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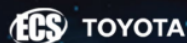
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Analysis of mathematical critical thinking skills: The impact of RMS (reading, mind mapping, and sharing) learning model assisted by PPW (props, powerpoint, and worksheet)

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Abstract. Mathematical critical thinking skills are required to improve the understanding of mathematics. The purpose of this research was to determine the influence of the RMS learning model (reading, mind mapping, and sharing) assisted by PPW (Props, PowerPoints, and Worksheets) toward students' thinking skills. This research is experimental research with a quasi-experimental design. The cluster random sampling technique was used to determine the sample. The data collection techniques used were tests. Before the tests were administered, they were tested using the realistic test, validity test, difficulty test, and discrimination index test. The data analysis technique used in this research was the one-way ANOVA with unequal cells. The results of the analysis showed that: $F_{\text{observed}} = 3.101296 < F_{\text{critical}} = 4.076109$ which indicated that H_0 was rejected. This indicated that there was an influence of the RMS learning model assisted by PPW on the students' thinking skills. Furthermore, concerning the hypothesis testing and data analysis, the result was that the RMS learning model assisted by PPW could significantly affect students' mathematical critical thinking skills.

Keywords: PPW, Mathematical Critical Thinking Skills, RMS

1. Introduction

Education is based on a mind that can actively increase one's potential [1, 2]. The development of science and technology helps to explore one's potential [3-5]. Also, attitudes and skills as well as basic knowledge and skills act as a means of knowledge science and technology [6,7]. Mathematics learning is considered as a scientific discipline that requires skills, accuracy, analysis, and critical thinking to create an active and creative learning atmosphere [8, 9]. The critical thinking skills require exercises to be used as a goal to make rational, sensible, and fact-making decisions which can be inferences to be considered by [10, 11]. The skills acquired are not only cognitive but rather affective and psychomotor [12-14]. One of the learning models that can be applied is RMS (reading, mind mapping, and sharing) that can improve metacognitive, retention, on the outcome of cognitive learning [15] as well as the skills of thinking and integrated communication so that the quality of human resources could be much superior [16, 17].



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This research utilized learning media, such as props, powerpoints, and worksheets that can be abbreviated to PPW [18, 19]. The use of powerpoints is interesting because there are many effects such as movement effects, pictures, and sounds that can stimulate students' imagination and attention to focus on the studied material [20]. The individual activities, discussions, and group collaboration are used to improve students' creativity and learning outcomes. Various studies had been conducted on the RMS Model on the basic concepts of science [21], RMS are able to improve intellectual capacity, critical, and creative thinking [22, 23], creativity [9, 24, 25], PPW [18], and mathematics [26, 27].

2. Research Method

This research is experimental, specifically the quasi-experimental design. The population of the research was the seventh-grade students in the 2019 academic year of Junior High School Al-Azhar 3 Bandar Lampung which consisted of five classes ranging from class VII A to VII E.

The samples in this study were selected randomly, the class that implemented the RMS learning model assisted by PPW, the class that implemented the RMS model, and the control class that applied a conventional learning model. Researchers employed the cluster random technique as the sampling technique.

