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# The Impact of the 5E Learning Cycle Model Based on the STEM Approach on Scientific Attitudes and Science Learning Outcomes

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**ABSTRAK**

*Ditemukan rendahnya hasil belajar siswa dan sikap ilmiah siswa. Tujuan penelitian ini yaitu mengaalisis Cycle 5E berbasis pendekatan STEM terhadap sikap ilmiah dan hasil belajar IPA. Penelitian ini merupakan penelitian eksperimen. Populasi berjumlah 294 siswa. Metode mengumpulkan data adalah tes dan non-tes. Instrumen yang digunakan yaitu lembar kuesioner atau angket untuk sikap ilmiah dan tes hasil belajar IPA. Teknik menganalisis data yaitu analisis deskripsi dan statistic inferensial. Hasil penelitian yaitu terdapat perbedaan sikap ilmiah antara siswa yang mengikuti pembelajaran menggunakan Learning Cycle 5E berbasis pendekatan STEM dengan siswa yang menggunakan model pembelajaran langsung, dengan taraf signifikan sebesar 0,026. Terdapat perbedaan hasil belajar IPA antara siswa yang mengikuti pembelajaran dengan menggunakan Learning Cycle 5E berbasis pendekatan STEM dengan siswa yang menggunakan model pembelajaran langsung, dengan taraf signifikansi lebih kecil dari 0,000. Disimpulkan bahwa terdapat perbedaan sikap ilmiah dan hasil belajar IPA antara siswa yang mengikuti pembelajaran menggunakan Learning Cycle 5E berbasis pendekatan STEM dengan siswa yang mengikuti pembelajaran langsung. Implikasi penelitian ini yaitu learning Cycle 5E berbasis pendekatan STEM dapat meningkatkan sikap ilmiah dan hasil belajar IPA.*

***ABSTRACT***

It was found that students' learning outcomes and scientific attitudes were low. This study aims to analyze Cycle 5E based on the STEM approach to scientific attitudes and science learning outcomes. This research is experimental. The population is 294 students. Methods of collecting data are test and non-test. The instruments used are questionnaire sheets or questionnaires for scientific attitudes and science learning outcomes tests. The technique of analyzing the data is descriptive analysis and inferential statistics. The results of the research are that there are differences in scientific attitudes between students who take part in learning using the 5E Learning Cycle based on the STEM approach and students who use the direct learning model, with a significant level of 0.026. There are differences in science learning outcomes between students who take lessons using Learning Cycle 5E based on the STEM approach and students who use direct learning models, with a significance level of less than 0.000. It was concluded that there were differences in scientific attitudes and science learning outcomes between students who participated in learning using Learning Cycle 5E based on the STEM approach and students who participated in direct learning. This research implies that the 5E learning cycle based on the STEM approach can improve scientific attitudes and science learning outcomes.

## 1. INTRODUCTION

Education is a tool that can help develop the potential and qualities possessed by each individual. Improving a nation's education quality will be useful in facing global competition (Harianti et al., 2020; Oktavian & Aldya, 2020). Therefore, education should receive serious attention and require renewal (Hartini et al., 2020; Suryana, 2020). One of the lessons that can bring students to be ready to face global competition and improve their intellectual quality is through meaningful learning. The rapid progress of science and technology greatly affects the educational development of students, especially in science education (Acesta, 2020; Nikmatillah, 2018; Qistina et al., 2019). Science is one discipline that deals with how to find out about nature systematically

