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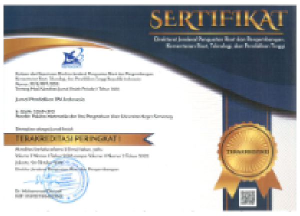

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#20425 Summary

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Title	The 7E Learning Cycle Approach to Understand Thermal Phenomena
Original file	20425-49695-1-SM.docx 2019-08-07
Supp. files	20425-49696-2-SP.docx 2019-08-07 20425-54539-1-SP.pdf 2019-12-06 20425-55034-1-SP.pdf 2019-12-17 20425-56353-1-SP.pdf 2020-01-14
Submitter	Ruhban Maskur
Date submitted	August 7, 2019 - 03:31 AM
Section	Articles
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Decision	Revisions Required 2019-08-09
Notify Editor	Editor/Author Email Record 2019-12-17
Editor Version	None
Author Version	20425-50047-1-ED.docx 2019-08-15 Delete 20425-50047-2-ED.docx 2019-09-17 Delete 20425-50047-3-ED.docx 2019-11-16 Delete 20425-50047-4-ED.docx 2019-11-16 Delete 20425-50047-5-ED.doc 2019-12-03 Delete 20425-50047-6-ED.pdf 2019-12-06 Delete 20425-50047-7-ED.doc 2019-12-06 Delete 20425-50047-8-ED.doc 2019-12-17 Delete
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Dr. H. Ruhban Maskur, M.Pd <ruhbanmaskur@radenintan.ac.id> Thu, Dec 26, 2019, 4:44 PM

to Jurnal

Dear Editor

Terimakasih atas perhatian dan perkenannya atas paper kami. berikut kami kirimkan Letter of Statement dan Agriment. serta kami lampirkan sedikit revisi atas pdf final yang dikirim ke kami. yang perlu diperbaiki kami beri yellow mark.

Sekali lagi terimaksih atas supportnya

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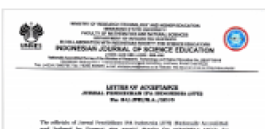

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JPII 8 (4) (2019)

Jurnal Pendidikan IPA Indonesia

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THE 7E LEARNING CYCLE APPROACH TO UNDERSTAND THERMAL PHENOMENA

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Abstract

Conceptual understanding is often a problem in science learning, and this issue has become the point of science education experts, including in Indonesia. Lately, ten articles in Indonesia and six articles in other countries have discussed the model of the 7E Learning Cycle. It was mentioned that this model is able to increase learners' conceptual understanding. This research intended to reveal the effectivity of physics learning using the 7E Learning Cycle in improving students' understanding of temperature and heat concepts. The research design is quasi-experimental with a non-equivalent control group design. The sample was senior high school students. Objective test in the form of multiple choices equipped with reason was employed as the data collection instrument. Based on the data analysis, the value of Effect Size was 0.5 and belonged to the medium category. In other words, the use of the 7E Learning Cycle model is sufficient to improve the learners' understanding of temperature and heat concepts. This could be seen from the success of the learning process that integrates the whole seven stages with the seven indicators of conceptual understanding in detail. Thus, the 7E Learning Cycle could be effectively applied and can increase the students' conceptual understanding.

Keywords: *Conceptual understanding in physics; Direct Learning; 7E Learning Cycle model*

INTRODUCTION

The outcome of the physics learning process, among others, is to enable students to comprehend the relevance of physics concepts to be applied in their daily life (Husein et al., 2017; Latifah et al., 2019; Pratiwi & Supardi, 2014). The students' inability to connect one concept to another is a common problem occurring in physics classes (Sagala et al., 2019b; Tanti et al., 2017). They are more likely to memorize than to understand the concepts (Maharani et al., 2019).

In this case, physics teachers should emphasize the students' understanding of the concepts based on the knowledge acquired in the previous level to the next (Widayanti et al., 2018; Yulianti & Gunawan, 2019; Lestari et al., 2017; Wahyuningsih, 2014). The use of varied learning model is needed (Saregar et al., 2018) in order to be an intermediary so that the material taught could be understood by students (Pitan & Atiku, 2017; Sagala et al.,2019a; Widayanti & Yuberti, 2018; Yıldırım & Akamca, 2017). Furthermore, at the final stage, it is expected to increase the students' mastery of the concepts (Saregar, 2016).

Some of the research results showed that conceptual understanding is fundamental in learning since concept mastery is the key to solve even the hardest problem (Alan & Afriansyah, 2017; Surosos, 2016). Many learners do not attain favorable learning outtakes. They are not aware of efficient and effective ways of learning because they only try to memorize lessons while Physics does not mean to be memorized as it requires reasoning and understanding of the concept (Lestari et al., 2017; Yuberti et al., 2019). As a result, if they are given a test, the learners will have difficulties (Yolanda et al., 2016). Therefore, conceptual understanding is highly required for the learners to get proper learning outcomes.

Many researchers have conducted many ways to improve students' conceptual understanding. One of which is through learning models and one of the learning models that has been proven in improving students' conceptual understanding is the constructivism (Balta & Sarac, 2016). There are various types of constructivism learning models, such as problem-solving, mind mapping, and 7E learning cycle. In this research, the 7E Learning Cycle model was selected since it provides chances for learners to build their knowledge (Febriana et al., 2014).

7E Learning Cycle model is the improvement of the 5E Learning Cycle model (Ghaliyah et al., 2015). The cycles of the applied learning model are emphasized in the understanding of the scientific physics concepts and misconception correction. Furthermore, it is also expected to be able to ameliorate the students' memorization process that is focused on the knowledge and knowledge transfer (Balta & Sarac, 2016). The learning cycle Approach (LCA) is a model that is deemed adequate for physics students (Olaoluwa & Olufunke, 2015) as it can help them to elaborate their understanding of certain aspects of scientific research (Hodson, 2014; Putra et al., 2018). One of the physics materials that is considered quite difficult for students to understand is temperature and heat (Sayyadi et al., 2016).

The constructivism basis of the 7E Learning Cycle possesses some weaknesses and strengths. One of the notable strengths of the 7E Learning Cycle is its ability to encourage the students to be active and think maximally to acquire the knowledge. On the other hand, the weakness of the 7E Learning Cycle is the length of time needed as the students are trained to explore their knowledge, and they are also given enough freedom to express their ideas. In order to minimize the weakness of this model, proper preparation is certainly required by the teacher acting as a facilitator (Rawa et al., 2016).

The previous researchers showed that the learning cycle could be used to enhance learners' understanding (Nurmalasari et al., 2014) and learning achievement (Sumiyati et al., 2016). Conceptual understanding means expressing the materials learned into a simplified version to overcome the problems of the interconnected concept. The cognitive process of conceptual understanding consists of interpreting, modeling, classifying, summarizing, predicting, comparing, and explaining (Setyawati et al., 2014). One of the factors that determine the the learning process outcome is the students' achievements measured by how much they can master the learning material (Parasamya et al., 2017).

There are some distinctions between this research and the previous ones. Firstly, there is an elaboration of each of the seven prescribed stages of the 7E Learning Cycle model implementation, exposing the pupils' level of understanding presented in the discussion. Besides, this study uses different learning materials, namely temperature and heat, which is very suitable for the object of measuring concept understanding (Damar, 2013). Then, the learning circumstances of this research are also relatively different.

The learning cycle is a learning model centered on learners (Balta & Sarac, 2016). It comprises a series of activities arranged in such a way that learners could master the established competencies in learning with an active role (Ngalimun, 2014; Ratiyani et al., 2014). The learning cycle in the classroom practice focuses on the experience and knowledge of the early learners (Ghaliyah et al., 2015). Is sum, in attaining well-organized students' concept, an organized procedure is needed.

The learning cycle model has been developed from 3E (Exploration, Explanation, Elaboration), 5E (Engagement, Exploration, Explanation, Elaboration, and Evaluation), and 7E (Elicit, Engage, Explore, Explain, Elaborate, Extend, and Evaluate). Some studies suggest that the 7E learning cycle can foster motivation and learning achievement (Febriana et al., 2014; Sumiyati et al., 2016), improve language comprehension (Balta & Sarac, 2016), is sufficient to achieve goals quickly (Bozorgpouri, 2016), improve the ability of mathematical connections (Rawa et al., 2016), and foster conceptual understanding (Nurmalasari et al., 2014). Thus, the researchers consider it is necessary to conduct research to see the effectivity of the 7E Learning Cycle in improving the students' conceptual understanding of the temperature and heat topic.