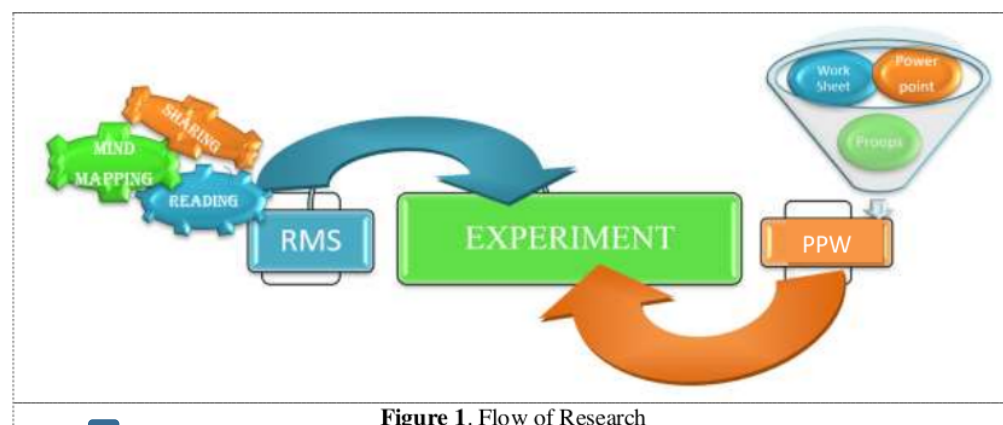


Figure 1. Flow of Research

The data collection techniques used in this research were tests. Before the test, the instruments had been tested in the form of realistic tests, validity tests, difficulty level test, and discriminating index test. The data analysis technique used for hypothesis testing was one-way ANOVA with unequal cells. Prerequisite tests were performed in the form of normality test with the Liliefors test and homogeneity test with the Bartlett test.

3. Results and Discussion

Based on the obtained data, a summary of the mathematical critical thinking skills data is presented in Table 1.

Table 1. The Mathematical Critical Thinking Skills Data

Group	Number of Value	Average	Variation	Standard deviation	Minimum	Maximum
RMS Assisted						
PPW	2430	78.3871	102.311	10.114	68.2721	88.502
RMS	2330	75.16129	149.139	12.212	62.949	87.3737
Control	1950	69.64286	172.089	13.118	56.524	82.761

Based on the analysis, it can be concluded that the students' mathematical critical thinking skills were different between the control class and the experimental class.

Table 2. The Normality Test Result

Group	$L_{observed}$	$L_{critical}$	Conclusion
Control	0,03571	0,1590	Normal
RMS assisted PPW	0,032	0,1559	Normal
RMS	0,03325	0,1559	Normal

Based on table 2, the values of $L_{observed}$ were lower than $L_{critical}$ with a significance level of 0.05. This means H_0 was accepted. So, it can be concluded that the sample groups came from a normally distributed population.

Table 3. The Homogeneity Test Result

Criteria	N	si2	DK	dk.si2	log.si2	dk.logsi2
Experiment 1	31	102.31	30	3069.35	2.01	60.3
Experiment 2	31	149.14	30	4474.19	2.17	65.21
Control	28	172.09	27	4646.43	2.24	60.37
Average	90		87	12189.98	6.42	185.9
s^2_{gab}	140.115					
B	186.744					
χ^2 Count	2.01038					
χ^2 Table	5.99146					

The data is said to be homogeneous (the same variance or not) when H_0 is accepted ($\chi^2_{observed} \leq \chi^2_{critical}$). The homogeneity of this research with a significance level of (α) = 0,05 and degrees of freedom (dk) = 1 obtained $\chi^2_{critical} = 5,9946$ and $\chi^2_{observed} = 2,01038$. Then, it can be concluded that H_0 was accepted which indicated that the data was homogeneous.

Since the normality and homogeneity had been fulfilled, then the hypothesis test was carried out. The hypothesis test was performed using the one-way ANOVA test. A summary of the one-way ANOVA test can be seen in table 4.

Table 4. Summary of One-Way ANOVA Test

Source of Variation	SS	DF	MS	F	P-value	F crit
Between Groups	1142	2	571.1226	4.076109	0.0203172	3.101296
Within Groups	12190	87	140.1147			
Total	13332	89				

Based on table 4, the results of the analysis indicated that $F_{observed} = 3.101296 < F_{critical} = 4.076109$, then H_0 was rejected. This means that the RMS learning model assisted by PPW affected students' thinking skills. Here is the summary of the comparison test done to see the significant influence on mathematical critical thinking skills.

