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The Effect of Virtual Science Teaching Model on Scientific Creativity and Learning Outcomes

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Abstract: VS-TM (Virtual Science Teaching Model) is a learning model that applies a virtual-assisted scientific approach and is implemented to improve scientific creativity and student understanding in science subjects. This study aims to determine the effect of VS-TM on scientific creativity and student learning outcomes. This research was conducted at SMPN 1 Bangorejo, which was carried out in the even semester of the 2023/2024 school year, precisely in February 2024. The study population was all students of SMPN 1 Bangorejo Class VIII. Sample determination. Determination of the sample using the homogeneity test that had previously been carried out before conducting the research. This type of research is a two-class quasi-experimental, including experimental and control classes. There are two data analysis techniques used, namely normality testing and hypothesis testing. Normality test using Kolmogorov Smirnov, hypothesis test using Mann-Whitney U test. The results of this study are that the that the VS-TM model affects the scientific creativity and learning outcomes of junior high school students.

Keywords: VS-TM (virtual science teaching model), scientific creativity, and learning outcomes.

▪ INTRODUCTION

Science learning is directly related to information obtained through experimentation, proof and observation based on the scientific method. The scientific method is a methodological process that begins with problem solving of events in nature to drawing conclusions (Rahmatih et al., 2020). In science learning, students will develop their skills in exploring and understanding scientifically through direct practicum as a method of delivering material. Science learning encourages students to develop analytical skills, practices, and scientific abilities as well as communication skills (Wilujeng, 2020).

Science is a body of knowledge acquired by scientists through scientific activities and is the result of an ongoing process of inquiry. Science is a collection of knowledge that is created through scientific activities to prove that science concepts consist of scientific thinking patterns and process skills (Hottecke et al, 2020). Science learning is directly related to information obtained through experiments, verification, and observation based on scientific methods. The process of presenting science learning is carried out through direct practicum to obtain skills in exploring and understanding nature scientifically.

In the 21st century, technological advances and communication are developing very rapidly, so teachers and educators must utilize technology in the teaching and learning process. The use of technology in education can produce active, collaborative, creative, integrative, and evaluative learning (Riani et al., 2021). Teaching technology for creativity in science learning must be carried out in a learning environment that can increase student motivation to respond to a problem about nature (Rosnaeni, 2021).

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Scientific creativity in science learning is a scientific innovation that is closely related to nature and the environment (Zulaichah et al., 2021). Scientific creativity brings together two elements, namely: elements of creativity and science, so it requires special measures and is different from the measures used to measure creativity in general (Rachmawati et al., 2018). Scientific creativity is very important for students because in the 2013 curriculum scientific creativity is one of the important objectives that apply in Indonesia (Aninnas et al., 2022). Creativity can improve academic achievement, especially learning outcomes, so creativity is very important in the learning process. According to Novianto et al. (2018) the effect of high creativity on the environment and student learning achievement shows that creativity has an important role in the learning process. Increasing creativity in a learning process is believed to be very important to achieve higher quality learning.

In fact, data at school shows that the level of scientific creativity is low because in the learning process students receive more material so that they are bored and less interested in engaging in learning activities (Zulaichah et al., 2021). The limited development of teaching materials and teacher support specifically aimed at increasing students' scientific creativity is the cause of the low level of scientific creativity (Aninnas et al., 2022). Teachers who have not been trained in dealing with the times, namely not having extensive experience in using technology in learning, are also one of the causes of low scientific creativity abilities (Rahim et al., 2019). In addition, the use of old-fashioned methods applied can also cause students' scientific creativity abilities to be very low. The lack of scientific creativity in students has a potential impact on the achievement of learning outcomes. According to Saputra (2020) the role of creativity is very important in improving the achievement of learning outcomes so that when the ability of creativity is low it will have an impact on low learning outcomes.