The results of the earlier quantitative and qualitative research on the understanding of the thermal concepts and phenomena showed that the majority of children do not master the concepts and the related phenomena even after receiving formal instruction on these subjects (Karabulut & Bayraktar, 2018). There is a confusion between the concepts "heat" and "temperature," and often they think that temperature is a measure of the heat.

Temperature is an intrinsic property of matter; it is hot and cold objects by nature. The warm and the cold are two separate entities, all materials if placed protractedly in an environment will reach the same temperature. Confusion with the meaning of words like 'heat', 'heat flow' or 'heat capacity', mixing hot and cold water has led to correct qualitative judgments but incorrect quantitative judgements, and difficulty in explaining how a thermometer works (Gönen & Kocakaya, 2009; Kampeza et al., 2016; Ravanis, 2013).

METHODS

Design of Study

The design used in this research was Quasi-experimental with *Non-equivalent Control Class Design* (Suharsimi, 2010; Sugiyono, 2010; Tanti et al., 2017). The research was conducted at the X IPA 1 and X IPA 2 class of SMAN 1 Kotabumi, North Lampung**.** The study was implemented in three phases (pre-test, teaching interventions in an experimental group and a control group, and post-test). The data of the study consisted of student responses to objective tests in the form of reasoned-multiple choices, which are able to show the characteristics of students' conceptual understanding (Pratiwi, 2016) and the ability of students to answer the question. Before the instruments were used, the questions were tested to find out the validity level, reliability, difficulty level, discriminating power, and destruction functions.

The subject of this research was learners of grade X IPA in SMA Negeri 1 Kotabumi (amounted to 240 students). Employing the cluster random sampling technique, the researchers chose 80 students from class X IPA 1 and X IPA 2.

The samples of this research were male and female students (age range 15-16 years old). The chosen students had similar socio-economic characteristics and were randomly split into two groups, thus forming the experimental class (hereafter E.C.) and control class (hereafter C.C.), respectively.

Teaching Interventions

The Experimental Class

The learning stage of 7E Learning Cycle can be seen in Figure 1:

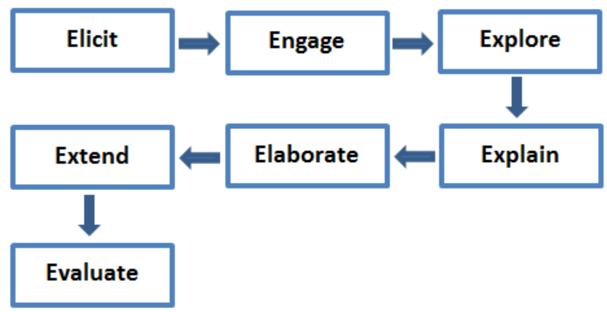


Figure 1. The Stages of the 7E Learning Cycle

Researchers applied the seven stages of the 7E Learning Cycle model during the teaching and learning activity. The first stage was Elicit to raise the student's initial knowledge by asking questions as displayed in Figure 2.

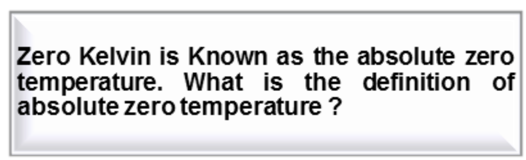


Figure 2. The First Stage: Elicit.

The second stage was to Engage. It was involving the students with the surrounding events related to the temperature material by carrying out the demonstration, as displayed in figure 3.

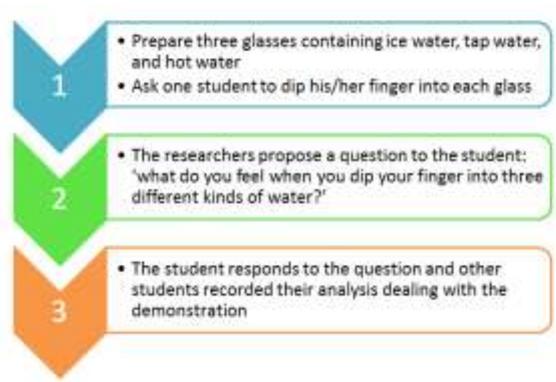


Figure 3. The Second Stage: Engage

The third stage was to Explore. This was the stage of collecting information. The procedure can be observed in the following figure 4.

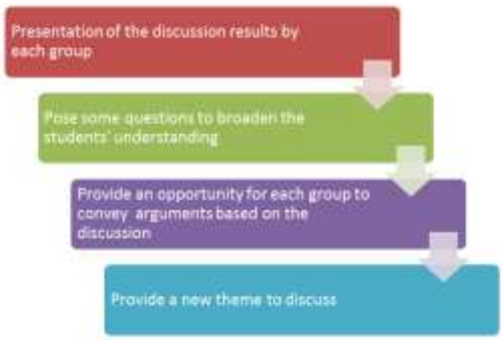


Figure 4. The Third Stage: Explore

It was expected that based on the information-gathering stage, the students were able to grasp the materials in detail.

The fourth stage was to Explain. The students were required to explain the results of the discussion by using their way to understand the material indicating the level of student' understanding, has appeared in the following figure 5.

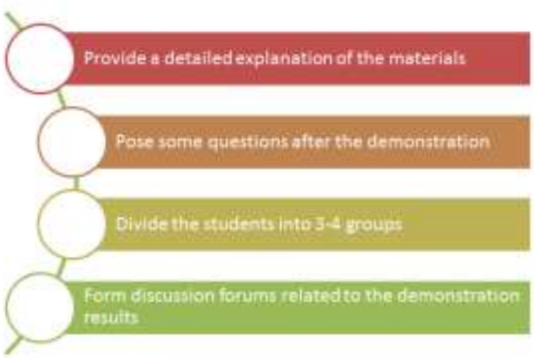


Figure 5. The Fourth Stage: Explain

The fifth stage was Elaborate. Elaborate was the proficiency stage for the researchers and the students to connect previously learned concepts with daily life. It can be seen in figure 6.

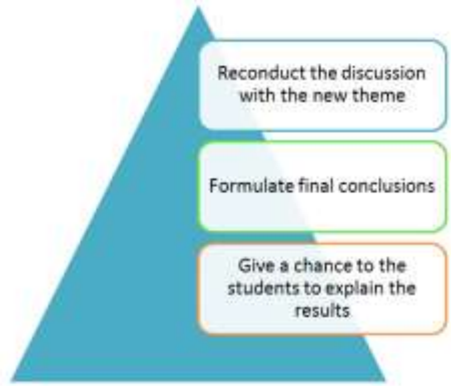


Figure 6. The Fifth Stage: Elaborate

In this stage, the students re-conducted the discussion to acquire new findings in order to overcome different problems and concepts and to produce the correct and clear conclusion.

The sixth stage was to Extend. The students' findings was extended to enable them to be more active and interested in searching for new concepts, as displayed in figure 7.

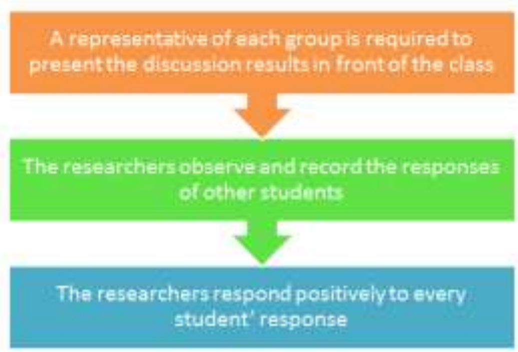


Figure 7. The sixth stage: Extend

The seventh stage was to Evaluate. The students were given opportunities to conclude everything related to the materials that had been studied. Then, an evaluation was carried out to obtain a profound understanding of the concept of the temperature by giving the task to the students. One of the conceptual understanding problems can be viewed in the following figure 8.

