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Application The Quantum Learning Method Using Simulation Media with The TANDUR Strategy to Improve Student Learning Outcomes

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ABSTRACT

Quantum Learning was a method that was capable of sharpening understanding and the ability to think actively and creatively of students in the learning process. In this study, we tried to implement the quantum learning method as described above, which had been shown to improve learning outcomes in various subjects across various levels, with the help of simulation media, optimized with the TANDUR strategy. This study aimed to determine whether there was a significant difference in students' learning outcomes improvement by applying the Quantum Learning method using simulation media with the TANDUR strategy and by applying conventional learning methods at SMP N 3 Bengkulu City. This research was a quasi-experimental design. The population in this study was students of class VIII SMP Negeri 3 Bengkulu City. The selection of the research sample used the Random Sampling technique, which consisted of 38 students in class VIII.2 as the experimental class and 38 students in class VIII.3 as the control class. The data collection technique used the learning achievement test instrument on the concept of light and student response questionnaires. Data analysis used two independent samples t-test. The results showed that the average post-test score of the experimental class differed significantly from the average post-test score of the control class with tcount 4.032 > ttable 1.992 at a significance level of 95%. Based on the results of the study, it could be concluded that: 1) there were differences in improving student learning outcomes between classes taught by applying the Quantum Learning method and classes with conventional learning at SMP N 3 Bengkulu City; 2) there was a good response from students with an average of 82% towards the application of the Quantum Learning method using simulation media with the TANDUR strategy.

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INTRODUCTION

Education is a conscious effort made by adults or educators in social situations with children or students through a process of changing all aspects of personality development in the form of learning or in the form of training, these changes include changes in thoughts, feelings, and skills (Mahmudi, 2022). According to Hidayat (2016), education is defined as a process of growth and development of human potential to reach perfection so that it can play its role as a creature of God who believes, has the knowledge, and has morals. This process is said to take place within a certain period of time and is recognized as a long-term investment that requires effort and funds for the development and improvement of educational facilities and infrastructure. For this reason, education must really be directed at producing and making quality human beings able to compete globally, have a noble character, and maintain good cultural and moral values (Hasbullah, 2017). Thus, education requires a planned system and the preparation of teaching programs as a process of scientific disciplines, realities, systems, and learning technology aimed at making the implementation of teaching run effectively and efficiently (Zazin, 2018).

New innovations in learning are needed to develop students' activeness and creativity in learning activities. Physics learning expects every learning process to be able to bring students to learn effectively, actively, creatively, innovatively, and delightfully. Various kinds of learning methods and learning media can be used in physics learning to convey messages or lesson concepts. This is to avoid learning that can make students feel bored and uncomfortable.

Based on observations made at SMP N 3 Bengkulu City, many students consider physics to be a very difficult and boring subject and students feel uncomfortable in every learning activity. This fact has an impact on student learning outcomes, even if some students have met passing grades for this subject. Various kinds of learning methods have been carried out by physics teachers to improve student learning outcomes and to make students feel happy and comfortable in learning physics.

The method that has been considered capable of making students feel comfortable, sharpening understanding, being able to optimize ways of thinking actively and creatively, learning based on experience to find concepts in the learning process is the Quantum Learning method (Sujatmika et al., 2018). The Quantum Learning method is tips, instructions, strategies, and the whole learning process that can sharpen understanding and memory, and make learning a fun and rewarding process (DePorter, 2013). The principle of Quantum Learning is that suggestion can and must affect the outcome of learning situations, and any detail provides positive or negative suggestions (DePorter, 2011).

The Quantum Learning model has been shown to positively affect learning outcomes and student character (Astra & Tisna, 2023). It has also been shown to increase learning and teaching activities with the help of video media (Putri & Landong, 2023). The results of research by Frianto (2013), concluded that applying Quantum Learning using multimedia has a significant effect on students' physics learning outcomes.

