmanship).
R : Are the steps you use correct?
S : Yes, mother, but I did not do it in sequence.
R : Can you do different problems with the same steps?
S : Yes ma'am (answer with hesitation)
R : Have you thoroughly checked your work?
S : Already mom, I check again to make sure my answer is correct (after a few minutes). Yes mother, I have checked the answer and I am sure my answer is correct.

Figure 7. Portrait Phase of the Student A

From the results of the guided interview above, it can be seen that the students have understood the purpose of the questions, arranged steps. However, students solve problems not based on the steps that have been prepared. Students do some initial steps at the end with the aim to make it easier, but this makes students confused with the results of the answers. This illustrates that students have not shown any serious attention in implementing completion steps. The final answer given by students after recounting is correct, but the steps taken in completion can have an effect (wrong). This can happen if the problem is presented in another form.
The interview process with student B on her metacognition skills.

R : What do you know after reading the problem?
B : I was asked to draw and develop a different graph from other friends.
R : Try to explain, what kind of answer is asked by that question?
B : Besides making a different graph and developing it, I also had to determine cardinality, determine the labeling of points and sides, calculate the weight and value of the graph of the graph.
R : What steps will you take to solve the problem?
B : First I made a graph and developed it. Then calculate cardinality, determine the labeling of points and sides, and calculate weights. The last one calculates the value of tHs from the graph. (write steps to be taken on paper)
R : Do you understand about the sealing of points and their sides on graphs that you have developed?
B : Yes mom, I understand, as you explained earlier, each point and neighboring side are labeled from the smallest number then for each label change between sub graphs must be the same in order to produce different weights and form a pattern.
R : Are the steps you are doing right?
B : Yes ma'am, I have arranged sequentially according to what was asked in the problem (checking the steps that have been written).
R : Have you calculated the cardinalities?
B : Not yet mother, I counted the cardinality at the end.
R : Do you work according to the steps that have been arranged?
B : No ma'am, I will rework sequentially according to the steps that I set (students pay attention to the results of the work).
R : Have you written down the answers as asked in the problem? Student B: Already mother, I have done it (students check more thoroughly). Researcher: Do you find difficulty in solving problems?
B : No ma'am, I can do everything (observe the workmanship).
R : Are the steps you use correct?
B : Yes, mother. Researcher: What you can do different problems with the same steps? Student B: Yes ma'am (answer confidently).
R : Have you thoroughly checked your work?
B : Already mom, I check again to make sure my answer is correct (after a few minutes). Yes mother, I have checked the answer and I am sure my answer is correct.

From the results of the tests and interviews guided above, it can be concluded that student B can complete the test questions. Student B can understand the purpose and objectives of the questions, plan completion steps and complete the work according to the steps that have been prepared and re-check. From the pattern formed, it is illustrated that student B is not in a hurry in solving problems.
and repeats at several points of completion. This is part of getting the right answer and minimizing errors.

4. Discussion
This study was intended to analyze the ability to think metacognition and the implementation of RBL learning models. This study found that the application of research-based learning with the RBL model had a significant influence on students' metacognitive thinking skills in the experimental class. Students in the experimental class group demonstrated metacognitive thinking skills compared to students in the control class. From the results of the post-test showed that the learning outcomes of the experimental class that received RBL model treatment were higher than the control class that used conventional models. Students in the experimental class have been able to understand concepts to solve problems, therefore RBL is very good at improving students' metacognitive thinking skills. From the data obtained in this study, the increase in student metacognition (pre-test-post test) in the experimental class 29% of students became 14% of students were in the level of aware use, 31% of students to 34% of students were in the level of strategic use and 40% of students became 52% of students are in the level of reflective use. Based on these results, it can be concluded that RBL is considered to help improve metacognitive thinking skills.

5. Conclusions
The purpose of this study was to determine whether RBL has an influence in improving students' metacognitive thinking skills. The results showed an increase in metacognitive thinking skills in the experimental group. Students with strong metacognitive thinking skills are able to go beyond their own metacognition indicators. As for students who have weak metacognitive thinking skills, they must be more careful in the re-examination phase. Improved thinking skills can be seen from the results of the post-test. Students in the experimental group scored better than those in the control class. This shows that the use of RBL can improve students' metacognitive thinking skills.