Look at the following Images:

The three containers are filled with liquid and heated with the same amount of heat. If the volume of each liquid is the same, and the density is different, namely $\rho_1 < \rho_2 < \rho_3$. Then the correct statement regarding the temperature rise is ...

a. Figure 1 has the most significant temperature rise
b. Figure 2 has the most significant temperature rise
c. Figure 3 has the most significant temperature rise
d. Figure 1 has the lowest temperature rise
e. Figure 2 has the lowest temperature rise

Figure 8. The Seventh Stage: Evaluate

In the final step of the seventh stage, the researcher conveyed information about the next materials that will be studied so the students should learn before the materials are delivered.

The learning process through the 7E Learning Cycle requires time accuracy considering its numerous stages. Time is one of the key factors in implementing this learning model. Furthermore, to achieve the learning objectives, this learning model should be done in complete seven stages. If only two stages were done or a stage is skipped, then the implementation of this learning model will not be optimum.

The Control Classes

The learning process in the control class was conducted using Direct Learning Model, which is commonly used by physics teachers. The researcher only delivered the lesson by writing the materials on the whiteboard. The whole process of learning was focused on the teacher/researcher (teacher center). The students responded passively and only listened to the researcher explained. It resulted in a lack of conceptual understanding; consequently, the students faced difficulty in solving some of the physics problems on the topic.

Based on the research design presented, we formulated two research problems: (1) how is the experimental class students' understanding of the thermal concept compared to the control class students'?; and (2) how is both groups' progress after the two educational interventions are performed?

The students' understanding of the concepts were measured through pre-test and post-test using objective test in the form of reasoned-multiple choices. Each test consisted of 15 items. Since the original version of the tests was the only multiple-choice format, then modification was carried out by asking the students to provide a reason for choosing the answer.

To go into the effectiveness of learning toward the learners' mastery of the concepts, the Effect Size test was used. It is a measurement to determine the effect of one variable on another. The effect Size can be counted using a particular formula (Cohen, 1998), and further explanation of it is also available (Anwar et al., 2019; Hake, 1998).

$$d = \frac{m_A - m_B}{\left[\frac{sd_A^2 + sd_B^2}{2}\right]^{1/2}}$$

Definition:

d	= *effect size*
m_A	= mean gain of the experimental class
m_B	= mean gain of the control class
sd_A	= standard deviation of experimental class
sd_B	= standard deviation of the control class

The value of Effect Size can be seen in Table 1, as follows:

Table 1. Effect Size Criteria.

Effect Size	**Category**
$d < 0.2$	Low
$0.2 \leq d < 0.8$	Average
$d \geq 0.8$	High

RESULTS AND DISCUSSION

The data display of pre-test and post-test score recapitulation of the control and experimental class can be seen in table 2,

Table 2. The Pre-Test and Post-Test Score of the Control and Experimental Class

Indicator of Conceptual Understanding	Pretest				Posttest			
	Experimental Class*		Control Class**		Experimental Class*		Control Class**	
	Highest Score	Lowest Score	Highest Score	Lowest Score	Highest Score	Lowest Score	Highest Score	Lowest Score
Interpreting	71	41	70	40	95	72	83	62
Modeling	72	40	70	38	94	70	80	63
Predicting	70	35	69	32	89	65	82	60
Explaining	70	32	68	30	90	66	80	61
Classifying	65	31	64	29	97	62	79	58
Comparing	64	30	62	28	94	68	78	59
Summarizing	62	31	60	30	92	66	78	57
The Highest and Lowest Total Score	474	240	463	227	651	469	560	420
The Highest and Lowest Average Score	68	34	66	32	93	67	80	60
Total Score	1.986,4		1.880		3.113,2		2.820	
Number of Students	40		40		40		40	
Total Average Score	49,66		47		77,83		70,5	

*Learning cycle 7e model **Conventional model

The pretest and posttest shown in Table 2 were measured through a multiple-choice test (example figure 8). The scores measured in this study included cognitive scores according to the blooms' taxonomy comprising cognitive 2, 3, 4, and 5 (C2, C3, C4, C5). There were seven indicators of conceptual understanding applied in this study. Table 2 indicates the outcomes of conceptual understanding tests in each indicator change. On the Interpreting, the highest and lowest scores in the experimental and the control class experienced an elevation, both as a result of pretest and posttest. Nonetheless, the highest and lowest scores in the experimental class were higher compared to the scores in the control class.

On the Modeling, the highest and lowest scores in the experimental and the control class experienced an increase, both the results of the pretest and posttest. However, the highest and lowest scores in the experimental class were higher than the scores in the control class. This significant increase was obtained from the results of Independent-Sample T-test that is shown in table 3.

Table 3. The Independent-Sample T-Test Results

Independent-Sample T-Test	Pretest	Posttest
Criteria	Sig.(2-tailed) > 0,05	Sig.(2-tailed) < 0,05
Sig. (2-tailed)	0,229	0,000
Decision	H_o is accepted	H_a is accepted

Table 3 informs that in the pretest, we got Sig. (2-tailed) of 0,229. It means Sig. (2-tailed) > 0,05; thus, the average pretest scores in the experimental class was equal to the average pretest scores in the control class. Furthermore, based on posttest results, we got Sig. (2-tailed) of 0,000, it means the average pretest scores in the experimental class was not equal to the average pretest scores in the control class.

On the Predicting, the highest and lowest scores in the experimental and the control class experienced an enhancement at both the results of the pretest and posttest. However, the highest and lowest scores in the experimental class were greater than the scores in the control class.

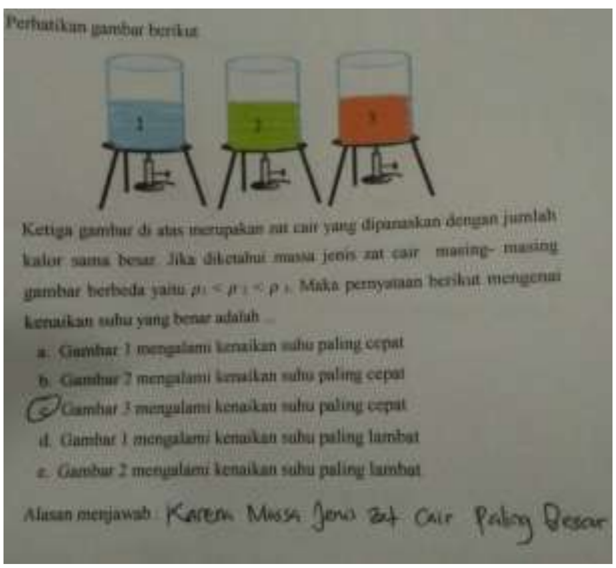
On the Explaining, the highest and lowest scores in the experimental class and the control class experienced an increase, both the results of the pretest and posttest. Nevertheless, the highest and lowest scores in the experimental class are higher than the scores in the control class.

On the Classifying, the highest and lowest scores in the experimental cand the control class experienced an upswing, both the results of the pretest and posttest. However, the highest and lowest scores in the experimental class were higher than the scores in the control class.

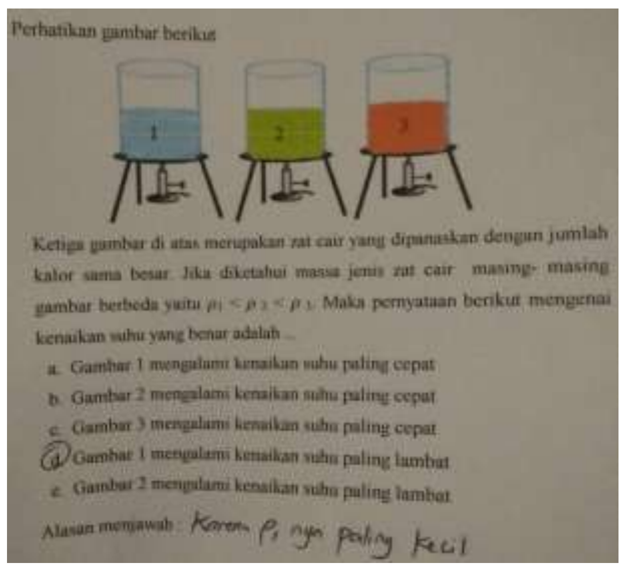
On the Comparing, the highest and lowest scores in the experimental class and the control class experienced an increase, both the results of the pretest and posttest. Nevertheless, the highest and lowest scores in the experimental class were higher than the scores in the control class.

