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Student Mental Model in Learning Using Worksheets Oriented Approach Science Technology in Elementary School

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Abstract

This research is motivated by the low mental model of students, so efforts are needed to improve it. This study aimed to enhance students' mental models by using worksheets oriented to the Science Technology approach in elementary schools. This study used the Research and Development method, which was later shortened to R&D. This study uses a 4-D model consisting of define, design, development, and disseminate stages. This study proves that mental models can be improved in learning by using worksheets which are stated to be very valid from the content aspect and the presentation aspect validity. This says that improving the mental model of elementary school students can be done by using worksheets oriented to the Science Technology approach.

Keywords: *Student Worksheets; STEM; Mental Models; Scientific Attitude*

Introduction

Along with the times, there is also a rapid process of developing science and technology (IPTEK). This development is by the birth of 21st-century competence et al.et al.(Wijaya et al, 2016; Fitria, 2017). The competence of the 21st century is born to present the suitability of development with new competencies that must be mastered. The new competencies consist of the ability to collaborate, the ability to communicate, the ability to think critically, and the ability to think creatively (Makhrus et al, 2019; fitria et al, 2013). Kompetensi ini bertujuan untuk menjawab tantangan abad 21 yaitu kemampuan untuk memproduksi dan mengambil ilmu pengetahuan dan teknologi yang dapat digunakan dalam proses pembelajaran.

These abilities can be used and enhanced in the learning process (Meilani et al., 2020; Fitria et al., 2018). Learning is done by focusing the learning process on students (student center) (Antika, 2014). Student-centered learning can be done by conducting analyses or experiments where students actively find information through their activities. The activities of these students in discovering science and technology are closely related to the nature of science. Nature of science consists of eight aspects, namely understanding of conducting scientific investigations using various forms of methods; scientific

understanding of knowledge based on empirical evidence; a genuine understanding of scientific knowledge; understanding of models, laws, and scientific mechanisms in explaining various forms of phenomena; understanding in using science to discover new knowledge; understanding of scientific knowledge that comprises natural systems; understanding knowledge is a form of human effort; and understanding of knowledge addresses questions about nature and its contents (Lederman and Lederman, 2019). The integration of the nature of science in the learning process can positively influence students' abilities to achieve the competencies and learning objectives that have been set. In addition, the integration of the nature of science will also be able to develop students' mental models and scientific attitudes (Brewer, 2001). Therefore, the integrating nature of science needs to be developed in the thematic learning process.

A mental model is one form of novelty in the thematic learning process that needs to be developed through integrating the nature of science. Mental models are a form of representation of domains that support the process of understanding, reasoning, and predicting information (Gentner and Stevens, 2014). A mental model is one form of study in cognitive psychology. Cognitive psychology is a study in psychology that deals with understanding humans through the process of learning, thinking, and remembering information. Stenberg stated that a mental model is a form of knowledge structure constructed by a person to understand and explain his experience (Clement and Steinberg, 2002). In addition, mental models are also related to cognitive activities, coding, and absorption of information during the learning process. However, based on the initial ability test of the mental model that the researcher conducted in one of the public elementary schools, it was stated that the students' mental model was low.

Based on the author's analysis of this student's less than optimal mental model due to the lack of interest of elementary school students in the learning process. This lack of student interest is because students are not actively involved in the learning process. Elementary school students are children who are in the concrete operational period. This means that students at this time learn by using tangible objects or learn through authentic experiences that are around students. It can be understood that elementary school students must be active in the learning process. Active student learning can be done by designing education oriented to busy students.

One way to activate student learning is to use student worksheets (LKPD). LKPD is a learning tool that contains work orders for finding the desired information (Rahayuningsih, 2018). LAPD has many advantages. Namely, it can make it easier for teachers to activate students through systematically arranged work (Lubis and Masniladevi, 2020). In addition, LKPD is also a means to facilitate students in finding information through various activities (Salwan and Rahmatan, 2017). LAPD is very appropriate to be applied to elementary school students. This is because the LKPD contains experiments using concrete objects, and students actively carry out these experimental activities so that they are by the developmental characteristics of elementary school students. LKPD is very appropriate to be applied to elementary school students. This is because the LKPD contains experiments using concrete objects, and students actively carry out these experimental activities so that they are by the developmental characteristics of elementary school students.