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(Ariesta & Olifia, 2019; Maison et al., 2020). Science is not only mastery of a collection of knowledge in the form of facts, concepts, or principles but also applies a process of discovery so that it can help students gain direct experience and develop their competencies to explore and understand the natural surroundings scientifically (Anif et al., 2020; Setiawan et al., 2017). Considering that science learning is very influential in everyday life and the field of increasingly advanced technology, it is proper that science learning in elementary schools gets serious treatment (Astalini et al., 2020; Tanti et al., 2020). The science teacher is not only obliged to convey the lesson's content but all problems related to the application of the lesson need to be carried out as intensively as possible. Teachers not only use the lecture method but can also combine other methods to support student activity in learning and thinking (Andriana et al., 2017; Kusumayuni & Agung, 2021). However, there are still many low student learning outcomes (Paramita, Tastra, et al., 2016; Paramita, Garminah, et al., 2016). The low scientific attitude of students is also a problem faced by education in Indonesia (Dewi, Dantes, et al., 2013; Fitriyanti et al., 2020). Often, students feel like they failed an assignment and didn't mean it (Arisantiani et al., 2017; Dwi Lestari & Putu Parmiti, 2020). Students must have a scientific attitude to avoid and minimize negative attitudes to develop their knowledge (Fitriyanti et al., 2020; Putra et al., 2019). Based on the description above, it can be seen that the low learning outcomes and scientific attitudes of students indicate that the practice of learning science in elementary schools is not optimal. Hasil observasi dan wawancara dengan guru wali kelas V di SD Gugus I Kecamatan Kuta Kabupaten Badung, diketahui bahwa siswa SD masih mengalami kesulitan dalam pembelajaran IPA. Pada saat dilaksanakannya proses pembelajaran IPA, aktivitas siswa cenderung kurang aktif. Hal ini disebabkan karena rendahnya sikap ilmiah siswa dalam mengikuti proses pembelajaran IPA. Hanya beberapa siswa yang mau benar-benar mengikuti proses pembelajaran tersebut. Beberapa dari siswa merasa gagal sebelum melakukan suatu tugas dan oleh karena itu ia tidak bersungguh-sungguh dalam proses pembelajaran. Maka dari itu diperlukan sikap ilmiah siswa yang sangat penting dimiliki untuk mengembangkan pengetahuan baru melalui kaidah penelitian yang tepat. Hasil belajar IPA siswa juga masih belum memenuhi KKM. Dengan nilai KKM yaitu 70. Hal ini dikarenakan siswa masih belum mampu menyerap semua materi yang diajarkan oleh guru. Permasalahan ini menandakan bahwa siswa belum memiliki pengetahuan dan sikap ilmiah yang baik. The solution to this problem is applying the 5E learning cycle model based on the STEM approach to improve scientific attitudes and science learning outcomes. Learning Cycle is a student-centered learning model based on a constructivist view in which knowledge is built from the student's knowledge (Paramita, Tastra, et al., 2016; Shofiah et al., 2018). Learning Cycle 5E is a series of activity stages (phases) organized so that students can master the competencies that must be achieved in learning by playing an active role (Dewi, Semara, et al., 2013; Sasono et al., 2017). The 5E learning cycle learning model (Learning Cycle 5E) motivates students to enter the topic through several learning stages to explore the subject, provide definitions of their experiences, get more detailed information about their learning, and to evaluate it (Anugraheni, 2019; Dewi et al., 2016). In addition to requiring a learning model, a learning approach is also needed that can help support scientific attitudes and students' science learning outcomes. The STEM approach is one of the breakthroughs in 21st-century learning that can be used to overcome the above problems. STEM (Science, Technology, Engineering, and Mathematics) is interdisciplinary learning between science, technology, engineering, and mathematics (Utami et al., 2018; Widayanti et al., 2019). Research evidence regarding education level shows that the integrated STEM model positively affects student achievement (Chonkaew et al., 2016; Lavi et al., 2021). In line with this, applying STEM can help develop knowledge, help answer questions based on investigations, and help students create new knowledge (Agustina et al., 2020; Conradty & Bogner, 2018).