One way to overcome this problem is through the application of VS-TM (Virtual Science Teaching Model). VS-TM is a learning model that applies a virtual-assisted scientific approach and is implemented to increase scientific creativity and student understanding in science subjects. This VS-TM model is based on virtual learning media, namely the PhET virtual laboratory to support the learning process by utilizing ICT (Wicaksono et al., 2017). PhET is a laboratory created by a team from the University of Colorado in the United States. This virtual laboratory has simulations that make what is difficult for students to observe easier. In addition, PhET can also provide high-level interactive and dynamic for students (Sumargo and Yuanita, 2014). By using the VS-TM learning model, it is expected that students can be more enthusiastic in carrying out learning so that it can improve scientific creativity abilities and learning outcomes.

The integration of PhET simulations into the VS-TM model aims to enhance the teaching and learning process of science, particularly physics concepts, by fostering student engagement and providing enriching learning experiences. Each PhET simulation incorporates interactive animations that captivate students' attention, promoting their active involvement and comprehension. PhET simulations prove to be highly beneficial as they offer students the opportunity to delve into inquiry-based learning, receive immediate feedback, explore multiple representations, and connect macroscopic, microscopic, and symbolic representations. The engaging nature of these simulations, which incorporate real-world scenarios, further enhances students' understanding. As a result, students are better equipped to grasp and retain the learning material presented by the teacher (Mallari et al, 2020).

According to Wicaksono et al. (2017) the VS-TM learning model has a syntax whose content and construction are good for scientific creativity and student concept assignment. The syntax consists of:

Table 1. VS-TM syntax

Stage	Adverb
Identify the problem	*Identifikasi masalah*
Ormulating electronic problem-solving alternatives	*Merumuskan alternatif dalam memecahkan masalah*
Discussing alternatives problem-solving	*Diskusi dalam mencari alternatif memecahkan masalah*
Design and apply experiments virtual	*Merancang dan menerapkan eksperimen virtual*
Elaborating experimental results	*Menguraikan hasil eksperimen*
Reflection	*Refleksi*

Based on this description, it can be seen that the use of the VS-TM learning model may have a significant effect on the creativity and learning outcomes of junior high school students. Therefore, proof is needed through a study entitled "The Effect of VS-TM on Scientific Creativity and Learning Outcomes of Junior High School Students".

▪ METHOD

Participants

This research is a quantitative descriptive study that describes descriptively according to the results of observations and measurements quantitatively using simple statistics by calculating the average scientific creativity and student learning outcomes. This research was conducted at SMPN 1 Bangorejo Banyuwangi which was carried out in the even semester of the 2023/2024 school year, precisely in February 2024. The study population was all students of SMPN 1 Bangorejo Class VIII. Meanwhile, the sample consisted of two classes from five VIII classes. The determination of the sample used a homogeneity test which had previously been carried out before conducting the research. This type of research is quasi-experimental. n carried out before conducting the research. This type of research is quasi-experimental. There are two classes in this study including experimental class and control class. The sample consists of 44 students, with 23 students in the experimental class and 21 students in the control class.

Research design and Produres

The research procedure has 3 stages, namely the preparation, implementation and final stages. The initial stage of preparation, interviews and initial observations to obtain documents on student names and learning models, determining the sample and population. The implementation stage is in the form of giving a pre-test, learning in the experimental class using the VS-TM model while the control class uses a conventional model and giving a post-test consists of 7 essay questions to measure scientific creativity and 5 multiple choice questions to measure students' cognitive learning outcomes. The final stage of data analysis, namely compiling results and discussions, and drawing conclusions.

Data Analysis

There are two data collection techniques in this study, namely the main data collection techniques which include cognitive tests based on scientific creativity indicators in the form of pre-test and post-test questions. And supporting data collection techniques which include interviews, documentation, and observation. Interviews with science teachers and documentation in the form of photos, videos, and written text.

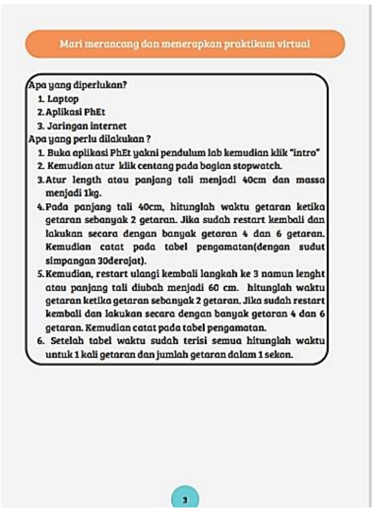
The data analysis of this study was to determine the effect of VS-TM on scientific creativity and student learning outcomes. There are two data analysis techniques used, namely normality test and hypothesis testing.