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References
[1] Al-Ukayli J W B 2018 International Journal of Science and Research (IJSR) Engineering & Technology 7(2) 1008-1022
[2] Anwarudin M and Dafik 2019 The analysis of students’ metacognition in solving local wisdom based mathematical problems and the application of murder strategy to increase their metacognition ability IOP Conference Series: Earth and Environmental Science 243(1) p 012051 IOP Publishing
[3] Arifin P 2010 Research Bassed Learnig (Bandung: Institut Teknologi Bandung)
[4] Arum R P 2017 Deskripsi Kemampuan Metakognisi Siswa Sma Negeri 1 Sokaraja Dalam Menyelesaikan Soal Cerita Matematika Ditinjau Dari Kemandirian Belajar Siswa AlphaMath: Journal of Mathematics Education 3(1)
[5] Creswell J W 2016 Desain Penelitian Metode Kualitatif, Kuantitatif, dan Campuran, 4th ed. ch. 10 288-319 (Yogyakarta: Pustaka Pelajar)
[6] Dini R P, Dafik and Slamin 2019 The analysis of generalization thinking Skills on solving local super H-decomposition antimagic total coloring regarding the application of research based learning Journal of Physics: Conference Series 1211(1) p 012080 IOP Publishing
[7] Yudha F, Dafik and Yuliati N 2018 The Analysis of Creative and Innovative Thinking Skills of the 21st Century Students in Solving the Problems of “Locating Dominating Set” in Research Based Learning International Journal of Advanced Engineering Research and Science 5(3)
[8] Kartikawati R D 2015 The implementation of teaching and learning for islamic education subject (fiqh) based on cognitive developmental psychology levels in MTsN Malang 1 International Journal of Engineering & Technology 7(3.30) 265-268
[9] Livingston J A 1996 Effects of metacognitive instruction on strategy use of college students. Unpublished manuscript, State University of New York at Buffalo.

[10] Monalisa L A, Dafik, Hastuti Y, Hussen S and Oktavianingtyas E 2019 The Implementation of research based learning in developing the students mathematical generalization thinking skills in solving a paving blocks design problem IOP Conference Series: Earth and Environmental Science 243(1) p 012168 IOP Publishing

[11] Polya G 1973 How To Solve it New Jersey: Princeton University Press

[12] Rohim M A, Dafik, Slamin and Sucianto B 2019 The analysis of implementation of research based learning implementation in developing the students’ creative thinking skill in solving dominating set problem IOP Conference Series: Earth and Environmental Science 243(1) p. 012143 IOP Publishing

[13] Sabrila A I T P, Dafik, Tirta I M and Malik R S 2019 Investigation the effect discovery-based learning on students’ metacognition in solving rainbow 2-connection numbers IOP Conference Series: Earth and Environmental Science 24(1) p 012053 IOP Publishing

[14] Schunk DH 2012 Teori Belajar dan Perspektif Pendidikan 6th edision. ch. 7 P., 400 (Yogyakarta: Pustaka Pelajar)

[15] Sucianto B, Dafik, Irvan M, and Rohim M A 2019 The Analysis of Student Metacognition Skill in Solving Rainbow Connection Problem under the Implementation of Research-Based Learning Model International Journal of Instruction 12(4) 1694-609

[16] Sota C and Peltzer K 2017 The Effectiveness of Research Based Learning among Master degree Student for Health Promotion and Preventable Disease, Faculty of Public Health, Khon Kaen University, Thailand. Procedia-Social and Behavioral Sciences 237, 1359-1365.

[17] Tarawneh I, Hasni R and Ahmad A 2016 On the edge irregularity strength of corona product of cycle with isolated vertices. AKCE International Journal of Graphs and Combinatorics, 13(3) 213-217

[18] Tohir M, and Abidin Z 2018 Students creative thinking skills in solving two dimensional arithmetic series through research-based learning Journal of Physics: Conference Series 1008 (1) p 012072 IOP Publishing