Simulation media is one of the computer-based learning media. Simulation is a technique of imitating or simulating an actual situation, something real, or the process of something. Simulation as a computer-based learning media provides students with opportunities to learn dynamically, interactively, and individually (Arsyad, 2011). Simulation media is used to stimulate students' learning activities, improve students' thinking skills, involve students, and stimulate students to use their knowledge to master the concepts taught through simulation media. With the right strategy, simulation media makes learning activities meaningful.

One of the strategies that can be optimized is the TANDUR strategy. The TANDUR strategy is a Quantum learning design framework. TANDUR is an acronym for *Tumbuhkan* (Grow), *Alami* (Experience), *Namai* (Name), *Demonstrasikan* (Demonstrate), *Ulangi* (Repeat), and *Rayakan* (Celebrate). The TANDUR strategy is designed to increase student learning activities through the provision of learning experiences, investigation, observation, and discussion (DePorter, 2010). The TANDUR learning design framework ensures that students become fascinated by each lesson, and makes the learning content real to themselves. According to the results of research at SuperCamp, the application of the TANDUR strategy in Quantum learning was able to increase motivation by 68%, increase scores by 73%, increase self-confidence by 81%, increase self-esteem by 84%, and continue the use of skills by 98% (DePorter in Purwanto, 2011).

In this study we try to implement the Quantum Learning method as described above, which has been shown to improve learning outcomes in various subjects across various levels, with the help of simulation media, optimized with the TANDUR strategy. This study aims to determine whether there is a significant difference in students learning outcomes improvement by applying the Quantum Learning method using simulation media with the TANDUR strategy and by applying conventional learning methods at SMP N 3 Bengkulu City. The study is needed to verify the effectiveness and benefit of using the Quantum Learning method with simulation media and optimized by the TANDUR strategy to improve learning outcomes, especially at SMP N 3 Bengkulu City.

METHODS

This research is classified as quasi-experimental with a nonequivalent control group design, which is an experimental research design conducted on two or more groups that receive different treatments for each group as well as a pre-test and post-test (Sugiyono, 2015).

Table 1. Research Design

Group (Class)	Pretest	Treatment	Posttest
Experimental	X_0	T	X_1
Control	X_0		X_1

note: X_0 = *pretest* T = *treatment*
X_1 = *posttest*

This research is conducted at SMP N 3 Bengkulu City in the even semester. A random sampling technique is used, which randomizes a group, not individual subjects (Sugiyono, 2015). Random results were obtained as a sample of class VIII.2 as many as 38 students as the experimental class and class VIII.3 as many as 38 students as the control class.

The research procedure consists of the preparation stage and the implementation stage. The planning stage includes observation, preparation of teaching materials and learning tools, as well as test instruments. The implementation phase includes the treatment of learning activities applying the Quantum Learning method using simulation media with the TANDUR strategy for the experimental class and learning activities applying conventional methods to the control class. The treatment of learning activities was carried out in two meetings, and at each meeting a pre-test was given at the beginning of the learning activity and a post-test question at the end of the learning activity. The research data were obtained from test assessment instruments (pre-test and post-test) of 10 objective questions on the concept of reflection and refraction of light as well as questionnaire sheets of 10 statements used to show feelings of pleasure, interest, and seriousness in learning physics through learning. the Quantum Learning method uses simulation media with the TANDUR strategy (Darmadi, 2014).

Data Analysis

1. **Inferential Analysis**
   a. **Normality Test**

The normality test is used to determine whether the data taken from the population is normally distributed or not, using the chi-square formula to test the hypothesis:

$$\chi^2 = \sum \frac{(O_i - E_i)}{E_i} \quad (1)$$

note: χ^2 = calculated chi-squared;
O_i = sample observation frequency;
E_i = expected/theoretical frequency (Arikunto, 2015).

H_0 = data come from a normally distributed population
H_1 = data does not come from a normally distributed population

The null hypothesis is accepted or rejected by consulting χ^2_{count} with a critical value χ^2_{table} at a significance level (α) = 95% with the following criteria:

H_0 is rejected if $\chi^2_{count} > \chi^2_{table}$
H_0 is accepted if $\chi^2_{count} \leq \chi^2_{table}$

b. **Homogeneity Test**

Homogeneity test is conducted to see whether the population has a homogeneous or heterogeneous variance. The homogeneity test is carried out if the population is normally distributed:

$$F_h = \frac{S_1^2}{S_2^2} \quad (2)$$

note: S_1^2 = largest variance;
S_2^2 = smallest variance (Arikunto, 2015).