Table 5. The Summary of the Result of Mathematical Critical Thinking Skills

Group	χ^2_{count}	χ^2_{table}	Conclusion
$H_0 : \mu_1 \text{ vs } \mu_2$	0,0646	3,841	Rejected
$H_0 : \mu_1 \text{ vs } \mu_3$	0,0680	3,841	Rejected
$H_0 : \mu_2 \text{ vs } \mu_3$	0,0680	3,841	Rejected

Based on the double comparison test between columns, the obtained results were:

- 1) $H_0 : \mu_1 \text{ vs } \mu_2$ obtained $F_{observed} = 0,0646 > F_{critical} = 3,841$. This indicated that H_0 was rejected. Thus, there was a difference between students who were given the RMS learning model assisted by PPW and the RMS learning model on critical thinking skills.
- 2) $H_0 : \mu_1 \text{ vs } \mu_3$ obtained $F_{observed} = 0,06840 > F_{critical} = 3,841$. This indicated that H_0 was rejected. Thus, it can be said that there was a difference between students who were given the RMS learning model assisted by PPW and students who were given a conventional model on critical thinking skills.
- 3) $H_0 : \mu_2 \text{ vs } \mu_3$ obtained $F_{observed} = 0,0680 > F_{critical} = 3,841$. This indicated that H_0 was rejected. It can be said that there was a difference between students who were given the RMS learning model and students who were given the conventional learning model on critical thinking skills.

Each of the applied instrument has been validated by the experts to obtain feasible instruments [24,9]. The two-way ANAVA test obtained result of $F_{observed} = 3.101296 < F_{critical} = 4.076109$ which indicated that H_0 was rejected. It can be concluded that there were influences of the RMS learning model assisted by PPW toward students' thinking skills.

PPW can help and motivate students to be interested in learning. Some students tend to be silent and less active in discussions because they haven't adapted to the RMS learning model assisted by PPW. Active students raise their ideas so that the learning process could be managed independently.

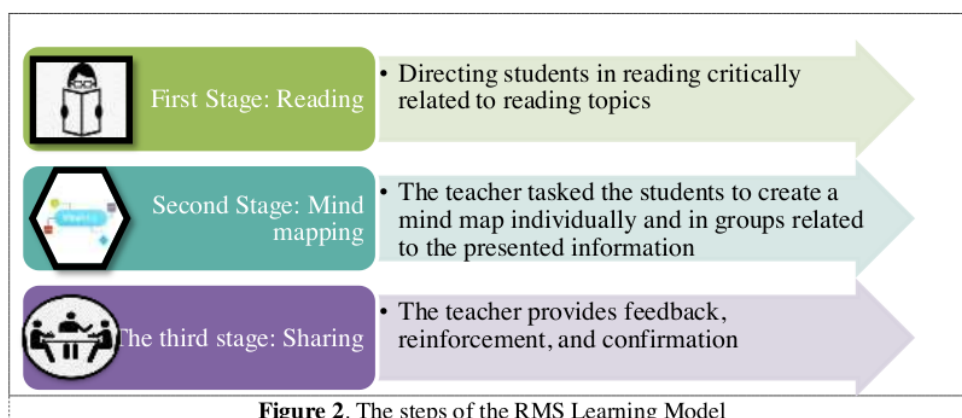
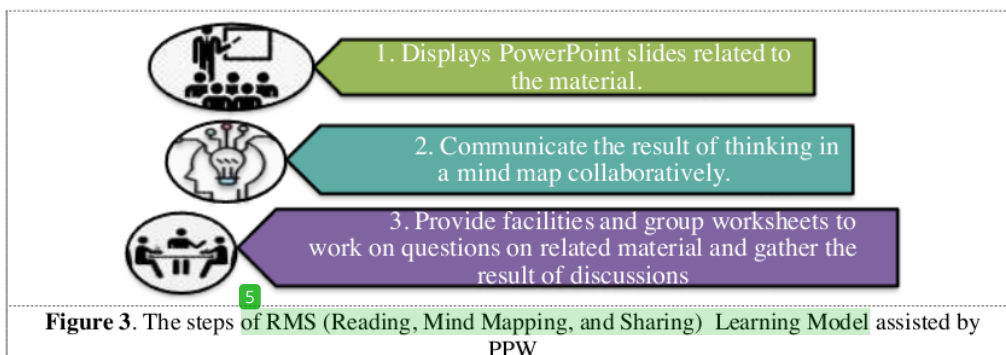


Figure 2. The steps of the RMS Learning Model

Through the RMS learning model, the learning activities were student-centered so that the students could be active in building their knowledge. The activities carried out in learning were critical reading by critically understanding the material by acknowledging facts and concluding the material. However, to understand the ideas and facts in detail, it was necessary to interpret the ideas and compare the research with others to make a conclusion in which the mind mapping activity was needed.

