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DIFFERENCES OF STUDENTS' CHEMISTRY LEARNING OUTCOMES BASED ON THE 5E LEARNING CYCLE MODEL

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ABSTRACT

The 5E learning cycle model is a learning model that gives opportunities for students to be able to maximize learning by guiding students to be involved in the learning process actively. One of the chemistry concepts that is difficult for students to understand is acid-base topic. This study aims to find out the differences in students' chemistry learning outcomes that apply the 5E learning cycle model by using handouts and PowerPoint-based learning media on acids and bases topic in the eleventh grade of a state senior high school of Medan. This research is included in a quasi-experimental research design with a pretest-posttest control group design. The sample in this study was eleventh grade with experimental class I taught using the 5E learning cycle model assisted by handout media and class experimental II taught using the 5E learning cycle model assisted by PowerPoint-based learning media. Sampling was completed using a random sampling technique. The instrument used in this study was an objective question in the form of multiple choice of 20 questions which had been tested for validity, difficulty level, discriminating, and reliability. The handout media used in this research has been validated by three expert validators and is suitable for use. The result of this research indicates that there are differences between the two classes with the average student learning outcome in experimental class I which was 85,33 compared with the average student learning outcome in experimental class II which is 80,67. Thus, it can be concluded that the 5E learning cycle model using handout media can be applied to the learning process, especially in acid-base topic.

Keywords: ***5E Learning Cycle, Chemistry, Differences, Handout, Learning Outcomes***

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Introduction

One of the studies related to the environment and human life is chemistry (Yana et al., 2021). Chemistry is one of the subjects considered difficult by high school students because chemistry consists of abstract concepts (Izzania and Widhihastuti, 2020). Furthermore, one of the chemistry concepts that is difficult for students to understand is acid-base (Andriani et al., 2019). Acid-base is a concept that requires memorization and understanding because this concept is related to the next concepts, namely hydrolysis, and buffer solutions.

Several studies describe that students' chemistry scores are low, especially in acid-base topic. Hasanah (2019) said that 65% of student learning outcomes were still below the criteria on the topic of acids and bases. The factors that cause the students' low score are learning process which is dominated by the teacher that affect on achieving learning outcomes less than optimal; the minimal use of instructional media and students who are still lacking in discipline in learning lead to less optimal student learning outcomes (Ma'arif et al., 2020; Jamilla and Lazulva, 2020; Kondoalumang et al., 2022).

The results of interviews with chemistry teachers at State Senior High School of 11 Medan showed that the model used was a conventional learning model as well as a problem-based learning model. Then, the teacher usually uses PowerPoint-based learning media, but for the last few years, this media has rarely been used by teachers. The teacher at this school also said that it was difficult for students when they learn the concepts of acid-base. Based on the results of the interviews, it was also found that there were 60% of students did not achieve criteria of the learning achievement. The solution to overcome the problems is by using appropriate learning model and media. One of the learning models that can be used in the teaching and learning process to improve student learning outcomes is the 5E learning cycle (Annisa, 2022; Aprianingsih et al., 2020).

The 5E learning cycle model is a student-dominated model that opens opportunities for students to be able to maximize learning methods and develop mindsets (Ramdani et al., 2021; Kartini et al., 2021). The 5E learning cycle model can help students to remember previous learning, motivate students to be more active, train students to discover concepts, train students to be able to express known concepts, and train students to be able to present examples of the application of known concepts (Faizan, 2020; Sartika, 2018). As it is already stated that the teaching and learning process, not only requires a learning model, but learning media is also important so that teaching and learning activities can be conducted effectively for improving the quality of the teaching and learning process (Nurseto, 2011). Using the learning media, students will motivate to the lessons and understand lessons because they are involved in learning process. One of the learning media that can increase students' interest, achievement, and learning outcomes is the handout (Yuniarsih et al., 2020; Ayu and Rinaningsih, 2021).

The handout is a learning media used by teachers in learning process which includes statements, topic descriptions, questions, practice questions, and reference topics (Syafriani and Jenifer, 2019; Maskur et al., 2019). The media used in this study are handouts and PowerPoint-based learning media. The handouts in this study are different from other handouts which usually only contain topic descriptions, sample questions, questions, and so on. In this study, the handouts were compiled concisely and completely which included topic descriptions, sample questions, practice questions, answer keys, topic summaries, practicum guides, and others. Furthermore, the PowerPoint-based learning media that is compiled is also adjusted to the indicators to be achieved which are dominated by pictures and also a little writing. By using handouts, students can be motivated to be active and help students understand concepts in the learning process becausehandout presented systematically according to the topic of learning (Asrizal et al., 2022).