Statistic hypothesis as follows:

H_0 : $\sigma_1^2 = \sigma_2^2$
H_1 : $\sigma_1^2 \neq \sigma_2^2$

H_0 is a hypothesis that states a population with the same variance or a population with a homogeneous variance. And H_1 is a hypothesis that states a population with unequal variance or a population with heterogeneous variance. The null hypothesis is accepted or rejected by consulting F_{count} with F_{table} at a significance level of 95% with the following criteria:

H_0 is accepted if $F_{count} < F_{table}$; otherwise H_0 is rejected

c. **Hypothesis Test**

Hypothesis tes is performed using an independent two-party t-test:

$$t = \frac{\bar{x}_1 - \bar{x}_2}{S^2 \sqrt{\frac{1}{n_1} + \frac{1}{n_2}}} \quad (3)$$

with: $$S^2 = \frac{(n_1 - 1)S_1^2 + (n_2 - 1)S_2^2}{n_1 + n_2 - 2} \quad (4)$$

note: t = calculated t value;
$\overline{x_1}$ = average value of group 1;
$\overline{x_2}$ = average value of group 2;
n_1 = total population of group 1;
n_2 = total population of group 2;
S_1^2 = variance of group 1;
S_2^2 = variance of group 2 (Arikunto, 2015)

Statistic hypothesis as follows:

H_0 : $\mu_1 = \mu_2$

H_1 : $\mu_1 > \mu_2$

Where H_0 is the hypothesis that the average score of the experimental class is the same as the average score of the control class. H_1 is the hypothesis that the average score of the experimental class is more than the average score of the control class. The null hypothesis is accepted or rejected by consulting t_{count} with t_{table} at a significance level of 95% with the following criteria

H_0 is accepted if $t_{count} > t_{table}$

H_0 is rejected if $t_{count} \leq t_{table}$

Respondent Characteristics

The term population is used for any group of objects that can be counted and for any number of groups both clear and unclear in number. The population is a collection of all similar elements that can be distinguished from each other because of their characteristics. These differences are due to the existence of different characteristic values (Supranto, 2008). Respondents in this study were students of class VIII.2 and class VIII.3 SMP N 3 Bengkulu City totaling 76 people. There are two characteristics of respondents included in this study, namely gender, and age.

Male respondents totaled 33 people or 43.43% of the total 76 respondents. While female respondents totaled 43 people or 56.57%. So on average, the majority of respondents are female. 50 respondents were aged 14, or 65.79% of the total 76 respondents. 16 respondents (21.05%) were aged 13, and 10 respondents (13.16%) were aged 15. So, the average majority of respondents' age is 14 years old.

RESULT AND DISCUSSION

A. Description of Students' Learning Outcome

Data on student learning outcomes are obtained from the average score of each meeting. In this study, two meetings were conducted. The teaching material at the first meeting was about the concept of light reflection, and the teaching material at the second meeting was about the concept of light refraction. At each meeting, students are given a pre-test question to determine the initial ability of students about teaching material before participating in the learning process. Furthermore, students are given post-test questions at the end of the lesson to determine the extent to which students master the material taught. The data from the pre-test and post-test scores were processed to obtain the results of hypothesis testing.