However, the use of LKPD in elementary schools has not been fully maximized. One approach that can be used in the LKPD development process is the characteristics of student development, LKPD characteristics, and the demands of 21st-century competencies that are integrated with the nature of science are the STEM approach. Research conducted by (Cotabish et al., 2013 and Isabelle, 2017) states that STEM learning is very suitable for learning in elementary schools. This is because STEM learning contains aspects of future demands. Research conducted by (Vincent-Ruz et al., 2018 and McComas et al., 2017) states that STEM is learning by the nature of science. Based on this research, it can be

concluded that STEM is suitable for developing LKPD to improve the literacy skills of elementary school students.

Based on this description, it can be concluded that there is a need for a student worksheet that is by the characteristics of student development, the characteristics of the worksheets, and the demands of 21st-century competencies that are integrated with the nature of science which can improve the mental models and scientific attitudes of elementary school students. So, the purpose of this study was to develop a STEM-based worksheet to love the mental models and scientific perspectives of good grade II elementary school students.

Method

This study used the Research and Development method, which was later shortened to R&D. This study uses a 4-D model consisting of define, design, development, and disseminate stages. The subjects of this study were teachers and second-grade students of SDN 17 Pasar Baru SawahLunto City (experimental class) and SDN 03 Lubang Panjang City of Sawah Lunto (control class) with one teacher and 15 students, respectively.

Result and Discussion

Result

The initial stage is the defining stage. This stage aims to perform a needs analysis. This stage aims to determine how the product needs to be developed by meeting the development requirements. In defining this, preliminary research and student analysis were carried out. The initial study states that the development of mental models and scientific attitudes of elementary school students is less than optimal. This is due to the lack of interest of elementary school students in the learning process. This lack of student interest is because students are not actively involved in the learning process. At the student analysis stage, elementary school students' characteristics were learning from concrete objects, being happy to feel, do or demonstrate something directly, working in groups, playing, and moving. These characteristics will be the basis for the development of STEM-based LKPD.

Mental Model Descriptive Analysis

(1) Results of the Pre-test of the Experimental Group

The results of the pre-test carried out before using the STEM-based LKPD can be seen in the following table 1.

Table 1. Pre-Test Experimental Group

Experimental Group	***Pre-Test***
Maximum Value	15
Minimum Value	12
mean	13.40
median	14.00
mode	14
Standard Deviation	0.98

In the experimental group, the highest mental model score was 15 and the lowest was 12. The mean count was 13.40, the median was 14.00, the model was 14 and the standard deviation was 0.98.

(2) Results of Pre-test Control Group

The results of the pre-test carried out before using the STEM-based LKPD can be seen in the following table 2.

Table 2. Pre-Test Control Group

Experimental Group	***Pre-Test***
Maximum Value	14
Minimum Value	10
mean	11.73
median	12.00
mode	10.00
Standard Deviation	1.48

In the control group, the highest mental model score was 14 and the lowest was 10. The mean count was 11.73, the median was 12.00, the model was 10.00 and the standard deviation was 1.48.

(3) Experimental Group Post-Test Results

The results of the post-test conducted after using the STEM-based LKPD can be seen in the following table 3.

Table 3. Post-Test Experimental Group

Experimental Group	***Post-Test***
Maximum Value	15
Minimum Value	12
mean	13.40
median	14.00
mode	14.00
Standard Deviation	0.98

In the experimental group, the highest mental model score was 24 and the lowest was 21. The mean count was 22.27, the median was 22.00, the model was 22 and the standard deviation was 0.88.