The 5E learning cycle model can improve student learning outcomes on the topic of solubility and solubility product as evidenced by the posttest average score obtained which is equal to 51.87 and the average N-gain is 0.359. Based on research conducted by Laela and Rinaningsih (2021), it is stated that handouts can improve student learning outcomes in chemistry learning as evidenced by the obtained average significant learning outcomes of 43.84 and a score of gain value of 0.7 (high category). The research that will be carried out aims to compare the learning outcomes of students who are taught with handout media and PowerPoint-based media with the same model, namely the 5E learning cycle.

This research is different from previous studies which only focused at the effect of the learning cycle model or the influence of handouts and powerpoint-based media on student learning outcomes. Therefore, it can be assumed that there is a novelty in this study, namely comparing student learning outcomes taught with the 5E learning cycle model using handouts and PowerPoint-based media. This research is important to find out the difference in student learning outcomes taught by the 5E learning cycle model using handouts and

PowerPoint-based media so that it can be applied by teachers in learning at school.

Research Methods

This research was conducted at State Senior High Scholl of 11 Medan with two samples, namely class XI IPA 1 and XI IPA 2 which were selected by random sampling technique. This type of research is a quasi-experimental research design with a pretest-posttest control group design research begins with determining the population and research sample. Furthermore, the samples were given a pre-test before doing different treatments and after the treatment is finished, the samples were completing post-test. Quantitative data collection was obtained from the results of the pre-test and post-test. The pre-test was used to measure students' initial abilities and the post-test was used to find out whether there were differences in student learning outcomes in the two samples.

The research was conducted by giving a different treatment, in which the two samples were given a pretest with the same questions. Then after being given a pretest, the two samples were engaged in different treatments. The experimental class I was taught using the 5E learning cycle model assisted by handout media while the experimental class II was taught using the 5E learning cycle model assisted by PowerPoint-based learning media.

The learning media used in this research are handout learning media and PowerPoint-based learning media. Handout learning media used in experimental class learning I and PowerPoint-based learning media media used in experimental class learning II. The handout learning media used has been validated by 3 validators with an average rating score of 92 (very good category) and concluded as appropriate to be used in the learning process. Before being validated, there were no summaries, sample questions, and answer keys. After being validated, the summary, sample questions, and also the answer keys are already in the handout.

The handout used is in the form of a printed version containing achievement indicators, learning objectives, topics, summaries, sample questions, practice questions, as well as answer keys, and also guides of investigation acitivities. The handouts used are in the form of theory handouts and practical handouts. The handout also contained investigation activities that was made because the acid-base topic is very closely related to everyday life so the investigation activity is important in order that students can more easily understand the topic. The following is a display of the handout used in experimental class I.

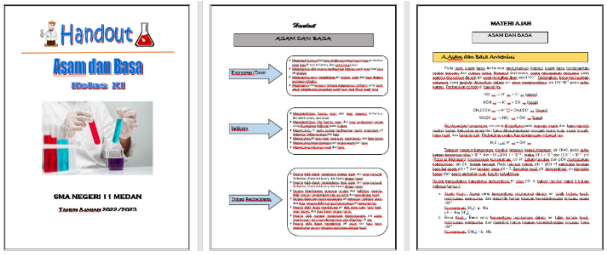

Figure 2a. Handout Learning Media in Theoretical Aspect

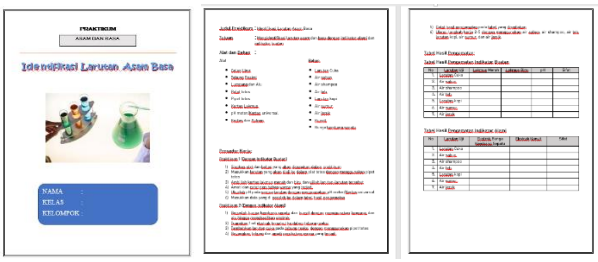

Figure 2b. Handout Learning Media in Investigation Aspect

Figures 2a and 2b showed a handout media that has been adapted to acid-base topic and is suitable for use in learning. In experimental class II, the learning media used is PowerPoint-based media. PowerPoint-based media that is made is adapted to acid-base topic, where the acid-base sub-topic contained in PowerPoint-based is acid-base theory, acid-base pH calculations, and acid-base indicators accompanied by examples of questions and practice questions. The following is a display of the handout used in the experimental class II.