B. Data Description

1. Data of Control Class Learning Outcome

The average results of the control class pre-test meeting 1 and meeting 2 are tabulated in a frequency distribution list with interval classes of 6. In the cognitive domain, a range of 45 is obtained from the difference between the highest score of 60 and the lowest score of 15. The length of the interval class is 8, the mean is 36.37, and the standard deviation is 9.60. This result is shown in the following table and graph:

Table 2. Mean Frequency Distribution of Control Class Pretest

No	Interval Class	Frequency	Percentage
1.	14 – 21	2	5,2 %

2.	22 – 29	6	15,9 %
3.	30 – 37	12	31,6 %
4.	38 – 45	12	31,6 %
5.	46 – 53	4	10,5 %
6.	54 – 61	2	5,2 %
∑		38	100 %

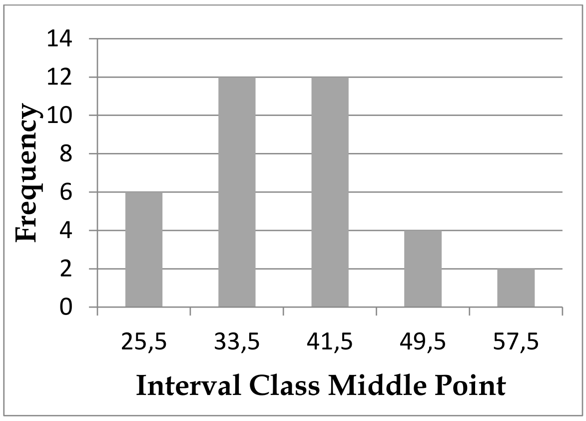

Figure 1. Control Class Pretest Data

The average results of the post-test of the control class from the first and second meetings are tabulated in the frequency distribution list with interval classes of 6. The cognitive domain obtained a range of 55 from the difference between the highest score of 95 and the lowest score of 40, the length of the interval class is 8, the mean is 63.03, and the standard deviation is 9.70. It is shown in the following table and graph:

Table 3. Mean Frequency Distribution of Control Class Posttest

No	Interval Class	Frequency	Percentage
1.	44 – 51	3	7,9 %
2.	52 – 59	5	13,2 %
3.	60 – 67	15	39,5 %
4.	68 – 75	8	21,1 %
5.	76 – 83	6	15,7 %
6.	84 – 91	1	2,6 %
∑		38	100 %

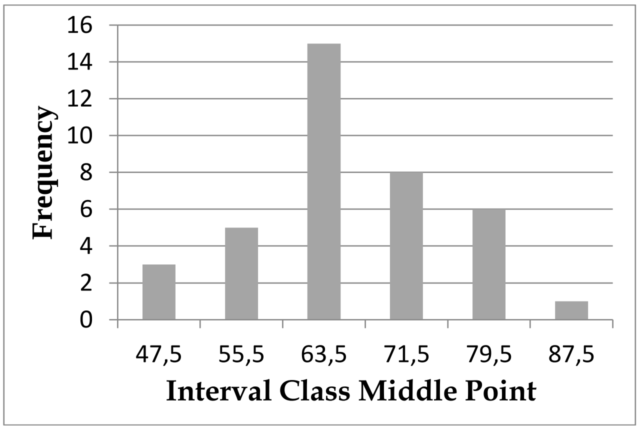

Figure 2. Control Class Posttest Data

2. Data of Experimental Class Learning Outcome

The average results of the pre-test of the experimental class from meeting 1 and meeting 2 are tabulated in the frequency distribution list with interval classes of 6. The cognitive domain obtained a range of 45 from the difference between the highest score of 60 and the lowest score of 15, the length of the interval class is 8 with a mean of 36.87 and a standard deviation of 12.76. This is shown in the following table and graph:

Table 4. Mean Frequency Distribution of Experimental Class Pretest

No	Interval Class	Frequency	Percentage
1.	14 – 21	2	5,2 %
2.	22 – 29	6	15,8 %
3.	30 – 37	11	29,0 %
4.	38 – 45	12	31,6 %
5.	46 – 53	6	15,8 %
6.	54 – 61	1	2,6 %
∑		38	100 %