It shows that learning guides students in growing creative thinking processes to solve various existing problems. Learning with the STEM approach consists of four elements: science, technology, engineering, and math (Zaki et al., 2020). Learning with this STEM approach can improve the relationship between all these STEM elements. Learning with the STEM approach does not only require students to have competence in the cognitive domain, but students are also expected to have other competencies (Belland et al., 2017; Beswick & Fraser, 2019). These competencies are closely related to skills, abilities, job satisfaction, and work values. These competencies can be achieved when students learn to become problem solvers, inventors, and creators and can work together (Nurjanah, 2020). It will be achieved when a student is active in learning. Previous research findings state that STEM can improve the learning atmosphere (Çinar et al., 2016; Rizaldi et al., 2020). Another finding states that STEM can improve learning outcomes (LaForce et al., 2017; Ngabekti et al., 2019). Other research states that the Learning Cycle is a student-centered learning model so that students become active and impact increasing student understanding (Darwis et al., 2020; Wiastuti et al., 2014). It was concluded that the STEM-based 5E Learning Cycle is a learning model that can stimulate students to have the skills needed in the 21st century, one of which is critical thinking. There is no study on applying the learning Cycle 5E model based on the stem approach to scientific attitudes and science learning outcomes. The advantage of this research is that Learning Cycle 5E, based on the STEM approach, puts students in the position to explore new concepts, re-evaluate their past experiences, and assimilate or accommodate new experiences and concepts into existing schemas. This study aims to analyze Cycle 5E based on the STEM approach to scientific attitudes and science

learning outcomes. The 5E learning cycle model based on the STEM approach is expected to improve scientific attitudes and student learning outcomes.

## 2. METHOD

This research is experimental. The type of experiment in this study is quasi-experimental. The research design used was a post-test-only control group design. It is because the existing classes have been formed previously so that no more random grouping is done. The implementation of learning was carried out six times and one meeting to provide a post-test. The population in this study were all fifth-grade elementary school students in Cluster I, Kuta District, totaling 294 students. The sampling technique used in this research is full sampling, VB SD No. 5 Kuta as the experimental class and class VB SD No. 1 Kuta as the control class. The method used to collect data in this research is test and non-test. The data collected in this study are scientific attitudes and student learning outcomes in science subjects. The non-test method in the form of a questionnaire was used to collect data about students' scientific attitudes. In contrast, multiple-choice tests collected data about students' science learning outcomes. This study uses two instruments: questionnaire sheets or questionnaires for scientific attitudes and science learning outcomes tests. The grid is presented in Table 1.

**Table 1.** Scientific Attitude Questionnaire

| No. | Dimension | Indicator |
|---|---|---|
| 1. | Curiosity | 1. Enthusiasm for answers<br>2. Attention to the observed object<br>3. Asking every step of the activity |
| 2. | Respect for data/facts | 1. Objective or honest<br>2. Not manipulating data<br>3. Make decisions based on facts |
| 3. | Critical thinking attitude | 1. Doubt the findings of my friends<br>2. Repeating the activities carried out<br>3. Don't ignore data, even if it's small |
| 4. | The attitude of discovery and creativity | 1. Showing different reports with classmates<br>2. Using experimental tools well |
| 5 | Open-minded and cooperative attitude | 1. Appreciate other people's opinions or findings<br>2. Want to change your opinion if the data is lacking<br>3. Actively participate in groups |
| 6. | Perseverance | 1. Repeating the experiment even though it failed.<br>2. Completing tasks on time |
| 7. | Sensitivity to the surrounding environment | 1. Attention to events around.<br>2. Participation in social activities<br>3. Keeping the school environment clean and beautiful |

(Modified from Putra et al., 2019)

The technique used to analyze the data is descriptive analysis and inferential statistics. Description analysis describes the data obtained on science learning outcomes and students' scientific attitudes. Statistical analysis used to test the hypothesis is by using MANOVA. This study investigates the effect of one independent variable on two dependent variables. The research data were collected and analyzed in stages. These stages are description analysis, data normality test, homogeneity of variance test, correlation test between dependent variables or multicollinearity, and hypothesis testing.

## 3. RESULT AND DISCUSSION

### Result

Data analysis to test the hypothesis in this study will use MANOVA. Before analyzing the data, firstly, the data distribution normality test, variance homogeneity test, variance/covariance matrix homogeneity test, and correlation test between dependent variables were carried out before analyzing the data. The first hypothesis states that there are differences in scientific attitudes between students who follow the Learning Cycle 5E learning model based on the STEM approach and students who follow the direct learning model. The decision-making for testing the first hypothesis uses analysis of variance (ANAVA) assisted by SPSS 16.00 for windows. Based on the first hypothesis testing with SPSS 16.00 for Windows, the dependent variable scientific attitude has an F score of 5.284 with a significance level of 0.026 or less than 0.050. It shows that the score of F on the dependent variable scientific attitude is significant. Therefore, it can be concluded that there is a significant difference in scientific attitudes between the group of students who use the Learning Cycle 5E learning model

based on the STEM approach and the group of students who use the direct learning model. The results of the first hypothesis test are presented in Table 2.