Figure 3. PowerPoint-based Learning Media

Figure 3 represents the PowerPoint-based learning media in the acid-base topic and used in the learning process for experimental class II. The learning model used in this study is the 5E learning cycle which consists of 5 stages, namely engagement, exploration, explanation, elaboration, and evaluation. At the engagement stage, the teacher tries to arouse students' interest and knowledge about the topic to be discussed by asking questions. The second stage is exploration, the teacher acts as a facilitator and explores students' initial concepts so that students can find out for themselves and make hypotheses in groups without being given prior explanation by the teacher. The third stage is the explanation, the teacher encourages students to express their opinions in

understanding a concept, and then the teacher gives an explanation of the concept to be discussed. The fourth stage is elaboration, the teacher invites students to be able to apply the concepts they have learned. Through the activities, students can learn meaningfully because students have been able to apply the concepts they have learned. One way that can be done is to provide practice questions and also do an investigation activity. The last stage is evaluation, the teacher observes students' knowledge in applying the concept by conducting a question-and-answer session with students. At this stage, the teacher will evaluate the extent to which students understand the concepts learned that day.

The instrument used in this study is a test instrument in the form of an objective test in the form of multiple choice with five options of 20 questions. This test instrument was previously validated by three expert validators which were then tested on students of class XII IPA. The data were processed from the test results of the instrument so that 20 questions were obtained that were valid and reliable, and adjusted for the indicators of achievement in acid-base topic. The research instruments that have been analyzed are then used as the pretest and posttest for the two experimental classes. The media handout used in this study has also been validated by three validators so that an average score of 92 (very good category) is obtained and is suitable for use in research.

After obtaining the data from the post-test results, statistical data processing was carried out with several testing techniques, namely normality tests, homogenity tests, and hypothesis testing to see whether there were differences in student learning outcomes in the two samples. Then the data from the pre-test and post-test results obtained were carried out with a gain test to see the increase in learning outcomes for each sample with the gain criteria shown in Table 1 below.

Table 1. Normalized Gain Criteria

Percentage	Classification
N - gain > 70%	High
30% ≤ N - gain ≤ 70%	Medium
N - gain < 30%	Low

Result and Discussion

The learning process in the experimental class I

Learning process in the experimental class I used the 5E learning cycle model with handout media. The learning process begins by arousing students' interest in the topic to be studied by asking questions to students so that students are interested in entering the learning process. Based on the research that has been done, students look enthusiastic in answering every question given about acids and bases. Next is the exploration stage, at this stage students are given handouts so they can be discussed in groups. The teacher provides opportunities for students to be able to understand the contents of the topic in the handout. In the next stage, the teacher provides opportunities for students to express their opinions about the topic that has been studied in the handout, after students give their opinions, the teacher provides a more detailed explanation to students about the concepts being studied. In the next stage, the teacher gives practice questions as a form of applying the concepts that have been learned. At this stage, students can work on the practice questions given properly, because the answer key is available in the handout so that students can find out whether the answer is correct or wrong. The last stage is evaluation, the teacher asks questions to students about the concepts that have been studied and applied so that the teacher knows whether students understand the concepts being studied or not. Student activities during the learning process of experimental class I as seen in Figure 4.

Figure 4. Teaching and Learning Activities in Experimental Class I

Figure 4 represents the learning process using the 5E learning cycle assisted by media handouts. On the left side, students learn about acid-base theory, and on the right side, students did investigation activities in acid-base topic.