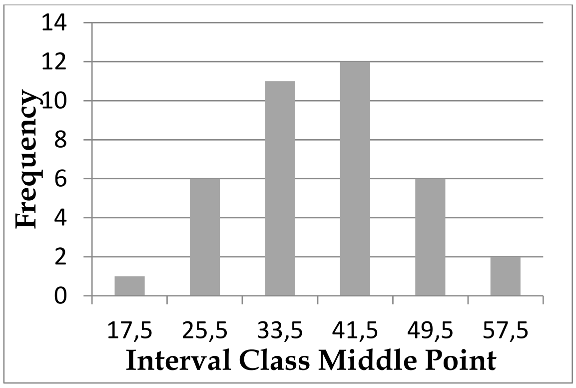

Figure 3. Experimental Class Pretest Data

The average results of the post-test of the experimental class from meeting 1 and meeting 2 are tabulated in a frequency distribution list with interval classes of 6. The cognitive domain obtained a range of 35 from the difference between the highest score of 90 and the lowest score of 55, the length of the interval class is 6 with a mean of 73.61 and a standard deviation of 7.26. Shown in the following table and graph:

Table 5. Mean Frequency Distribution of Experimental Class Posttest

No	Interval Class	Frequency	Percentage
1.	55 – 60	1	2,6 %
2.	61 – 66	6	15,8 %
3.	67 – 72	9	23,7 %
4.	73 – 78	12	31,6 %
5.	79 – 84	8	21,1 %
6.	85 – 90	2	5,2 %
∑		38	100 %

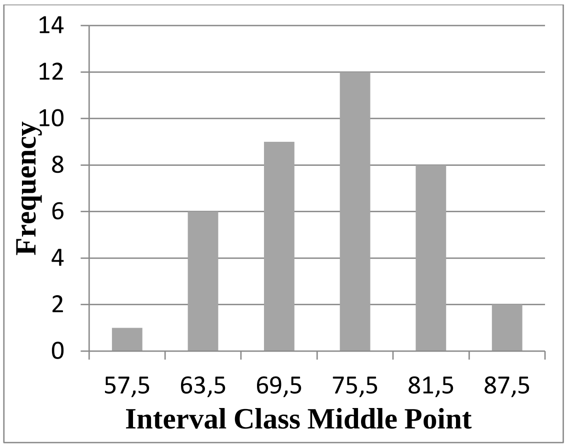

Figure 4. Experimental Class Posttest Data

C. Hypothesis Requirement Test

1. Normality Test

Normality testing is carried out as a condition for hypothesis testing. The results of the normality testing of the data can be seen in the following table:

Table 6. Normality Test of Control and Experimental Class

Class	Data	χ^2 calculated	χ^2 table	Status
Control	Pretest	2,561	11,070	Normal
	Pottest	5,962	11,070	Normal
Experimental	Pretest	2,644	11,070	Normal
	Posttest	3,722	11,070	Normal

2. Homogeneity Test

Homogeneity testing is carried out as one of the requirements for hypothesis testing. The results of the homogeneity test can be seen in the following table:

Table 7. Homogeneity Test of Control and Experimental Class

Class	n	Variance	
		Pretest	Posttest
Control	**38**	92.13	93,77
Experimental	**38**	162,91	52,75
F calculated		1,76	1,77
F table		1,88	1,88
Status		Homogen	Homogen

D. Hypothesis Test

The results of the hypothesis test using an independent two-party t-test are shown in the table below:

Table 8. Independent Two-Party t-test of Cognitive Learning Outcomes

Result	Class	N	Mean	Variance	$t_{calculated}$	t_{table}	Coclusion
Pretest	Control	38	36,37	135,70	0,27	1,99	No significant difference
	Experimental	38	36,87	162,91			
Posttest	Control	38	63,03	93,77	4,03	1,99	Significant difference
	Experimental	38	73,61	52,75			

From the test results obtained the value of $t_{calculated}$ = 4.032. The value of t_{table} = 1.992 at a significance level of 95% with degrees of freedom (dof) = 76 - 1 = 75. The value of $t_{calculated}$ = 4.032 > t_{table} = 1.992. Because the $t_{calculated}$ is higher than the t_{table}, it can be said that the average post-test of the two classes is significantly different. This means that there is a significant difference between the increase in learning outcomes by applying the Quantum Learning method using simulation media compared to using conventional learning methods.

E. Students' Response

The average student gives a good response to learning by applying the Quantum Learning method using simulation media with TANDUR strategy. 83% of students with very good criteria showed a feeling of pleasure towards physics through learning by applying the Quantum Learning method, 79% of students with good criteria showed interest in simulation media, and 83% of students with very good criteria showed seriousness in learning the concept of light with the Quantum Learning method.