(4) Control Group Post-Test Results

The results of the post-test conducted after using the STEM-based LKPD can be seen in the following table 4.

Table 4. Post-Test Control Group

Experimental Group	***Post-Test***
Maximum Value	24
Minimum Value	21
mean	22.27
median	22
mode	22
Standard Deviation	0.88

In the control group, the highest mental model score was 15 and the lowest was 12. The mean count was 13.40, the median was 14.00, the model was 14.00 and the standard deviation was 0.98.

Normality Test

The normality test was carried out on two data, namely the pre-test and post-test data for the experimental group and the control group. In this study, the normality test was obtained using the Kolmogorov-Smirnov or Shapiro-Wilk test. The normality test is used to determine whether the data is normally distributed or not, provided that the data is normally distributed if it meets the criteria for the value of sig > 0.05. More details can be seen in the following table 5.

Figure 5. Mental Model Data Normality Test

Tests of Normality

		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	KELAS	Statistic	df	Sig.	Statistic	df	Sig.
HASIL	PREEKSPERIMENMODELMENTAL	.329	15	.115	.803	15	.004
	POSTEKSPERIMENMODELMENTAL	.219	15	.052	.888	15	.063
	PREKONTROLMODELMENTAL	.212	15	.070	.870	15	.034
	POSTKONTROLMODELMENTAK	.329	15	.115	.803	15	.004

a. Lilliefors Significance Correction

Based on the table above, all data for the experimental and control groups as well as the pre-test and post-test showed sig values. Kolmogorov-Smirnov and Shapiro Wilk > 0.05. So the conclusion of this distribution is that it is normal. Due to the normal distribution of research data, the research can be continued using parametric statistics.

Paired Sample T-test

Paired Sample T-Test was conducted to see whether there was a difference in the results of the pre-test and post-test of students from the experimental and control groups. The results of the calculation of the pre-test and post-test hypotheses can be seen in the following table 6.

Figure 6. Paired Sample T-test results

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	PREEKSPERIMENMODELMENTAL - POSTEKSPERIMENMODELMENTAL	-8.66667	1.06010	.27372	-9.45373	-8.27960	-32.394	14	.000
Pair 2	PREKONTROLMODELMENTAL - POSTKONTROLMODELMENTAL	-1.66667	1.04654	.27021	-2.24622	-1.08711	-6.168	14	.000

- Based on the output of Pair 1, the sig value is obtained. (2 tailed) of 0.000 < 0.05, it can be concluded that there is a difference in the average mental model of students for the pre-test experimental class and post-test experiment (classes that study with STEM-based LKPD)

- Based on the output of Pair 2, the sig value is obtained. (2 tailed) of 0.000 < 0.05, it can be concluded that there is a difference in the average mental model of students for the control class pre-test and the control class post-test (conventional learning class)

Based on these calculations, it can be concluded that there is a significant effect before (pre-test) learning using STEM-based LKPD and after learning using STEM-based LKPD is carried out on students' mental model abilities. To see more clearly the average learning outcomes before and after learning using STEM-based LKPD can be seen in the following table 7.

Table 7. Calculation Results of Paired Samples Statistics

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	PREEKSPERIMENMODELMENTAL	13.4000	15	.98561	.25448
	POSTEKSPERIMENMODELMENTAL	22.2667	15	.88372	.22817
Pair 2	PREKONTROLMODELMENTAL	11.7333	15	1.48645	.38380
	POSTKONTROLMODELMENTAL	13.4000	15	.98561	.25448

From the table, it can be seen that the average score of students' mental models before learning to use STEM-based worksheets was 13.40 and increased after learning to 22.26. This proves that there is an effect of using STEM-based LKPD on improving the mental model of second-grade elementary school students. Furthermore, an independent sample t-test can be performed to answer the second question.