The learning process in the experimental class II

Learning in experimental class II using the 5E learning cycle model with PowerPoint-based media. The learning process begins by arousing students' interest in the topic to be studied by asking questions to students so that students are interested during the learning process. Based on the research that has been done, students look enthusiastic in answering every question given about acids and bases. Next is the exploration stage, at this stage students have learned through the PowerPoint-based media that has been developed so that it can be discussed in groups. The teacher provides opportunities for students to be able to understand

the contents of the topic in PowerPoint-based learning media. In the next stage, the teacher provides opportunities for students to express their opinions about the topic that has been studied, after students give their opinions, the teacher provides an explanation regarding the concepts being studied. In the next stage, the teacher gives practice questions as a form of applying the concepts that have been learned. At this stage, students can work on the practice questions given well, even though students still ask questions about solving these questions. The last stage is evaluation, the teacher asks questions to students about the concepts that have been studied and applied so that the teacher knows whether students understand the concepts being studied or not. Student activities during the learning process of experimental class II as seen in Figure 5.

Figure 5. Teaching and Learning Activities in Experimental Class II

Figure 5 was taken during the learning process using the 5E learning cycle assisted by PowerPoint-based learning media. On the left side, students learn about acid-base theory, and on the right side, students did investigation activities in acid-base topic.

Result of Pre-test and Post-test

Based on the research that has been done, statistical data was obtained from student learning outcomes in experimental classes I and II. The data were taken from the results of the pre-test and post-test of student learning outcomes in the form of an objective test of 20 questions with variations in the cognitive level of the questions from C1-C3. Statistical data on student learning outcomes are presented in Table 2 as follows.

Table 2. Statistical Data on Student Learning Outcomes

Data	Statistic	Class	
		E I	E II
Pre-test	Minimum Value	30	10
	Maximum Value	65	40
	Average Value	55	25
	Standard Deviation	9,09	7,42
	Variance	82,75	55,17
Post-test	Minimum Value	75	65
	Maximum Value	95	90
	Average Value	85,33	80,67
	Standard Deviation	4,90	6,53
	Variance	24,02	42,64

The data above represents the pre-test and post-test result data in the form of minimum scores, maximum scores, averages, standard deviations, and also the variance of student learning outcomes from both the experimental class I which was taught with the 5E learning cycle model assisted by handout media and the experimental class II which was taught with PowerPoint-based learning media in the 5E learning cycle model. Based on the research findings, it can be described the average pre-test and post-test scores for experimental class I and experimental class II in Figure 6 below.

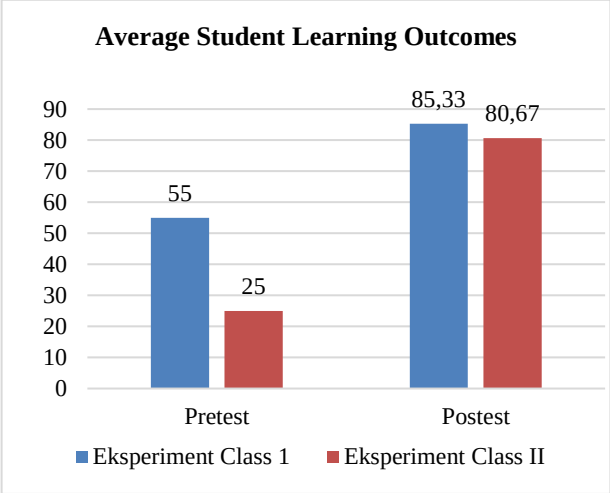

Figure 6. Average of Student Learning Outcomes

The average pre-test score for the experimental class I before being taught using the 5E learning cycle model assisted by handout learning media was 55 and the post-test average score after being given treatment was 85.33. The average pre-test score for the experimental class II before being taught using the 5E learning cycle model assisted by PowerPoint-based learning media learning media was 25 and the post-test average score after being given treatment was 80.67. In both experimental class I and experiment II, the average student learning outcomes were above the criteria score, which was 75.

Normality test

After obtaining pre-test and post-test data on student learning outcomes in both samples, data processing was carried out. The first data processing carried out is the data normality test to determine whether the research data is normally distributed or not as a condition for being able to proceed to the next test. The normality test for student learning outcomes data was carried out using the chi-square test at a significance level of $\alpha = 0.05$. In the post-test data normality test for an experimental class I, the calculated chi-square value was $10.3235 < (X^2)_{table}$ 11.0705 and the post-test data for experimental class II obtained the $(X^2)_{count}$ $2,3026 <$

$(X^2)_{table}$ 11.0705. Data from the results of the normality test for student learning outcomes are presented in Table 3 as follows.