F. Discussion

Learning by applying the Quantum Learning method using the TANDUR strategy consists of 6 stages, namely (1) Grow (2) Experience (3) Name (4) Demonstrate (5) Repeat (6) Celebrate. In the control class conventional learning methods are applied, namely the lecture method with practice questions and assignments.

Based on the pre-test and post-test data of the two classes, by testing the normality test described above, it was found that the value of $\chi^2_{calculated} < \chi^2_{table}$ for each pre-test and post-test data of the two classes. So, it can be concluded that the pre-test scores and post-test scores of both classes are normally distributed. Furthermore, from the homogeneity test with two variances, the value of $F_{calculated} < F_{table}$ gives the conclusion that the two groups have the same data variance, or in other words distributed homogeneously. The average score of post-tests for the experimental class was 73.61 and the average score of post-tests for the control class was 63.03. From the two-party independent t test, the value of $t_{calculated} = 4.032$ was obtained. The value of $t_{table} = 1.992$ at the 95% significance level with degrees of freedom (dof) = 75. Because the value of $t_{calculated} < t_{table}$, it can be concluded that there is a significant difference between the increase in learning outcomes of the experimental class and the increase in learning outcomes of the control class. This result is in agreement with another study which shows that the learning outcome for students studying with quantum learning model is higher than students studying with direct instruction learning model (Astra & Tisna, 2023).

The difference in cognitive learning outcomes between experimental class students and control class students can be influenced by various factors, including learning methods, strategies, and media. Conventional learning applied to the control class is learning using the lecture method with practice questions and assignments. Conventional learning can produce high scores but this is not followed by an exploration of students' thinking skills and problem-solving skills. While learning in experimental classes by applying the Quantum Learning method with the TANDUR strategy provides an increase in student learning outcomes because the use of the TANDUR strategy in the Quantum Learning method can help sharpen understanding and memory, and make learning a fun process. This is in line with research conducted by (Anisa et al., 2019) that there is a significant difference between the effect of the Quantum Learning model and the Direct Instruction model. Deporter (in Purwanto, 2011) also stated that the application of the TANDUR strategy in the Quantum Learning method was able to increase the value by 73%.

In addition, the use of simulation media provides learning experiences to students through observation. Simulation provides an opportunity for students to discover concepts and facts, as well as relate and show what they already know from past experiences. Saputra et al., (2020) also concluded that the use of simulation media in learning affects student learning outcomes.

The application of the TANDUR strategy also affects student learning motivation. Students responded well to learning with the Quantum Learning method using simulation media with the TANDUR strategy, with an average of 82% good responses to questionnaires that have been given. The good responses show the students' feelings of pleasure and interest in physics through learning Quantum Learning methods using simulation media with TANDUR strategies, showing students' interest in simulation media as learning media, and showing the seriousness and willingness of students in learning the concept of light through the application of Quantum Learning methods using simulation media with TANDUR strategies. Research conducted by (Firdiani et al., 2018) also states that the application of the TANDUR strategy shows higher learning motivation and student learning outcomes compared to the application of the expository strategy.

CONCLUSION

Based on the results of the research that has been done, it can be concluded that there is a significant difference between the improvement of student learning outcomes when the Quantum Learning method using simulation media is applied compared to using conventional learning methods. The learning outcomes of students with the application of the Quantum Learning method using simulation media are significantly higher than the learning outcomes of students taught using conventional learning methods. In addition, a good response was also shown by SMP N 3 Bengkulu City students towards the application of Quantum Learning methods using simulation media with the TANDUR strategy.

The application of the Quantum Learning method using simulation media with the TANDUR strategy is to help students sharpen their understanding and memory so that student learning outcomes can be improved, as well as to create a pleasant learning atmosphere. In Quantum Learning method, a variety of media can be used, apart from simulation media. This research was only conducted on the subject of Light, it is hoped that other similar studies can be carried out on other subjects.

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