On the Summarizing, the highest and lowest scores in the experimental class and the control class experienced an increase, both the results of the pretest and posttest. However, the highest and lowest scores in the experimental class were more significant than the scores in the control class.

In general, the results of concept understanding tests on each indicator experienced an increase in both the experimental class and the control class. Yet, before applying the 7E Learning Cycle, there was no notable difference of the experimental class learners' understanding of the concepts. Nonetheless, after the implementation of the 7E Learning Cycle model, the scores of the experimental class students were significantly improved. Based on the analysis result of each student's answers, their conceptual understanding had not been trained when answering the conceptual questions in the form of multiple choices when they chose the answer (Figure 9). The results changed after applying the 7E Learning Cycle and the conventional model, as there were significant differences between the conceptual understanding of the experimental and the control class. The answer of experimental class students was more appropriate than the control class students (Figure 10).

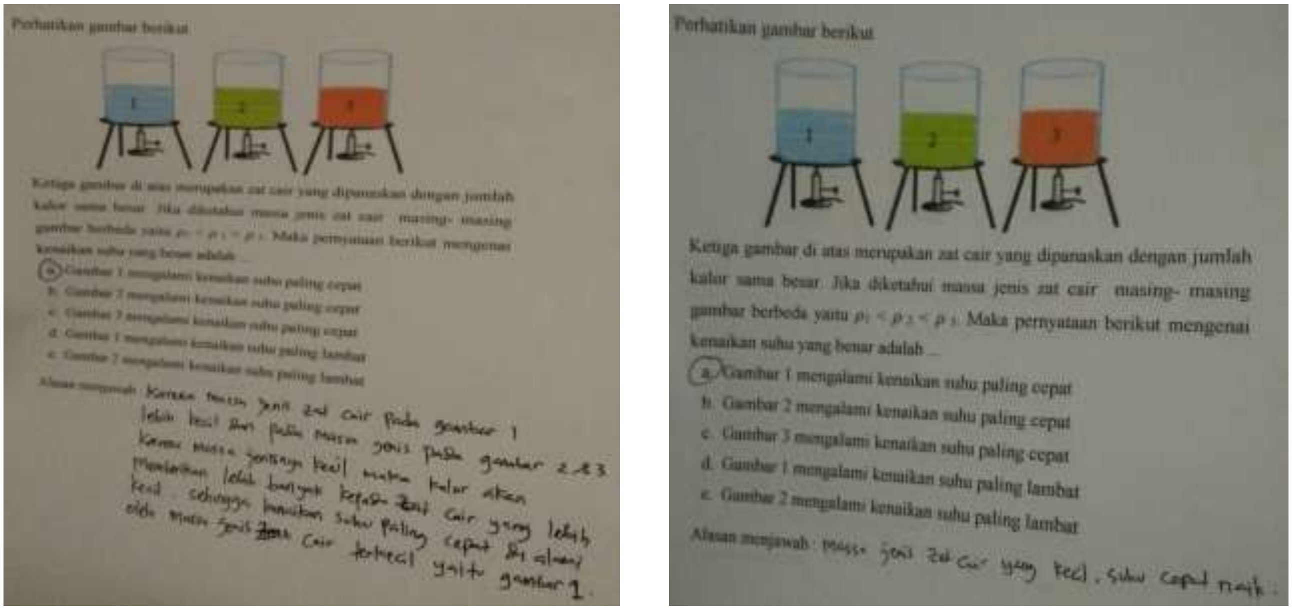


(a) The 7E Learning Cycle



(b) The Conventional Model

Figure 9. The Student Answer before the Implementation of the 7E Learning Cycle and the Conventional Model



(c) Learning Cycle 7e Model (d) Conventional Model

Figure 10. The Student Answer after the Application of the 7E Learning Cycle and the Conventional Model

In addition to the cognitive score results, the management of learning is also the key to the learning model's successful implementation. The following is an explanation of the learning management in this study.

Learning Management

The scoring percentage given by the physics teacher while the researcher was applying the learning model can be seen in the following figure 11.

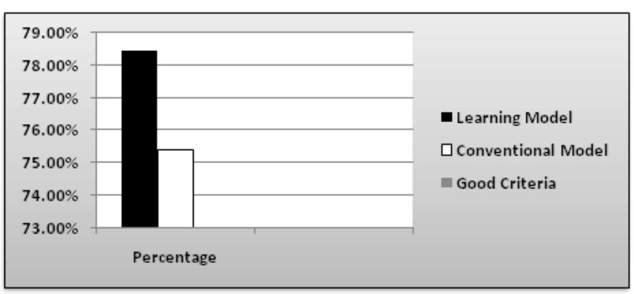


Figure 11. Graphic Percentage of Learning Management

Based on Figure 11, the gain percentage showed that the learning management through 7E Learning Cycle was 78.46% compared to the conventional learning which amounted to 75.38%. The percentage fell into satisfying criteria, and this improvement occurred due to sistematic implementation of the 7E Learning Cycle by the teacher. In the class where the 7E Learning Cycle was applied, the teacher started the lesson by eliciting knowledge and involving students through engaging demonstrations. In the Elicit step, the students responded enthusiastically when the teacher gave a question to raise students' initial knowledge. They were willing to present the answer in front of the class and thus brought about the impact of an active classroom atmosphere at the beginning of the learning process. In the class where the conventional model was applied, the teacher started the lesson by psychologically preparing the students through stories without demonstrations or involving the students.

The core activity in the 7E Learning Cycle began with the grouping to discuss the continuation of the demonstration by changing the object of the demonstration and discussion to find solutions to the questions given by the teacher (explore). Then, each group conducted a presentation by explaining the results of the discussion (Explain). On the other hand, the teacher gave feedback to each group to expand the discussion materials in the group through question and answer between groups (Elaborate & Extend). In the class applying the conventional model, the core activity began with the teacher explaining the materials then forming a group to observe events related to the materials in daily life. Next, the students were asked to communicate the materials through assignments.

The closing activity in the 7E Learning Cycle was asking each group to conclude the discussion results, and the teacher concluded the overall results of the discussion. Diversely, the closing activity in the conventional learning was giving homework.

Based on the learning management description, the 7E Learning Cycle is student-centered while the teacher only acts as a facilitator. Contrarily, the conventional model is still teacher-centered. Thus, the 7E Learning Cycle is in line with the current 2013 curriculum applied in Indonesia which emphasizes student-centered learning. Other countries such as Finland, England, the United States, and other developed countries also implement student-centered learning, which is more effective than teacher-centered learning.

The effectiveness of the learning model implementation was analyzed with effect size formula. A further description is presented in Table 3.

Table 4. The Results of Effect Size

Class	Mean Gain	Standard Deviation	Effect Size	Category
Experiment	28,17	36,64	0,5	Average
Control	23,50	137,72		

Table 4 shows that the gain of effect size was 0.5 and belonged to the average category. This shows that the use of the 7E Learning Cycle model could effectively improve the students' understanding of Physics concepts.

Based on the recapitulation of the post-test scores, the students' conceptual understanding, in both the experimental and the control class, increased significantly. This might be caused by the fact that the 7E Learning Cycle model has such distinctive characteristics that the students not only listen to the teachers but can also play an active role in exploring and enriching their comprehension of the concepts studied.

The importance of conceptual understanding in school requires researchers to use various ways to analyze it including: (1) the use of interactive multimedia (Husein et al., 2017); (2) the realization of the 7E Learning Cycle for junior high school students (Nurmalasari et al., 2014); (3) the utilization of PhET Simulation (Saregar, 2016); (4) the application of guided inquiry learning model (Setyawati et al., 2014); (5) the application of experiential learning models (Wahyuningsih, 2014); and (6) the use of TTCI and CRI instruments (Yolanda et al., 2016).

This study supports Nurmalasari et al.'s (2014) research that the 7E Learning Cycle could improve students' conceptual understanding. In the study, the 7E Learning Cycle was applied to the junior high school students, but in this study, it was applied to senior high schools students. It means that the model could improve both junior and senior high school students' conceptual understanding.

CONCLUSION

In short, the use of the 7E Learning Cycle is successful in enhancing students' conceptual understanding. In other words, the learning process through 7E Learning Cycle Model is more effective compared to the conventional model in escalating the students' concept understanding, especially on temperature and heat topic. This is because each learning process truly integrates the seven stages of the 7E Learning Cycle with the seven indicators that must be achieved.

