Contribution of observing indicators to temperature and heat experiments in improving science process skills

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Abstract. This study aims to determine whether there are significant differences in the science process skills of students who are taught using the 5E learning cycle model with students who are taught using conventional learning and what indicators play a role in increasing students' science process skills. This research is a quasi-experimental study with two group pretest-posttest designs. The population of this study was students of class XI of SMA Negeri 4 Pematang Siantar consisting of 8 classes. The sample in this study was taken by cluster random sampling technique, namely as many as two classes, where class XI MIPA 7 as an experimental class taught with learning cycle model 5E and class XI MIPA 8 as a control class taught with conventional learning. The instrument used was a non-test instrument for science process skills in the form of student worksheets. Data will be analyzed using the SPSS program. The results of the study concluded that there were significant differences in the science process skills of students who were taught using the 5E learning cycle model with students who were taught using conventional learning and observing indicators had a significant contribution in improving students' science process skills.

1. Introduction

Education is one of the basic human needs which has a significant role in delivering humans to achieve a quality life. Inadequate education will result in a lack of knowledge and skills to solve problems faced in maintaining and developing life. One way to produce quality education is changing from traditional learning to modern learning [1]. This path aims to ensure students have knowledge, learning skills, innovation and skills to use technology to find information, in this case schools should be able to equip students to acquire these competencies [2].

The facts in the field show that there are still schools that use traditional learning, especially when learning physics. The results of interviews with teachers in the field of physics in class XI at SMA Negeri 4 Pematang Siantar show that in the learning process, teachers still use traditional learning, namely teacher-centered or teacher-centered learning. Teachers tend to transfer the knowledge that students have and are concerned with results rather than processes. The results of the interview also revealed that the learning outcomes for the temperature and heat material of the students' scores below the KKM value were 86.1% or 31 people, while the learning outcomes that met the KKM value were 13.9% or 5 people. The involvement of students in the learning process is also very lacking, students are rarely motivated to ask questions, interact with teachers and do not involve students to do practicum in laboratories that have been provided at school. This results in the science process skills of students not developing because they rarely carry out group investigations that should be carried out. Meanwhile, if students are used to doing practicum, it can improve students' science process skills.
State that science process skills are basic skills that facilitate learning in science, enable students to be actively involved, develop a sense of responsibility, improve learning and research methods[3]. Science process skills are also a person's skills in using thoughts, reasoning and actions effectively to achieve certain results [4]. Because learning physics can basically be seen as a process and a product so learning physics does not rule out the discovery process. Physics as a product includes a set of knowledge consisting of facts, concepts and principles of physics [5]. Physics as a process is not effective if it only emphasizes understanding but must also emphasize the mastery of skills obtained through practicum activities [6]. Practical activities are activities that emphasize providing direct experience to students so that students can better understand various natural phenomena around scientifically [7]. Practical activities play an important role in learning physics because practicum provides opportunities for students to be creative in carrying out science process skills. Science process skills are skills that can be developed through practicum activities. Aspects of science process skills include: designing and implementing experiments, predicting, observing, asking questions, formulating hypotheses, finding patterns and variable relationships, communicating effectively, measuring and calculating [8]. Thus, the indicators of science process skills contributed greatly in training students to improve students' science process skills.

To overcome the problems faced, a solution is needed in the learning process in order to improve students' science process skills and be able to find out how the contribution of each indicator of science process skills is using the 5E learning cycle model [9]. The 5E learning cycle model is a model that makes students play a direct role or is student centered and can develop their own knowledge so that the learning process can attract students' attention, generate motivation, involve students actively understanding concepts by exploring knowledge through various explorative educational experiences[10].

The 5E learning cycle model is a learning cycle model designed to improve science process skills on each indicator through the activities carried out in the 5E learning cycle model as follows: (1) Engagement stage (involved), at this stage students are mentally involved to involved in the learning process such as asking questions, defining events / cases that raise questions and can increase interest and help in making connections between what students want to know and what students can do in this activity will train indicators to ask questions and formulate hypotheses; (2) Exploration stage, at this stage students are trained to be able to apply what they have learned in this activity will train predictive indicators; (3) Explanation stage, at this stage it is called the concept development stage because the evidence and concepts that are newly developed and combined into the logical structure of students in this activity will train indicators to communicate effectively; (d) Elaboration stage, at this stage students are trained to be able to apply what they have learned in this activity will train predictive indicators; (e) Evaluation Stage, at this stage the teacher evaluates students' understanding of the extent to which understanding of concepts and mastery of skills can be done by giving tests at the end of learning[11]. Each "E" phase sequentially provides learners with learning experiences to connect previous knowledge with new concepts through scientific activities so that science process skills can be improved [12].