The learning process through the RMS learning model assisted by PPW runs well and the students were more active in the group discussion and presentation. One of the disadvantages of the RMS learning model assisted by PPW is the long duration. Thus, the students are expected to follow the learning so that the learning objectives could be achieved optimally. The media-assisted activity provides an opportunity for less-active students to take turns in a presentation.



Based on previous researches the RMS learning model to improve concept mastery, critical thinking skills, metacognitive skills, and the retention of students with different academic ability were indicated by the average score of 4.05. It indicated that there was a significant influence of the RMS learning model on concept mastery, critical thinking skills, and metacognitive skills. Furthermore, there was no influence of different academic abilities toward concept mastery, critical thinking skills, metacognitive skills, and retention [18]. Multiple thinking model assisted by PPW affected the mathematical critical thinking skills [18]. The minimum gain value of the experiment class = -0.60 and the maximum gain value = 1 while for the control class obtained the minimum gain value of = -0.20 and the maximum gain value of = 1. It can be concluded that there was a significant difference in the mathematical critical thinking ability between the application of the Contextual Teaching and Learning approach and a conventional approach [25,24].

The use of the RMS learning model was initially experiencing difficulties where students were not accustomed to learning. The RMS learning model assisted by PPW was not fully implemented because there was a tendency where only high-skilled students conveyed their ideas. However, less-active students were allowed to take turns in the presentation. After the learning process had been carried out, the final evaluation was conducted to determine the students' mathematical critical thinking skills. It was discovered that the students in the three classes possessed different mathematical critical thinking skills.

Based on the comparative test, the RMS learning model assisted by PPW and the RMS learning model obtained a good result. However, the RMS learning model assisted by PPW was better than the conventional learning model and the RMS learning model was better than the conventional learning model [22]. Based on the differences, the RMS learning model assisted by PPW provided better results for the seventh-grade student of Al-Azhar Junior High School 3 Bandar Lampung.

Based on the results of one-way ANOVA, the value of $F_{observed} < F_{critical}$ which indicated that H_0 was accepted. Based on the theory, the RMS learning model assisted by PPW should have been better than only the RMS learning model. However, the results of the double comparative test indicated that the RMS learning model was as good as the RMS learning model assisted by PPW. $F_{observed} > F_{critical}$ means that H_0 was rejected so that there was a significant difference between the RMS learning model assisted by PPW and conventional learning model on mathematical critical thinking skills. Based on the theory, the RMS learning model assisted by PPW was better than the conventional learning model. Based on the one-way ANOVA, the value of $F_{observed}$ was higher $> F_{critical}$ which indicated that H_0 was rejected so that there was a significant difference between the RMS learning model assisted by PPW and conventional learning model on mathematical critical thinking ability. Based on the theory, the RMS learning model should be better than the conventional learning model. It was proven through the test that the RMS learning model was better than the conventional learning model.

The learning process through the conventional model runs well although some students did not submit their assignments and the lack of motivation to learn showed by their unwillingness to read the learning material [21, 28-29]. Several studies are relevant to the RMS learning model, namely R₁₀ learning model which has a strong effect on increasing h₇-level critical thinking skills seen from the acquisition of sig value of 0.027 < 0.05 which indicates that there is a difference between the critical thinking skills and the effectiveness of the RMS learning model seen from the effect size value [22]. The highest student response indicator was the aspect of attention with an average of 32 and the lowest was the aspect of satisfaction with an average of 23.5. Previous research on RMS learning model on the basic concepts of science [21] indicates that RMS can improve intellectual abilities, critical thinking, and creative thinking [22,23], creativity [9,24,25], and mathematics learning outcomes [18,26,27].

4. Conclusions

Hypotheses and analysis of data generated $F_{\text{observed}} = 3.101296 < F_{\text{critical}} = 4.076109$ where H_0 was rejected which indicated that the RMS learning model assisted by PPW affected students' mathematical critical thinking skills. It is suggested to apply the RMS learning strategy assisted by PPW to develop students' mathematical critical thinking skills. This research can be used as a reference for subsequent research.

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