Table 3. Data Normality Test of Students' Learning Outcomes

Data	$(X^2)_{count}$	$(X^2)_{table}$	Note
Post-test in Experimental Class I	10,3235	11,0705	Normal Distributed Data
Post-test in Experimental Class II	2,3062	11,0705	Normal Distributed Data

Based on Table 3 above, it can be concluded that the $(X^2)_{count}$ value in both experimental class I and experiment II has a value that is more than the $_{table}$ value. Because $(X^2)_{count} < (X^2)_{table}$ it can be concluded that the post-test data of student learning outcomes has a normal distribution of data.

Homogenity Test

The data homogenity test is carried out to find out whether the distribution of data in the population is homogeneous or not. The results of the post-test data homogenity test of student learning outcomes can be seen in Table 4 below.

Table 4. Homogenity Test of Students' Learning Outcomes

Data	S^2	F_{count}	F_{table}	Note
Post-test in Experimental Class I	24,02	1,775	1,860	Homogeneous Data
Post-test in Experimental Class II	42,64			

The value of F_{table} at db quantifier = (n1-1) = 30-1 = 29 and db denominator (n2-1) = 30-1 = 29. At the significance level α = 0.05, namely F(0.05) (29, 29) obtained a F_{table} value of 1.860. With the homogenity test criteria $F_{count} < F_{table}$ and obtained the value of F_{count} 1.775 $< F_{table}$ 1.860, it can be concluded that the post-test data for the two experimental classes were homogeneous. This data means that there can be no difference, either in the mean value or in the value of the variance in the sample group.

Hypothesis testing

After the data is known to be normally distributed and homogeneous, it can be tested the hypothesis using a statistical test, namely t-test. The t-test is used to determine whether the hypothesis in the study is accepted or rejected. Data on the results of hypothesis testing can be seen in Table 5 as follows.

Table 5. Hypothesis testing

Class Data		t_{-count}	t_{-table}	Note
Experiment I	Experiment II			
$\bar{X}_1 = 85,33$ S = 4,90 $S^2 = 24,02$	$\bar{X}_2 = 80,67$ S = 6,53 $S^2 = 42,64$	3,1275	2,002	Ha accepted

Based on the t-test calculation, the t_{-count} value is 3.1275. The critical area is at -t < - t ½ α and t > t ½ α, where α = 0.05 then ½ α = 0.025, db = n1 + n2 -2 = 58. Based on the calculations that have been done, it is obtained t_{-table} = 2.002 with ½ α = 0.025. Based on the calculation of the t-test test, it is obtained t_{-count} = 3.1275, so that t_{count} is in the critical area, namely reject H_0 with $-t_{count}$ < - 2.002 or t_{count} > 2.002. Thus H_0 rejected and Ha accepted. The alternative hypothesis (Ha) in this study is that there are differences in student learning outcomes that are taught in the 5E learning cycle model using a handout learning media and Powerpoint-based learning media in acid-base topic.

Gain Test

The gain test was carried out to determine the increase in student learning outcomes in both samples whether the increase was high (g > 0.7), moderate (0.3 > g ≤ 0.7), or low (g <0.3). Based on the calculation of the gain of the two samples, the average gain of the experimental class I and experiment II is summarized in the in Figure 7 as follows.

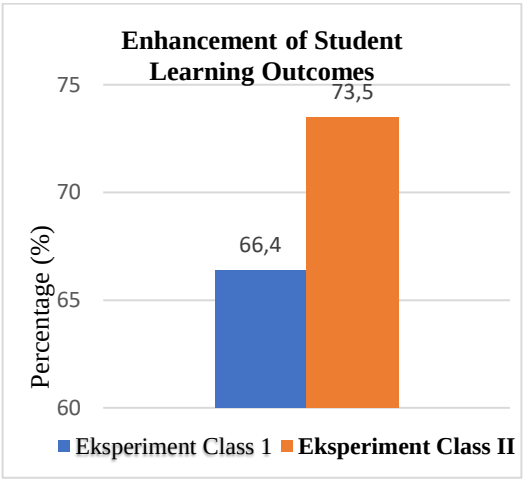

Figure 7. Enhancement of Student Learning Outcomes

Based on the data in the diagram above, the percentage increase in student learning outcomes in experimental class I which was taught with the 5E learning cycle model assisted by handout learning media was 66.4% and the increase in student learning outcomes in experimental class II was taught with the 5E learning cycle model assisted by

Powerpoint-based learning media was 73. 5%. It can be concluded that the increase in student learning outcomes in experimental class II is higher than the experimental class I.