If the data is normal then use the paramteric test, namely the independent sample t-test. If the data is not normal, use the Mann-Whitney U test. The Independent-Sample T-test method test uses data on the pre-test and post-test scores of the control class and the experimental class.

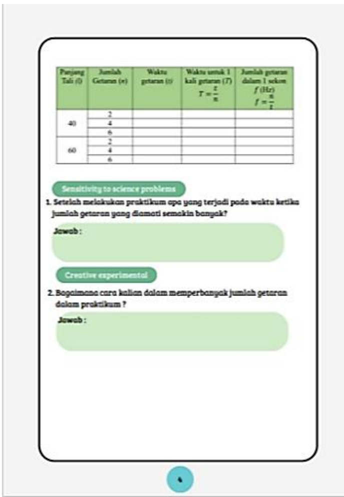
The purpose of this technique is to determine whether VS-TM affects scientific creativity and student learning outcomes. The point is to test the influence of the significance of the research results in the form of the average pre-test and post-test scores of the experimental class and control class.

▪ RESULT AND DISSCUSSION

The application of the VS-TM model is based on virtual learning media, namely the PhET virtual laboratory, to support the learning process researchers use LKPD so that students are easier when doing practicum. The following is an example of LKPD to support the VS-TM model in Figure 1:



Learning steps according to VS-TM syntax and practicum steps



Data table and questions based on scientific creativity indicators

Figure 1. LKPD VS-TM

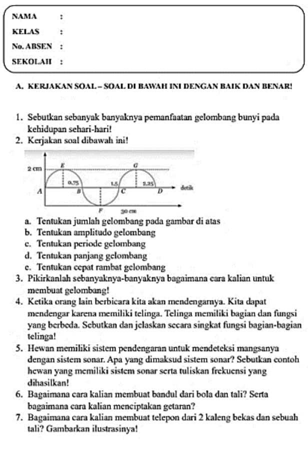
This study was conducted to examine the effect of VS-TM learning model on scientific creativity and student learning outcomes in science subjects of junior high school students. In achieving this goal, hypothesis testing will be carried out based on the pre-test and post-test scores that have been carried out by students. Before testing the hypothesis, a normality test will be carried out to determine whether the data is normal or not, then the hypothesis test can be determined using the independent sample t-test if the data is normal if the data is not normal using the Mann-Whitney U test. The sample used, namely class VIII, will then be tested for homogeneity to determine that the sample tested is homogeneous. The homogeneity test technique uses Levene's Test which can be seen in Table 1. below:

Table 1. Homogeneity test

Tests of Homogeneity of Variances				
	Levene Statistic	*df1*	*df2*	*Sig.*
Based on Mean	.671	4	110	.613
Based on Median	.459	4	110	.765
Based on Median and with adjusted df	.459	4	92.350	.765
Based on trimmed mean	.672	4	110	.613

Table 1. shows that the significance value is 0.613 so it can be seen that the significance value > 0.05 means that the test scores of class VIII are homogeneous. Determination of class samples using cluster random sampling technique, so class C was selected as the experimental class and class D as the control class.