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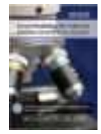

APPROACHING THE UNDERSTANDING OF THERMAL PHENOMENA USING 7ELEARNING CYCLE

Abstract

Conceptual understanding is often a problem in science learning, and this has become the focus of science education experts including in Indonesia. Lately,ten articles in Indonesia and six articles in other countries havediscussed the model of 7ELearning Cycle. It was mentioned that this model is able to increase the understanding of learners' concept. This research is aimed to reveal the effectiveness of physics learning using 7E Learning Cycle modelafter being reviewed with control classes in improving students' understanding of temperature and heat concepts. The research design is quasi-experimental with non-equivalent control group design.The sample was senior high school students. Objective test in the form of multiple choices equipped with reason was employed as the instrument to collect the data. Based on the data analysis, it was obtained that the value of Effect Size was as much as 0.5with the medium category.It can be concluded, then, that the use of 7E Learning Cycle learning model is effective to improve learners' understanding of temperature and heat concepts.

Keywords:*Conceptual understanding; Direct Learning; 7E Learning Cycle model*

INTRODUCTION

The outcome of the physics learning process, among others, is to enable the students to understand the relevance of physics concepts so that the students can apply the knowledge in their daily life(Husein, Herayanti, &Gunawan, 2015; Latifah et al., 2019; Pratiwi & Supardi, 2014). Students' inability to connect one concept to another is a common problem occurring in physics classes(Anwar etal., 2019; Tanti, Jamaluddin, & Syefrinando, 2017). Students are more likely to memorize than to understand the concepts (Saregar, Diani & Kholid, 2017). In this case, physics teachers should emphasize the students' understanding of the concepts (Lestari & Rahayu, 2015; Wahyuningsih, 2014) based on theknowledge acquired in the previous level to the next(Wekke, 2017; Widayanti, Yuberti, Irwandani, & Hamid, 2018).The use ofvaried learning model is needed(Saregar, Latifah, & Sari, 2016) in order to be an intermediary so that the material taught couldbe understood by students(Pitan & Atiku, 2017; Wekke etal., 2017; Widayanti & Yuberti, 2018; Yıldırım & Akamca, 2017). Furthermore, at the final stage, it is expected to increase the students' mastery of the concepts (Saregar, 2016).

There are various types of constructivism learning models such as problem-solving learning model, mind mapping, and 7E learning cycle. In this research,the 7E Learning Cycle model was selected since it provides opportunities for students to build their knowledge (Febriana, Wartono & Asim, 2014).

7ELearning Cycle model is the improvement of the 5E Learning Cycle model (Ghaliyah, Bakri, & Siswoyo, 2015).The cycles of the applied learning model are emphasized in the understanding of the scientific physicsconcepts and correcting the knowledge misconception. Furthermore, it is also expected to be able to enhance the students' memorization process that is focused on the knowledge and knowledge transfer (Yerdelen & Ali, 2016). The model of the learning cycle Approach (LCA) is a model that is deemed effective for physics students (Olaoluwa & Olufunke, 2015). It can help them to elaborate their understanding toward certain aspects in scientific research (Hodson, 2012). One of the physics materials that

Comment [M1]: Stating your research impact could strengthen the trustworthy of your study

Comment [M2]: This section shall cover the research background and gap analysis between this research and previous studies. The gap analysis is expected to emerge the research urgency, novelty, and stance (whether it corrects, supplements, supports, or debates other prior studies). After those elements are included, the research objective must be stated.

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Comment [M7]: Use 'et al.' to cite a source having more than two authors is considered quite difficult for students to understand is temperatureandheat(Sayyadi, Hidayat, & Muhardjito, 2016).

The constructivism basis of the 7E Learning Model possesses some weaknesses and strengths. One of the notable strengths of the 7E Learning Cycle is that it could make the students active since the students are thinking maximally to acquire the knowledge. On the other hand, the weakness of7ELearning Cycle is the length of time needed in its applicationsince the students are trained to explore their knowledge, and they are also given enough freedom to express their ideas. In order to minimize the weakness of this model, proper preparation is certainly needed by the teacher acting as a facilitator (Rosalina Rawa, Sutawidjaja & Sudirman, 2016).

The previous researchers showed that the Learning Cycle could be used to improve students' understanding (Nurmalasari, Kade & Kamaluddin, 2014). It can also be used to improve students' learning achievement (Sumiyati, Sujana & Djuanda, 2016). To understand a concept means to be able to express the material having been learned into a simplified version to overcome the problems of the interconnected concept. The cognitive process of concepts understanding consists of interpreting, modeling, classifying, summarizing, predicting, comparing, and explaining (Setyawati, Candiasa & Yudana, 2016).One of the factors that determine the outcome of the learning process is the students' achievements measured by how much they are able to master the learning material (Parasamya & Wahyuni, 2017).

There are some distinctions between this research and the previous ones. Firstly, there is an elaboration of each of the seven prescribed stages of the 7ELearning Cycle model implementation exposing the students' level of understanding presented in the discussion. In addition, there is the use of different learning materials, namely temperature and heat which is very suitable for the object of measuring concept understanding(Kambouri-Danos, Ravanis, Jameau, & Boilevin, 2019). Then, the learning circumstances where the subjects of this research study are also relatively different.

Learning cycle is a learning model centered on learners (Yerdelen & Ali, 2016). Learning cycle consists of a series of stages of activities organized in such a way that learners can master the competencies that must be achieved in learning with an active role(Ngalimun, 2014; Ratiyani, Wachju Subchan, & Slamet Hariyadi, 2014).Learning cycle in the classroom practice focuses on the experience and knowledge of the early learners(Ghaliyah et al., 2015),based on the opinions,it can be concluded that the model of learning cycle centered on learners so that learners can actively find their own concept. In order for the learners' concept can be well-organized, an organized procedureis needed.

The development of learning cycle model has been developed from learning cycle 3e (Exploration, Explanation, Elaboration), learning cycle 5e (Engagement, Exploration, Explanation, Elaboration, and Evaluation), and learning cycle 7e (elicit, engage, explore, explain, elaborate, extend, and evaluate). The latest development is the learning cycle 7e.

Some studies suggest that learning cycle 7e can foster motivation and learning achievement (Febriana et al.,2014; Sumiyati et al., 2016), improve language comprehension(Yerdelen & Ali, 2016) effective to achieve goals quickly(Bozorgpouri, 2016), improve the ability of mathematical connections(Rosalina Rawa et al., 2016), and foster conceptual understanding (Nurmalasari et al., 2014).

In some of the research results, understanding of concepts is very important in learning because,with the concept mastery of the materials, the hardest problem can be solved easily (Alan & Afriansyah, 2017; Suroso, 2016). Many learners do not give good results in learning. Learners are not aware of efficient and effective ways of learning because they only try to memorize lessons. Though physics is not a material to memorize, but requires reasoning and understanding the concept(Lestari & Rahayu, 2015). As a result, if given a test, learners will have difficulty(Yolanda, Syuhendri, & Andriani, 2016). Therefore, understanding the concept is needed by every learner; by understanding the concept, it is expected for the learners to get good learning outcomes.

The results of the earlier quantitative and qualitative research on the understanding of the thermal concepts and phenomena show that the majority of children do not master the concepts of heat and temperature and the related phenomena even after receiving formal instruction on these subjects. By analyzing this bibliographic spectrum, we can

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Comment [M18]: Use 'et al.' to cite a source having more than two authors

Comment [M15]: Use 'et al.' to cite a source having more than two authors specify some constant and strong obstacles in the reasoning and explanations of students.