Before entering the lesson, the two experimental classes were given pre-test questions to find out the initial state of the students as many as 20 multiple-choice questions that met the requirements for the validity test, level of difficulty, differential power, and the reliability of the questions. From the results of the pre-test, it was obtained that the average student learning outcomes of experimental class I was 55 and the average in experimental class II was 25. Based on the data above, there was a significant difference between the pretest averages of the experimental class I and the experimental class II.

After carrying out the initial test (pre-test), learning is carried out according to the 5E learning cycle model for two experimental classes assisted by handout (Experiment I) and PowerPoint media (Experiment II) which were conducted in three meetings. At the end of the lesson, students are given a final test (post-test) with the same questions as the pretest. It was obtained that the posttest average student learning outcomes for experimental class I was 85.33 and for experimental class II was 80.67. Based on these data, there were differences in student learning outcomes between experimental class I and experimental class II, namely the average student learning outcomes in experimental class I were higher than the average student learning outcomes in experimental class II.

It can be assumed that there are obstacles in teaching students in experimental class II with 5E learning cycle model assisted by PowerPoint media including power outages during the learning process, as well as less teaching time due to preparations for installing infocus in class. The learning process in experimental class I used the media handout took place more efficiently than learning in experimental class II which used PowerPoint media. This happened because students are more prepared to learn. After all, students have studied the topic that will be studied before the handout that has been given. When the learning took place, the students in the experimental class looked more active and enthusiastic because the students had a little understanding of the topic to be studied in the handouts which are given. Students have also practiced the questions on the handout so that when learning takes place, students can do the exercises well. While students in the experimental class II, almost all of them had just learned the topic being taught at the time the learning took place so it took a lot of time during the learning process because students asked a lot about things that were not understood in learning.

In the 5E learning cycle, during the interest generation and exploration stages, the two experimental classes were equally enthusiastic about entering learning, then at the explanation stage, the experimental class I explained more about what they knew than the experimental class II. At the elaboration stage, students in experimental class II asked more questions about the questions they were working on compared to the experimental class I who already understood more about the questions given. In the last stage, the two experimental classes were able to conclude well the topic learned that day.

The data obtained in this study were in the form of students' pre-test and post-test scores from the two experimental classes. The students' pre-test scores in the experimental class I were higher than the students' pre-test scores in the experimental class II. This is due to differences in student learning activities in the classroom. In experimental class I, students are accustomed to learning new topic in advance by making notes so that students can do the pre-test better than in experimental class II. The post-test scores of students in experimental class I were higher than the post-test scores of students in experimental class II so it can be said that the learning outcomes of the students in experimental class I were higher than the learning outcomes of the students in the experimental class II.

This finding means that there are differences in student learning outcomes in experimental classes I and II. In the test for increasing student learning outcomes, the score gain for experimental class II was higher than the percent gain for experimental class I, which was due to the pre-test score for experimental class I being higher than the post-test score for experimental class II so that the percent increase in learning outcomes was not high in experimental class I. This research is also in line with research conducted by Syafriani and Jenifer (2019); Harefa (2020) that there are significant differences in student learning outcomes taught using media handouts compared to student learning outcomes taught using PowerPoint media on buffer solution topic. Other studies also say that the implementation of the 5E learning cycle model has a significant effect on student learning outcomes in acid-base topic with an average learning outcome of 80.14 compared to an average learning outcome of conventional models of 76.00 (Asmuni, 2020; Rahmawati, 2017).

Conclusion

The purpose of this study was to determine the differences in students' chemistry learning outcomes that apply the 5E learning cycle model by using handouts and PowerPoint learning media on acid-base topic. Based on the results of the research that has been done, it can be concluded that there are differences in student learning outcomes who are taught using the 5E learning cycle model and handout media and students who are taught using the 5E learning cycle model assisted by PowerPoint-baed learning media. The average student learning outcome in experimental class I was 85.33 and the average student learning outcome in experimental class II was 80.67.

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