Based on research conducted at SMPN 1 Bangorejo in class VIII C as the experimental class and class VIII D as the control class obtained pre-test and post-test data. Examples of pre-test and post-test questions can be seen in Figure 2. below:



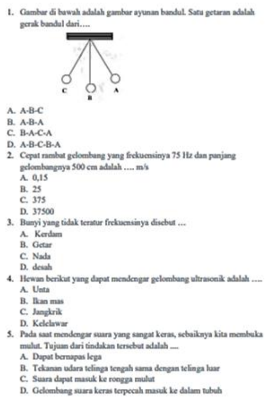
NAMA :
KELAS :
No. ABSEN :
SEKOLAH :

A. KERJAKAN SOAL – SOAL DI BAWAH INI DENGAN BAIK DAN BENAR!

1. Sebutkan sebanyak banyaknya pemanfaatan gelombang bunyi pada kehidupan sehari-hari!
2. Kerjakan soal dibawah ini!

   a. Tentukan jumlah gelombang pada gambar di atas
   b. Tentukan amplitudo gelombang
   c. Tentukan periode gelombang
   d. Tentukan panjang gelombang
   e. Tentukan cepat rambat gelombang
3. Pikirkanlah sebanyaknya-banyaknya bagaimana cara kalian untuk membuat gelombang!
4. Ketika orang lain berbicara kita akan mendengarnya. Kita dapat mendengar karena memiliki telinga. Telinga memiliki bagian dan fungsi yang berbeda. Sebutkan dan jelaskan secara singkat fungsi bagian-bagian telinga!
5. Hewan memiliki sistem pendengaran untuk mendeteksi mangsanya dengan sistem sonar. Apa yang dimaksud sistem sonar? Sebutkan contoh hewan yang memiliki sistem sonar serta tuliskan frekuensi yang dihasilkan!
6. Bagaimana cara kalian membuat bandul dari bola dan tali? Serta bagaimana cara kalian menciptakan getaran?
7. Bagaimana cara kalian membuat telepon dari 2 kaleng bekas dan sebuah tali? Gambarkan ilustrasinya!

Figure 2a. Examples of pre-test and post-test questions on scientific creativity



1. Gambar di bawah adalah gambar ayunan bandul. Satu getaran adalah gerak bandul dari....

A. A-B-C
B. A-B-A
C. B-A-C-A
D. A-B-C-B-A
2. Cepat rambat gelombang yang frekuensinya 75 Hz dan panjang gelombangnya 500 cm adalah .... m/s
   A. 0,15
   B. 25
   C. 375
   D. 37500
3. Bunyi yang tidak teratur frekuensinya disebut ...
   A. Kerdam
   B. Getar
   C. Nada
   D. desah
4. Hewan berikut yang dapat mendengar gelombang ultrasonik adalah ....
   A. Unta
   B. Ikan mas
   C. Jangkrik
   D. Kelelawar
5. Pada saat mendengar suara yang sangat keras, sebaiknya kita membuka mulut. Tujuan dari tindakan tersebut adalah ....
   A. Dapat bernapas lega
   B. Tekanan udara telinga tengah sama dengan telinga luar
   C. Suara dapat masuk ke rongga mulut
   D. Gelombang suara keras terpecah masuk ke dalam tubuh

Figure 2b. Example of pre-test and post-test learning outcomes

Scientific Creativity

The normality test for scientific creativity can be seen in Table 2. :

Table 2. Normality test of scientific creativity

Tests of Normality						
Kelas	***Kolmogorov-Smirnov***[a]			***Shapiro-Wilk***		
	Statistic	***df***	***Sig.***	***Statistic***	***Df***	***Sig.***
Pre-test Eksperimen	.180	23	.052	.868	23	.006
Post-test Ekperimen	.275	23	<.001	.843	23	.002
Pre-test Kontrol	.106	21	.200*	.948	21	.309
Post-test Kontrol	.142	21	.200*	.929	21	.132

Based on Table 2. it is known that the significance value of the pre-test experimental class is 0.052 > 0.05 and the post-test is <0.001 < 0.05. While in the control class the pre-test significance value is 0.200 > 0.05 and the post-test is 0.200 > 0.05. According to Setyawam (2021) data can be said to be normally distributed, if the P value (Sig.) > 0.05, both in Kolmogorov-Smirnov and Shapiro-Wilk. So it can be concluded that there is data that is not normally distributed, namely in the experimental class, because the significance value is < 0.05. Because there is data that is not normally distributed, the Mann-Whitney U test will then be carried out as shown in Table 2 below:

Table 3. Mann-whitney u test of scientific creativity

Test Statistics[a]	
	Scientific Creativity
Mann-Whitney U	92.500
Wilcoxon W	323.500
Z	-3.511
Asymp. Sig. (2-tailed)	<.001

Based on Table 3. scientific creativity hypothesis testing using the Mann-Whitney U test, the significance value gets Sig. (2-tailed) < 0.001 less than 0.05. According to Utomo (2021) the test criteria for the Mann-Whitney U test are if the p-value ≤ 0.05, then H0 is rejected and if the p-value ≥ 0.05, then H0 is accepted. So that the significance value of scientific creativity H0 is rejected or there is a significant difference. So it can be concluded that the use of the VS-TM learning model affects students' scientific creativity. In accordance with the statement of Wicaksono et al., (2017) which states VS-TM is a learning model that applies a virtual-assisted scientific approach and is implemented to increase scientific creativity and student understanding in science subjects. VS-TM was created after analyzing the 5E teaching model that offers to provide ideas, highlighting the concepts used during experiments and problem solving models that lack quality in the learning process of science, especially physics. Thus, the VS-TM learning model can be applied so that scientific creativity and students increase.

Based on the N-gain diagram for scientific creativity, it can be observed that there was an improvement in both classes after the intervention. In the experimental class, there was a significant improvement as the N-gain value was greater than 7. The fluency indicator score was 0.75, the flexibility indicator score was 0.83, and the originality indicator score was 0.93. Since the value is greater than 7, the N-gain test results indicate

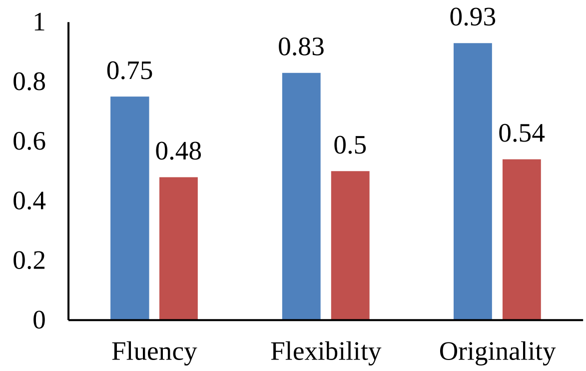


Figure 3. N-gain of every indicator of scientific creativity

that there was a significant improvement in the experimental class. In contrast, the N-gain value for the control class falls under the medium category, with scores of 0.48 for fluency, 0.5 for flexibility, and 0.54 for originality. Based on the N-gain scores, it can be concluded that the experimental class experienced a significant improvement, while the control class experienced a moderate improvement. The greater improvement in the experimental class compared to the control class can be attributed to the implementation of a learning model in the experimental class. This is in line with the statement by Wicaksono et al. (2017) that the VS-TM is a learning model that applies a virtual-assisted scientific approach and is implemented to enhance students' scientific creativity and understanding of science subjects.

Learning Outcomes

Table 4. Normality test of learning outcomes

Tests of Normality						
Kelas	***Kolmogorov-Smirnov[a]***			***Shapiro-Wilk***		
	Statistic	***Df***	***Sig.***	***Statistic***	***df***	***Sig.***
Pre-test Eksperimen	.186	23	.038	.878	23	.009
Post-test Eksperimen	.341	23	<.001	.761	23	<.001
Pre-test Kontrol	.181	21	.070	.854	21	.005
Post-test kontrol	.360	21	<.001	.783	21	<.001

Based on Table 4. the normality test of the experimental class pre-test is 0.038 < 0.05 and post-test < 0.001 < 0.05 while the control class significance value in the pre-test is 0.070 > 0.05 and post-test < 0.001 < 0.05. According to Setyawam (2021) data can be said to be normally distributed, if the P value (Sig.) > 0.05, both in Kolmogorov-Smirnov and Shapiro-Wilk. So it can be concluded that there is data that is not normally distributed, namely in the experimental class, because the significance value is <0.05. Then for hypothesis testing will be carried out with the Mann-Whitney U test which can be seen in Table 5. following:

Table 5. Mann-whitney u test of learning outcomes

Test Statistics[a]	
	Learning Outcomes
Mann-Whitney U	166.000
Wilcoxon W	397.000
Z	-2.074
Asymp. Sig. (2-tailed)	.038

Significance value got Sig. (2-tailed) 0.038. According to Utomo (2021) The test criteria for the Mann-Whitney U test are if the p-value ≤ 0.05, then H0 is rejected and if the p-value ≥ 0.05, then H0 is accepted. So that the significance value of learning outcomes H0 is rejected or there is a significant difference. Learning outcomes can be interpreted as an evaluation or result of a learning process that involves improvements in skills, abilities and knowledge. Learning outcomes refer to the achievements obtained by students after going through a learning process that includes an assessment of students' knowledge, attitudes, and abilities, as well as changes in behavior that occur in students (Nurita, 2018).

Through the application of VS-TM, it can increase scientific creativity and student understanding in science subjects. According to Saputra (2020) the role of creativity is very important in improving the achievement of learning outcomes so that when the ability of creativity is low it will have an impact on low learning outcomes (Wicaksono et al., 2017). It is proven by hypothesis testing that the VS-TM learning model has an effect on learning outcomes.

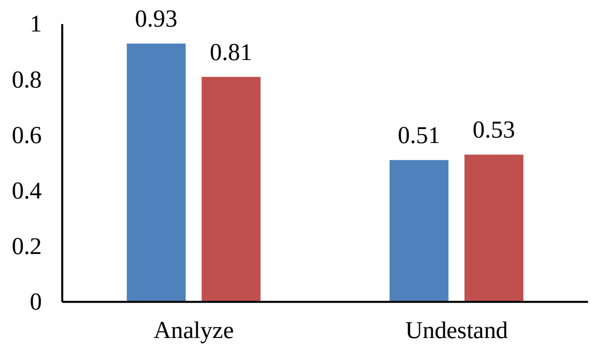


Figure 4. N-gain of every indicator of learning outcomes

Based on the N-gain diagram for learning outcomes, it can be observed that there was an improvement in both classes after the intervention. In the experimental class, there was a significant improvement as the N-gain value was greater than 7. The analysis indicator score was 0.93, indicating a high improvement category, while the understanding indicator score was 0.51, indicating a moderate improvement category. This difference in improvement between the two indicators suggests that the VS-TM model was more effective in enhancing students' analytical skills compared to their comprehension skills. In the control class, the N-gain value was similar to that of the experimental class, with an analysis indicator score of 0.81 (high improvement category) and an understanding indicator score of 0.53 (moderate improvement category). This pattern of improvement mirrors that of the experimental class, further supporting the effectiveness of the VS-TM model in promoting both analytical and comprehension skills. These findings align with the statement by Wicaksono et al. (2017) that the VS-TM is a learning model that applies a virtual-assisted scientific approach and is implemented to enhance students' scientific creativity and understanding of science subjects.

▪ CONCLUSION

Based on the results of the analysis, it can be seen that the analysis of creativity using the Mann-Whitney U test, the significance less than 0.05 H0 is rejected. So that the significance value of scientific creativity H0 is rejected or there is a significant difference. While the analysis of learning outcomes hypothesis testing of learning outcomes using the Mann-Whitney U test the the significance value of learning outcomes H0 is rejected or there is a significant difference. So, it can be concluded that the use of the VS-TM learning model has an effect on students' scientific creativity. VS-TM learning has a significant effect on scientific creativity and student learning outcomes.

The VS-TM learning model is a learning model that can increase scientific creativity and student understanding in science subjects. VS-TM was created after analysing the 5E teaching model which offers to provide ideas, highlighting concepts used during experiments and problem-solving models that lack quality in the learning process of science, especially physics. This increase in scientific creativity ability affects student learning outcomes. So that by using the VS-TM learning model in addition to increasing scientific creativity can also improve the learning outcomes of junior high school students. A notable limitation of research on instructional models is that it often takes place in controlled research settings, which may not accurately reflect the realities of everyday classroom teaching practices. This disconnect can pose a significant challenge in translating research findings into effective classroom practices.

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