There is a confusion between the concepts "heat" and "temperature," and often they think that temperature is a measure of the heat, temperature is an intrinsic property of matter, they are hot and cold objects by nature, the warm and the cold d are two separate entities, all materials if they are placed long in an environment with a temperature given, will reach the same temperature,confusion with the meaning of words like 'heat', 'heat flow' or 'heat capacity', mixing hot and cold water lead to correct qualitative judgements but incorrect quantitative judgements,difficulty explaining how a thermometer works (Gönen & Kocakaya,2010; Harrison, Grayson, & Treagust, 1999; Kampeza, Vellopoulou, Fragkiadaki, & Ravanis, 2016; Ravanis, 2013; Tytler, 2000)

METHOD

Design of Study

The design used in this research was Quasi-experimental with *Nonequivalent Control Class Design*(Sugiyono, 2014; Tanti et al., 2017). The research was conducted at the X Science 1 and X Science 2 class of SMAN 1 Kotabumi North Lampung. The study was implemented in three phases (pre-test, teaching interventions in an experimental group and a control group and post-test). The data of the study consisted of student's responses to objective tests in the form of multiple choices equipped with the reason for the answers. The pre-test took place X weeks before the teaching interventions, and the post-test were held X weeks after the intervention.

Participants

The sampling technique employed was Cluster Sampling (Arikunto, 2010). The sample of the study consisted of X subjects, X male and X female (age 15-16; average age X years). The children were attending public secondary classes with similar socio-economic characteristics and were randomly divided into two groups of X children each, thus forming the experimental class (hereafter E.C.) and control class (hereafter C.C.) respectively.

Teaching Interventions

The Experimental Class

The learning stage of 7E Learning Cycle modelcan be seen in Figure 1:

Figure 1. The Stages of 7E Learning Cycle Model.

The Researchers applied the sevenstages of 7E Learning Cycle model during the teaching and learning activity. The first stage was Elicit to raise the student's initial knowledge by asking questions as displayed in Figure 2 below;


Zero Kelvin is known as the absolute zero temperature. What is the definition of absolute zero temperature?

Figure 2. The first Stage: Elicit.

The students responded enthusiastically when they were givensucha question. They were willing to present the answer in front of the class. Thus, it brought about the impact of active classroom atmosphere at the beginning of the learning process.

The second stage was to Engage. It was involving the students with the surrounding events related to the temperature material by carrying out the demonstration as displayed in Figure 3.

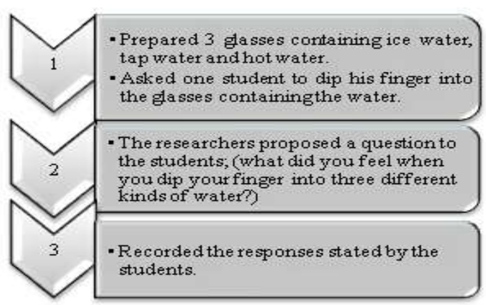

Figure 3. The Second Stage: Engage.

The results of the demonstration were able to stimulate the students in order to answer each question of

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the demonstration. Besides, it could attract students' attention to focus on the learning process.

The third stage was to Explore. This was thestage of collecting information. The procedure can be seen in the following figure4,

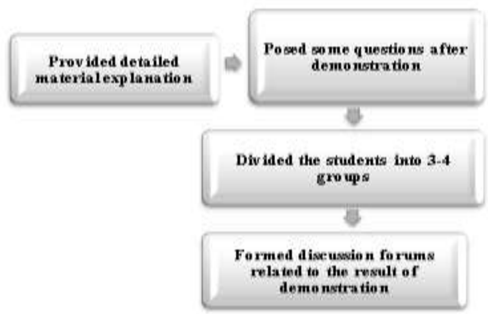


Figure 4. The Third Stage: Explore.

It was expectedthat based on the information-gathering stage the students were able to understand the material in detail.

The fourthstage was to Explain. The students were required to explain the results of the discussion by using their way tounderstand the material indicating the level of student' understanding, has appeared in the following figure5,

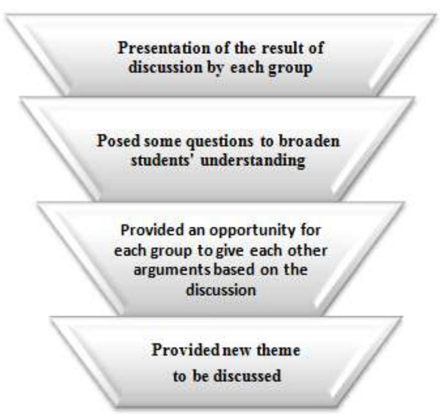


Figure 5. The Fourth Stage: Explain.

The fifth stage was Elaborate. Elaborate was the proficiency stage for the researcher and the students to connect previously learned concepts with daily life. It can be seen in Figure 6.

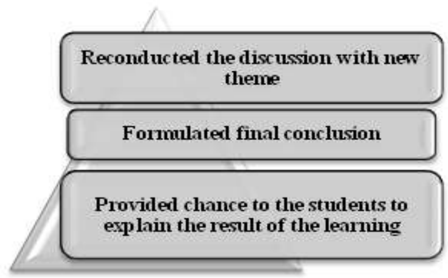


Figure 6. The Fifth Stage: Elaborate.

In this stage, the students re-conducted the discussion to acquire new findingsin order to overcome different problems and concepts and to produce theconclusionthatwas correct and clear.

The sixth stage was to Extend. The result of the students' findings was extended to enable the students to be more active and interested in searching for new concepts as displayed in Figure 7.

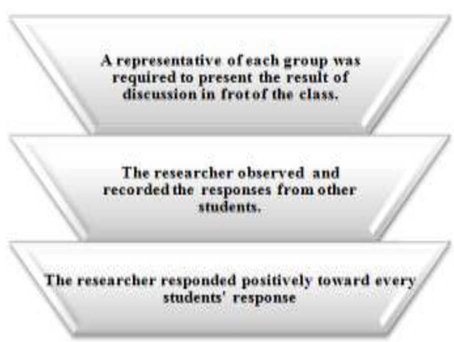


Figure 7. The sixth Stage: Extend.

The seventh stage was to Evaluate. The students were given opportunities to conclude everything related to the material that had been studied. Then, an evaluation was carried out in order to gain adeeper understanding of the concept of the temperature material by giving thetask to the students. One of the conceptual understanding problems can be seen in the following figure8:

Look at the following Images:

The three images above are liquid which are heated with the same amount of heat. If the density of each liquid is different, namely ρ1 <ρ 2 <ρ 3, then the correct statement regarding the temperature rise is...

a. Figure 1 has the fastest temperature rise
b. Figure 2 has the fastest temperature rise
c. Figure 3 has the fastest temperature rise
d. Figure 1 has the lowest temperature rise
e. Figure 2 has the lowest temperature rise

Figure 8. The Seventh Stage: Evaluate.

In the final step of the seventh stage, the researcher conveyed information about the next material that will be studied so that the students should learn before the material is delivered.

The learning process through the 7E Learning Cycle model requires time accuracy considering its numerous stages. Time is one of the keyfactors in implementing this learning model. Furthermore, to achieve the learning objectives, this learning model should be done in complete seven stages, if only two stages were done or skipping even a stage, then the implementation of this learning model will not be optimum.

The control classes

The learning process in the control class wasconducted using Direct Learning Model whichis commonly used by physics teachers. The students responded passively and only listened to the researcher explained. It resulted in a lack of understanding of the concepts of the material; consequently, the students were having difficulty in solving some of the physics problems on temperature and heat materials.

The research questions

Based on the research design presented, we formulated two research questions.

With the first research question, we ask if the students of the experimental class (who took part in a 7E teaching intervention) would be able to better understand the thermal concepts and phenomena, compared to the children in the control class (who participated in a Direct Learning Model.

With the second research question, we ask we ask whether students of both groups progress after the two didactic interventions.

Data analysis

Research Instrument and its development the students' understanding of the concepts were measured through pre-test and post-test using objective test in the form of multiple choices equipped with the reason for the answers. Each test consisted of 15 items. Since the original version of the tests was the only multiple-choice format, then modification was carried out by asking the students to provide a reason for choosing the answer.

To investigate the effectiveness of learning toward the students' understanding of the concepts, the Effect Size test was used. Effect Size is a measurement to determine the effect of one variable on another. Effect Size can be counted using a particular formula(Cohen, 1998), and further explanation of it is also available(Hake, 1998; Saregar et al., 2016).

$$d = \frac{m_A - m_B}{\left[\frac{(sd_A^2 + sd_B^2)}{2}\right]^{1/2}}$$

Definition:

d	= *effect size*
m_A	=mean gain of the experimental class
m_B	= mean gain of control class
sd_A	=standard deviation of experimental class
sd_B	= standard deviation of control class

The value of Effect Size can be seenin Table 1, as follows:

Table 1. Effect Size Criteria.