Research on the 5E learning cycle model has been researched by previous researchers. Cakir[13], the results of his research show that learning with the 5E model affects academic achievement, attitudes and science process skills of students. The same thing was conveyed by Nida et al [11], namely the application of the 5E learning cycle model combined with effective mind mapping techniques can improve students' science process skills compared to conventional learning. According to Yaman & Karasah[15], there is an effect of using the learning cycle model on the science process skills of students. Gazali et al [16]also states that the science process skills of students who learn using the 5E learning cycle model are higher than the science process skills of students who learn using conventional models. Then according to Perwita et al[9] that the 5E learning cycle model with a scientific approach can improve students' understanding of physics concepts. With the application of
the 5E learning cycle model to the material being taught, it is expected that there will be an increase in the science process skills of students, especially when doing temperature and heat experiment activities to be applied in everyday life and to find out how each indicator of science process skills contributes.

2. Method
This research was conducted at SMA Negeri 4 Pematang Siantar which is located at Jalan Patimura No. 1, Pematang Siantar City. The implementation time is in the even semester of 2019/2020. The population in this study were all students of class XI MIPA SMA Negeri 4 Pematang Siantar. The sample in the study as an experimental class was class XI MIPA 7 with 36 students who were applied with the 5E learning cycle model and as a control class was class XI MIPA.8 with 36 students who applied conventional learning. The type of research used in this study is quasi-experimental.

The science process skills instrument used was a non-test instrument. The indicators of science process skills in this study are designing and implementing experiments, predicting, observing, asking questions, formulating hypotheses, finding patterns and variable relationships, communicating effectively, measuring, and calculating. Observation of science process skills is measured based on indicators of each aspect. Assessment of science process skills will be carried out by observing directly by the observer and checking the results of students' reports after completing the practicum.

3. Result and Discussion
The results obtained for the pretest data on the science process skills of students in the experimental class and control class are presented in Table 1.

| Score Range | Experimental Class | Control Class |
|-------------|--------------------|---------------|
| 29 – 30     | 2                  | 2             |
| 31 – 32     | 4                  | 7             |
| 33 – 34     | 7                  | 7             |
| 35 – 36     | 9                  | 9             |
| 37 – 38     | 7                  | 6             |
| 39 – 40     | 7                  | 5             |
| Total       | 36                 | 36            |
| Mean        | 35.71              | 34.99         |
| Std. Deviation | 3.51              | 3.50          |

The pretest data for the science process skills scores of students in the experimental class and control class are shown in Figure 1.

![Figure 1. Students' Science Process Skills Pretest](image-url)
Figure 1 shows that the pretest average score of students' science process skills in the two classes is not much different. This means that both classes have the same initial science process skills. This is due to the lack of preparation of students both in the experimental class and in the control class to study the material to be studied and teachers rarely bring students in scientific activities during the learning process.

The results obtained for the posttest data on students' science process skills in both classes are presented in Table 2.

| Table 2. Recapitulation of posttest data for experimental and control classes |
|------------------------------|------------------------------|------------------------------|
| Score           | F     | Score           | F     |
| 59 – 62         | 2     | 59 – 62         | 12    |
| 63 – 66         | 3     | 63 – 66         | 4     |
| 67 – 70         | 8     | 67 – 70         | 10    |
| 71 – 74         | 12    | 71 – 74         | 5     |
| 75 – 78         | 4     | 75 – 78         | 2     |
| 79 – 82         | 4     | 79 – 82         | 2     |
| 83 – 86         | 3     | 83 – 86         | 1     |
| Total           | 36    | Total           | 36    |
| Mean            | 72.35 | Mean            | 67.65 |
| Std. Deviation  | 6.26  | Std. Deviation  | 6.59  |

Post-test data on the score of understanding the concepts of students in the experimental class and control class is shown in Figure 2.

Figure 2. Posttest data for experimental class

Figure 2 shows that the post-test average score of students' science process skills in the two classes is much different. This means that there is an effect after being given different treatment where the experimental class is taught using the 5E learning cycle model and the control class is taught using conventional learning.

Analysis of the contribution of indicators can be seen from the achievement of the percentage of each item indicator of science process skills of students who are taught using the 5E learning cycle model and students who are taught by conventional learning can be seen in Table 3.

| Table 3. Contribution analysis of Science Process Skills Indicators |
|-----------------------------------------------|-----------------|-----------------|
| No                                      | Science Process Skills Indicators | Learning Cycle 5E (%) | Conventional (%) |
| 1.                                      | Designing and implementing experiments | 72.05 | 65.80 |
| 2.                                      | Predicting | 66.67 | 61.11 |
| 3.                                      | Observing | 86.11 | 84.26 |
| 4.                                      | asking questions | 76.39 | 74.31 |
5. formulating hypotheses 74.07 71.30  
6. finding patterns and relationships of variable 70.83 67.13  
7. communicating effectively 70.37 63.89  
8. measuring and calculating 65.74 62.04

In summary, the analysis of the contribution analysis of science process skills indicators of students in the experimental class and control class can be seen from in Figure 3.

Figure 3 shows the analysis of the contribution analysis of the science process skills indicators of students who are taught with the 5E learning cycle model better than students who are taught using conventional learning. Contribution The highest percentage of achievement lies in the observing indicator. While the lowest percentage of achievement lies in measuring and calculating indicators.