**Table 2.** Summary of the First Hypothesis Test

| Source | Dependent variable | JK | Df | RJK | F | Sig | Conclusion |
|---|---|---|---|---|---|---|---|
| Between | Scientific attitude | 72.000 | 1 | 72.000 | | | |
| Inside | Scientific attitude | 654.080 | 48 | 13.627 | **5.284** | **0.026** | Significant |
| Total | Scientific attitude | 726.080 | 49 | | | | |

The second hypothesis states that there are differences in science learning outcomes between students who follow the Learning Cycle 5E learning model based on the STEM approach and students who follow the direct learning model. Decision-making on the second hypothesis testing using analysis of variance (ANAVA) assisted by SPSS 16.00 for windows. Based on the second hypothesis testing with SPSS 16.00 for Windows, the dependent variable of science learning outcomes has an F score of 28.240 with a significance level of 0.000 or less than 0.050. It shows that the score of F on the dependent variable of science learning outcomes is significant. Therefore, it can be concluded that there are significant differences in science learning outcomes between the group of students who use the Learning Cycle 5E learning model based on the STEM approach and the group of students who use the direct learning model. The results of the second hypothesis are presented in Table 3.

**Table 3.** Summary of the Second Hypothesis Test

| Source | Dependent variable | JK | Df | RJK | F | Sig | Conclusion |
|---|---|---|---|---|---|---|---|
| Between | Science Learning Outcomes | 1,352.000 | 1 | 1,352.000 | | | Significant |
| Inside | Science Learning Outcomes | 2,298.000 | 48 | 47.875 | **28.240** | **0.000** | |
| Total | Science Learning Outcomes | 3,650.000 | 49 | | | | |

The third hypothesis states that there are differences in scientific attitudes and science learning outcomes between students who take lessons using the Learning Cycle 5E learning model based on the STEM approach and students who use direct learning models. The third hypothesis analysis uses MANOVA analysis, whose decisions are made with the analysis of Pillai's Trace, Wilks' Lambda, Hotelling's Trace, and Roy's Largest Root with the help of SPSS 16.00 for windows. The analysis results show that the F score for Pillai's Trace, Wilks' Lambda, Hotelling's Trace, and Roy's Largest Root has an F score of 15,479 with a significantly smaller level than 0.05. Therefore, the F scores for Pillai's Trace, Wilks' Lambda, Hotelling's Trace, and Roy's Largest Root are significant. So, it can be concluded that there are significant differences in scientific attitudes and science learning outcomes between the students who use the Learning Cycle 5E learning model based on the STEM approach and those who use the direct learning model. Based on the analysis using the MANOVA statistical model with the help of the SPSS 16.00 for the windows application above, the results of hypothesis testing in this study can be summarized as follows. First, testing the first hypothesis, the null hypothesis is rejected, and the alternative hypothesis is accepted. It means that there is a significant difference in scientific attitudes between the students who use the Learning Cycle 5E learning model based on the STEM approach and those who use the direct learning model. Second, testing the second hypothesis, the null hypothesis is rejected, and the alternative hypothesis is accepted. There is a significant difference in science learning outcomes between students who use the Learning Cycle 5E learning model based on the STEM approach and those who use the direct learning model. Third, testing the third hypothesis, the null hypothesis is rejected, and the alternative hypothesis is accepted. It means that there are significant differences in scientific attitudes and science learning outcomes between the group of students using the Learning Cycle 5E learning model based on the STEM approach and those using the direct learning model.