Effect Size	**Category**
d < 0.2	Low
0.2 ≤ d < 0.8	Average
d ≥ 0.8	High

RESULT AND DISCUSSION

The data display of pre-test and post-test score recapitulation of the control and experimental class can be seen in table 2 below,

Table 2. The Pre-Test and Post-Test Score of the Control and Experimental Class

Indicator of Concept Understanding	Pretest				Posttest			
	Experimental Class*		Control Class**		Experimental Class*		Control Class**	
	Highest Score	Lowest Score	Highest Score	Lowest Score	Highest Score	Lowest Score	Highest Score	Lowest Score
Interpreting	69	70	40	41	95	83	72	62
Modeling	72	70	37	40	94	80	70	63
Predicting	72	69	35	30	89	82	65	60
Explaining	70	67	30	32	90	80	66	61
Classifying	64	65	31	29	97	79	62	58
Comparing	62	64	28	28	94	78	68	59
Summarizing	60	64	30	31	92	78	66	57
The Highest and Lowest Total Score	469	469	231	231	651	560	469	420
The Highest and Lowest Average Score	67	67	33	33	93	80	67	60
Total Score	1.986,4		1.880		3.113,2		2.820	
Number of Students	40		40		40		40	
Total Average Score	49,66		47		77,83		70,5	

*Learning cycle 7e model **Conventional model

The pretest and posttest shown in Table 2 were measured through a multiple-choice test of concept understanding (example figure 8). The scores measured in this study are cognitive scores according to the blooms' taxonomy that includes cognitive 2, 3, 4 and 5 (C2, C3, C4, C5). There are seven indicators of understanding the concept applied in this study. Table 2 shows that the results of the concept of understanding tests in each indicator change. On the test of understanding the concepts (interpreting), the highest and lowest scores in the experimental class and the control class experienced an increase, both as a result of pretest and posttest. However, the highest and lowest scores in the experimental class are higher compared to the scores in the control class.

On the concept understanding test (modeling), the highest and lowest scores in the experimental class and the control class experienced an increase, both the results of the pretest and posttest. However, the highest and lowest scores in the experimental class are higher than the scores in the control class.

On the concept understanding test (predicting), the highest and lowest scores in the experimental class and the control class experienced an increase, both the results of the pretest and posttest. However, the highest and lowest scores in the experimental class are higher than the scores in the control class.

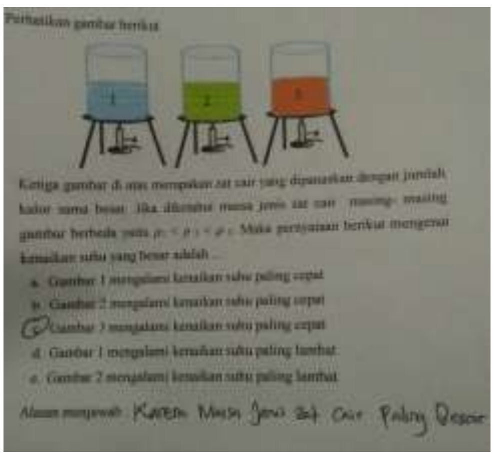
On the concept understanding test (explaining) the highest and lowest scores in the experimental class and the control class experienced an increase, both the results of the pretest and posttest. However, the highest and lowest scores in the experimental class are higher than the scores in the control class.

On the concept understanding test (classifying) the highest and lowest scores in the experimental class and the control class experienced an increase, both the results of the pretest and posttest. However, the highest and lowest scores in the experimental class are higher than the scores in the control class.

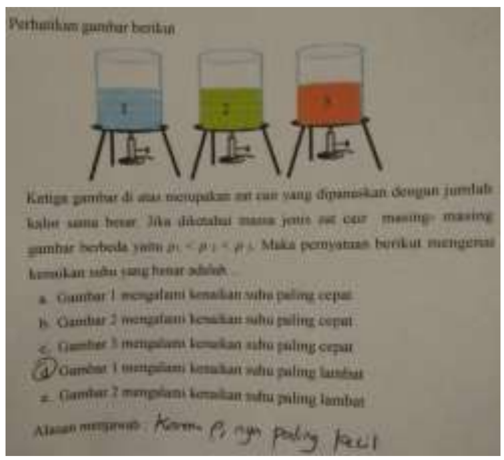
On the concept understanding test (comparing) the highest and lowest scores in the experimental class and the control class experienced an increase, both the results of the pretest and posttest. However, the highest and lowest scores in the experimental class are higher than the scores in the control class.

On the concept understanding test (summarizing) the highest and lowest scores in the experimental class and the control class experienced an increase, both the results of the pretest and posttest. However, the highest and lowest scores in the experimental class are higher than the scores in the control class.

In general, the results of concept understanding tests on each indicator experienced an increase in both the experimental class and the control class. However, before applying the learning cycle 7e model, there was no significant difference in the understanding of the concepts of the experimental class students. However, after the implementation of the learning cycle 7e model, the scores of the experimental class were significantly improved. Based on the results of the analysis of each student's answers, the understanding of their concepts had not been trained when answering the conceptual understanding questions in the form of multiple choices when they choose the answer (figure 9). In contrast to the results after applying the learning cycle 7e model and the conventional model, there are significant differences in the understanding of the concepts in the experimental class and the control class. In the experimental class, the answer is more appropriate than the control class (figure 10).

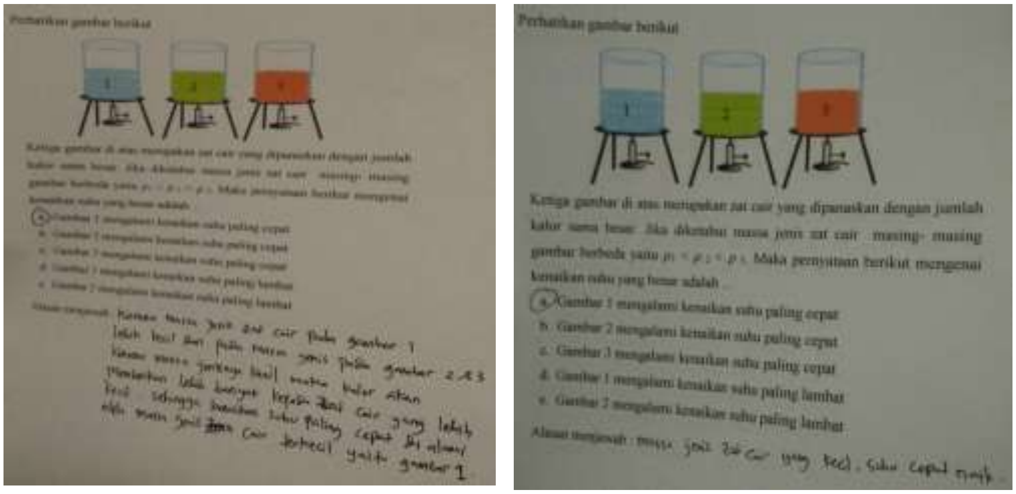


(a) Learning Cycle 7e Model



(b) Conventional Model

Figure9.Before the Application of Learning Cycle 7e and the Conventional Model



(c) Learning Cycle 7e Model

(d) Conventional Model

Figure 10.After the Application of Learning Cycle 7e and the Conventional Model

In addition to the results of cognitive scores, the management of learning is also the key to the successful implementation of the learning model. The following is the explanation of the learning management in this study.

Learning Management

The scoring percentage given by the physics teacher while the researcher was applying the learning model can be seen in the following figure 11:

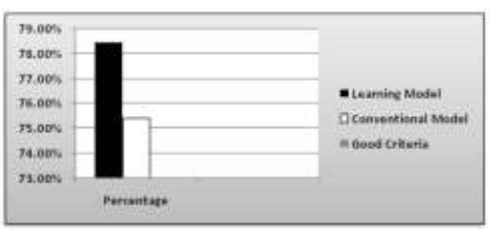


Figure 11. Graphic Percentage of Learning Management.