The physics science process skills of students who are taught using the 5E learning cycle model with students who are taught using conventional learning have differences. From the results of the posttest, it was obtained that the average value of the science process skills of students who were taught using the 5E learning cycle model was 72.35 and the average value of the science process skills of students who were taught using conventional learning was 67.65. This is because the experimental class that was taught using the 5E learning cycle model in the learning process students were trained to carry out scientific activities, which was seen in the exploration phase. In this phase students carry out practicum activities to find or find the concept themselves so that they can train students' science process skills while the control class is taught by conventional learning, namely direct teaching.

The results of this study are also supported by several experts who state that these differences are due to several things, namely (1) Tania & Murni [17] in each phase of the 5E learning cycle model can train science process skills as well as specifically in the exploration phase which is designed so that students can formulate concepts, processes and skills in concrete activities. One of the skills that students acquire is science process skills, namely by carrying out exploration activities, (2) Rahmawati et al [9] with the 5E learning cycle model students learn actively in carrying out practicum activities that are able to identify variables, formulate hypotheses, provide questions to seek answers to a
problem so as to foster students' science process skills, (3) Gazali et al [16] there are activities in the exploration and explanation phases in learning that bring students actively involved in practicum activities and communicate effectively so that students can improve science process skills, (4) Yulasti et al [11] the existence of experimental activities in the learning process can provide opportunities for students to look for a theory or concept and be able to prove the truth of their hypothesis by conducting investigations, for example by conducting research. measuring and calculating which are then presented in the form of tables or graphs on the observation report seen in the explanation phase, this activity will provide opportunities or exercises to improve the science process skills of students. Therefore, Yaman and Karasah[15] state that the 5E learning cycle model brings students to phenomena or events related to the material so that it allows students to do more investigations or investigations that can improve students' science process skills.

When viewed from the contribution of indicators of science process skills tested, the percentage of achievement of indicators of science process skills of students who are taught with the 5E learning cycle model is better than students who are taught using conventional learning. The highest percentage of achievement lies in the observing indicator of 86.11%. The observing indicator is the ability to use the five senses and the right tools to collect information about objects, events or phenomena. So using the 5E learning cycle model, especially in the exploration phase, trains students to be able to observe well in scientific activities. The lowest percentage of achievement lies in measuring and calculating indicators of 65.74%. Measuring and counting is showing accuracy in checking measurements and calculations. Students cannot count correctly if students are wrong in reading or writing the observation data. Calculations made must show accuracy in checking measurements so that they can perform calculations accurately and completely with variables related to measurement results. In this case, students are still less trained in using the right measuring instrument, less trained in reading scales and converting units which can be seen in the exploration phase. While the percentage of achievement of other indicators such as: (1) asking questions and formulating hypotheses of 76.39 and 74.07 this is because students begin to be trained before doing practicum students must be able to provide temporary answers and provide questions about problems or material to be taught at the beginning of each lesson or during the engagement phase, (2) designing and carrying out experiments of 72.05% this is because students are trained in designing and carrying out experiments such as deciding the tools and materials used and carrying out experiments in accordance with work procedures, this activity can be seen in the exploration phase, (3) communicating effectively by 70.37% this is because after doing practicum in the exploration phase students are trained to collect and present data in table form and change the presentation form in graphical form according to what is stated in LKPD. In addition, students are also trained to describe the results of research in appropriate language in the LKPD practicum data analysis. Then students are also trained to provide an explanation of the results of observations or practicum in the explanation phase, (4) find patterns and variable relationships of 70.83% this is because students are trained in determining what to measure and how to measure these variables which activities This is seen in the exploration phase, (5) predicts 66.67% this is because students are trained in suggesting what will happen next and predicting an event based on patterns or concepts from the results of observations that have been carried out, which can be seen in this phase elaboration. So that more opportunities are needed so that students can practice their science process skills which are known during the evaluation phase, which is the phase that can see the extent to which students' science process skills can improve.

The 5E learning cycle model is also a learning model developed in accordance with the essence of science as a process and science as a product. This learning model provides guidelines for teachers to guide students to acquire knowledge using scientific methods like scientists. Apart from being based on the nature of science, this learning model is also developed based on an inquiry approach which requires students to learn to solve problems or reveal a natural phenomenon scientifically [18]. In accordance with the nature of physics as part of science, the learning process of physics must rely on the scientific process. The scientific process involves various scientific process skills that are applied
in scientific activities to acquire new knowled [19]. Rahmawati et al [9] stated that in learning activities that use the 5E learning cycle model, it encourages students to acquire science process skills.

Unlike the case with conventional learning which prioritizes the training process for students. Knowledge is taught by training students, the tendency of students is required to memorize the knowledge given by the teacher. A series of activities carried out instructional without giving the opportunity for students to find their own knowledge. This series of instructional activities conditions a silent classroom situation, without student activity, without question and answer activities, students only pay attention to the teacher's explanation. The passive student activities have an impact on the weak absorption of knowledge by students. The knowledge obtained does not last long in the memory of students, so that the science process skills of students are low.

4. Conclusion
There is a significant difference in the science process skills of students who are taught using the 5E learning cycle model with students who are taught using conventional learning and observing indicators have a significant contribution in improving students' science process skills.

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