Homogeneity Test

Before the independent sample t-test was carried out on the two research groups, there were conditions that would be carried out, namely to find the value of homogeneity. In this study, the homogeneity of variance test was used. This sample is declared homogeneous if the value of sig. Based on Mean > 0.05. The results of the homogeneity test of the two groups of research samples can be seen in the following table 8

Table 8. Homogeneity Test Results

Test of Homogeneity of Variance

		Levene Statistic	df1	df2	Sig.
Model_Mental	Based on Mean	.640	1	28	.430
	Based on Median	.057	1	28	.812
	Based on Median and with adjusted df	.057	1	25.033	.813
	Based on trimmed mean	.705	1	28	.408

Based on the table above, the sig value is obtained. based on a mean of 0.430 > 0.05 so it can be concluded that the variance of the experimental post-test and control post-test data is the same or

homogeneous, thus one of the requirements (not absolute) of the independent sample t-test has been fulfilled.

Independent Sample T-test

The independent t-test was conducted to see whether there was a difference in student results from the post-test of the experimental group and the post-test of the students from the control group. The results of the calculation of the hypothesis can be seen in the following table 9.

Table 9. Independent Samples Test

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Model_Mental	Equal variances assumed	.640	.430	25.941	28	.000	8.867	.342	8.167	9.567
	Equal variances not assumed			25.941	27.673	.000	8.867	.342	8.166	9.567

Based on the table above, the sig value is obtained. (2 tailed) of 0.000 < 0.05, it can be concluded that there is a difference in the average mental model of students using STEM-based worksheets and those using conventional methods.

For more details, to know the post-test average for the experimental class and the control group, it can be seen in the following statistical table 10.

Table 10. Group Statistics

Group Statistics

	Kelas	N	Mean	Std. Deviation	Std. Error Mean
Model_Mental	Posttest_Eksperimen_ModelMental	15	22.27	.884	.228
	Posttest_Kontrol_ModelMental	15	13.40	.986	.254

From the table, it can be seen that the average mental model of students who study using STEM-based LKPD gets a score of 22.27 higher than the class that learns conventionally. This proves that STEM-based LKPD is effective for improving the mental model of grade II elementary school students.

Discussion

Mental models play an essential role in developing the conceptual domain of science. Developing mental models will affect connecting students' cognition through the internalization of concepts. Coll stated that mental models are essential in learning science because the beginning of the process of developing science requires mental models as the primary trigger. In addition, the development of mental models also affects the prediction process, testing new ideas and helping students solve problems in the learning process (Supriadi et al., 2018).

Children's mental models must be observed from an early age. This will relate to the way children can develop their scientific thinking skills and non-scientific abilities. This ability is essential in developing children's thinking patterns and activities in the future (Kurnaz, 2008; Kildan et al., 2013). This indicates that the mental model will affect cognitive abilities in the form of scientific and non-scientific skills and affect children's attitudes. Therefore, it is necessary to pay special attention to the development of children's mental models.

The difference in the average mental model of students for the experimental class pre-test with the experimental post-test (a class that learns with STEM-based worksheets). This means that there is an effect of using STEM-based LKPD on improving the mental model of second-grade elementary school students. then based on the independent sample T-test, the sig value was obtained. (2 tailed) of 0.000 < 0.05, it can be concluded that there is a difference in the average mental model of students using STEM-based worksheets and those using conventional methods. These two calculations prove that the use of STEM-based learning tools effectively improves the mental models of elementary school students. While the paired sample T-test results on scientific attitude data get Pair 1 output, the sig value is obtained. (2 tailed) of 0.000 <0.05, it can be concluded that there is a difference in the average scientific attitude of students for the pre-test of the experimental class and the post-test of the experiment (courses that study with STEM-based LKPD). This means that there is an effect of using STEM-based worksheets on increasing the scientific attitude of second-grade elementary school students.

Conclusion

There is a significant difference in the average mental model of students in learning using Science Technology-oriented worksheets with learning using conventional methods. This means that students' mental models in learning can be improved effectively using Science, Technology-oriented student worksheets.

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