## Discussion

The data analysis results showed significant differences in scientific attitudes and science learning outcomes between the students who used the Learning Cycle 5E learning model based on the STEM approach and those who used the direct learning model. It is due to several things. First, the 5E Learning Cycle model based on the STEM approach improves scientific attitudes. A scientific attitude is needed in learning activities,

especially science learning (Kurniawan et al., 2018; Suryantari et al., 2019; Susilo et al., 2018). With a scientific attitude, student learning outcomes will be optimal because a scientific attitude will encourage students to seek their knowledge so that the knowledge gained is long-term memory (Astalini et al., 2018; Widani et al., 2019). The provision of the Learning Cycle 5E model has been implemented in science learning to improve students' scientific argumentation skills (Paramita, Tastra, et al., 2016; Shofiah et al., 2018). The 5E Learning Cycle model emphasizes the role of students as the center of learning and knowledge self-making. The Learning Cycle 5E model can create meaningful learning that can improve student achievement and student learning motivation and help them to learn actively (Dewi et al., 2016; Sasono et al., 2017). Second, the Learning Cycle 5E model based on the STEM approach improves learning outcomes. The 5E learning cycle model effectively improves students' understanding and learning achievement, helps students enjoy science, understand the material, and apply it in scientific situations (Anugraheni, 2019; Asthira et al., 2016). It makes students active and creative by developing their thinking skills in solving problems in the learning process so that they can foster student curiosity to find answers to problems solved (Asthira et al., 2016; Dewi et al., 2016). Conducting discussions in solving problems will foster student curiosity. Thus, students are enthusiastic and diligent in finding solutions or answers to the problems being solved. Previous findings stated that the 5E Learning Cycle model significantly influences student learning outcomes (Darwis et al., 2020; Zulchaidar, 2015). It is influenced by the characteristics of the Learning Cycle 5E learning model, which always provides opportunities for students to find, apply, and use their learning styles to understand the concepts in the material provided. Student learning outcomes can be seen from the understanding and ability of students to solve the problems given. It is concluded that the Learning Cycle 5E learning model helps improve student learning outcomes.

Third, the Learning Cycle 5E model based on the STEM approach improves scientific attitudes and learning outcomes. Based on the STEM approach, the Learning Cycle 5E learning model views the learning process as an activity of the brain and the whole body. In the learning process in this study, students were grouped into several heterogeneous groups, and then they solved problems together through experiments. Learning in groups can open students' understanding of critical thinking to solve problems so that it has a positive impact on students to share their knowledge with other students (Faisal Mustofa et al., 2019; Fauzi & Mustadi, 2019). The direct learning model depends on the teacher's communication style (Aditya et al., 2019; Tania & Murni, 2017). The findings of previous studies stated that Learning Cycle 5E is suitable to be applied in science learning (Darwis et al., 2020; Tania & Murni, 2017). Other research findings state that the STEM approach makes it easy for students to understand the material and increases motivation so that it is suitable to be applied in science learning (Ngabekti et al., 2019; Sari & Apriyantika, 2020; Zaki et al., 2020). This research implies that applying Learning Cycle 5E based on the STEM approach in science learning can help teachers create an effective and interesting learning atmosphere with limited abilities and available time and help students improve science learning outcomes. The research contribution, namely the development of scientific attitudes, can be made with the Learning Cycle 5E learning model based on the STEM approach, providing opportunities for students to develop their potential broadly. Scientific attitude builds student activity in the learning process. This student's active attitude causes a high interaction between students and teachers, as well as students and students. It makes the classroom atmosphere fun and conducive because students can involve their abilities as much as possible in learning. Scientific attitudes from the learning process will refer to the formation of knowledge and skills that improve student learning outcomes.

## 4. CONCLUSION

There are differences in the scientific attitude of students who take lessons with the Learning Cycle 5E learning model based on the STEM approach with students who take lessons using the direct learning model. There are differences in the learning outcomes of students who take lessons with the Learning Cycle 5E learning model based on the STEM approach with students who take lessons using the direct learning model. It was concluded that simultaneously there were differences in scientific attitudes and science learning outcomes between students who took part in learning using the Learning Cycle 5E learning model based on the STEM approach and students who took part in direct learning.

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