Based on figure 11, the gain percentage shows that the learning management through 7e Learning Cycle was 78.46% compared to the conventional learning amounting 75.38%. The percentage falls into satisfying criteria.Improvement can occur because the teacher applied the learning cycle 7e systematically. In the class that the learning cycle 7e model was applied, the teacher started the lesson by eliciting knowledge and involving students through engaging demonstrations. In the class that the conventional model was applied, the teacher started the lesson by psychologically preparing the students through stories without demonstrations or involving the students.

The core activity in learning cycle 7e model begins with the grouping to discuss the continuation of the demonstration by changing the object of the demonstration and discussion finding solutions to the questions given by the teacher (explore). Then each group conducts a presentation by explaining the results of the discussion (explain), the teacher gives feedback to each group to expand the discussion material in the group through question and answer between groups (elaborate & extend). In the class that applies conventional models, the core activity begins with the teacher explaining the material then the teacher forms a group to observe events related to the material in daily life. Then students are asked to communicate the material through assignments.

The closing activity in the learning cycle 7e model is ended by asking each group to conclude the results of the discussion and the teacher concludes the overall results of the discussion. The closing activity in the conventional model is ended by giving homework.

Based on the description of learning management, the learning cycle 7e model is a student-centered model. The teacher only acts as a facilitator in learning while the conventional model is still a teacher-centered model. The curriculum in Indonesia is the 2013 curriculum which emphasizes student-centered learning. In addition, other countries such as Finland, England, the United States, and other developed countries also implement student-centered learning which is more effective than teacher-centered learning.

The effectiveness of the application of the learning model is analyzed with effect size formula. Further description is shown in Table 3.

Table 3. The Result of Effect Size.

Class	Mean Gain	Standard Deviation	Effect Size	Category
Experiment	28,17	36,64	0,5	Average
Control	23,50	137,72		

Table 3 shows that the gain of effect size is 0.5 in the average category. This shows that the use of the 7E Learning Cycle model could effectively improve students' understanding of concepts in Physics subjects.

Based on the recapitulation of the post-test scores, both the experimental and the control class of the students' conceptual understanding have increased significantly. This might be caused by the fact that the7E Learning Cycle model has such distinctive characteristics that the students not only listen to the teachers but can also play an active role in exploring and enriching their understanding of the concepts learned.

The importance of understanding the concept of learning in school requires researchers to use various ways to analyze and improve understanding of concepts, including: increasing mastery of concepts through interactive multimedia(Husein et al., 2015), improving understanding of concepts through 7e learning cycle for junior high school students(Nurmalasari et al., 2014), improving understanding of concepts by utilizing PhET Simulation (Saregar, 2016), increasing understanding of concepts through the application of guided inquiry learning model(Setyawati et al., 2016), increasing understanding of concepts through the application of experiential learning models (Wahyuningsih, 2014)and understanding analysis of concepts through TTCI and CRI instruments (Yolanda et al., 2016).

This study supports Nurmalasari's research that the learning cycle 7e model can improve concept understanding. In the Nurmalasari study, the learning cycle 7e model was applied to the junior high school students, but in this study, it was applied to senior high schools students. It means that the learning cycle 7e model can improve concept understanding to both junior and senior high school students

The findings of this study indicate that the use of the learning cycle model 7e was able to improve the mastery of the concept of the learners effectively. In this paper, the procedures of the learning cycle model 7e in the classroom are discussed in detail and thoroughly.

CONCLUSION

In short, it can be concluded that the use of 7E Learning Cycle Model is effective in improving students' conceptual understanding. In other words, the learning process through 7E Learning Cycle Model was more effective compared to the conventional model in improving the students' concept understanding, especially on temperature and heat subject matte.

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Comment [M23]: 1. Please provide at least **30 references** which 80% of them are taken from **the last10 years (>2009)** articles of no-predatory journals, written in accordance with the APA Standard. You may go to Google Scholar and find the right format for APA Style provided.

2. For books, please refer to the original/primary book reference no matter the date.

3. All of the listed references must be cited in the body of the article, and vice versa.

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JPII 7 (1) (2018)

Jurnal Pendidikan IPA Indonesia

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APPROACHING THE UNDERSTANDING OF THERMAL PHENOMENA USING 7ELEARNING CYCLE

Abstract

Conceptual understanding is often a problem in science learning, and this has become the focus of science education experts including in Indonesia. Lately,ten articles in Indonesia and six articles in other countries havediscussed the model of 7ELearning Cycle. It was mentioned that this model is able to increase the understanding of learners' concept. This research is aimed to reveal the effectiveness of physics learning using 7E Learning Cycle modelafter being reviewed with control classes in improving students' understanding of temperature and heat concepts. The research design is quasi-experimental with non-equivalent control group design.The sample was senior high school students. Objective test in the form of multiple choices equipped with reason was employed as the instrument to collect the data. Based on the data analysis, it was obtained that the value of Effect Size was as much as 0.5with the medium category.It can be concluded, then, that the use of 7E Learning Cycle learning model is effective to improve learners' understanding of temperature and heat concepts. This can be seen from the learning process that integrates the whole 7 stages of the 7e learning cycle model with the 7 indicators of conceptual understanding in detail so that the use of the 7e learning cycle model could be effectively used and is able to increase students' conceptual understanding.

Too long sentence

Keywords:*Conceptual understanding; Direct Learning; 7E Learning Cycle model*

INTRODUCTION

The outcome of the physics learning process, among others, is to enable the students to understand the relevance of physics concepts so that the students can apply the knowledge in their daily life(Husein et al., 2015; Latifah et al., 2019; Pratiwi & Supardi, 2014). Students' inability to connect one concept to another is a common problem occurring in physics classes(Sagala et al., 2019; Tanti et al., 2017). Students are more likely to memorize than to understand the concepts (Maharani et al, 2019). In this case, physics teachers should emphasize the students' understanding of the concepts (Lestari et al., 2015; Wahyuningsih, 2014) based on theknowledge acquired in the previous level to the next(Widayanti et al., 2018; Yulianti & Gunawan, 2019). The use ofvaried learning model is needed(Saregar et al., 2018) in order to be an intermediary so that the material taught couldbe understood by students(Pitan & Atiku, 2017; Sagala et al.,2019; Widayanti & Yuberti, 2018; Yıldırım & Akamca, 2017). Furthermore, at the final stage, it is expected to increase the students' mastery of the concepts (Saregar, 2016).

There are various types of constructivism learning models such as problem-solving learning model, mind mapping, and 7E learning cycle. In this research,the 7E Learning Cycle model was selected since it provides opportunities for students to build their knowledge (Febriana et al., 2014).

7ELearning Cycle model is the improvement of the 5E Learning Cycle model(Ghaliyah et al., 2015).The cycles of the applied learning model are emphasized in the understanding of the scientific physicsconcepts and correcting the knowledge misconception. Furthermore, it is also expected to be able to enhance the students' memorization process that is focused on the knowledge and knowledge transfer (Yerdelen & Ali, 2016). The model of the learning cycle Approach (LCA) is a model that is deemed effective for physics students (Olaoluwa & Olufunke, 2015). It can help them to elaborate their understanding toward certain aspects in scientific research (Hodson, 2012; Putra et al., 2018). One of the physics materials that is considered quite difficult for students to understand is temperatureandheat(Sayyadi et al., 2016).

The constructivism basis of the 7E Learning Model possesses some weaknesses and strengths. One of the notable strengths of the 7E Learning Cycle is that it could make the students active since the students are thinking maximally to acquire the knowledge. On the other hand, the weakness of7ELearning Cycle is the length of time needed in its applicationsince the students are trained to explore their knowledge, and they are also given enough freedom to express their ideas. In order to minimize the weakness of this model, proper preparation is certainly needed by the teacher acting as a facilitator (Rosalina et al., 2016).

The previous researchers showed that the Learning Cycle could be used to improve students' understanding (Nurmalasari et al., 2014). It can also be used to improve students' learning achievement (Sumiyati er al, 2016). To understand a concept means to be able to express the material having been learned into a simplified version to overcome the problems of the interconnected concept. The cognitive process of concepts understanding consists of interpreting, modeling, classifying, summarizing, predicting, comparing, and explaining (Setyawati et al., 2016).One of the factors that determine the outcome of the learning process is the students' achievements measured by how much they are able to master the learning material (Parasamya & Wahyuni, 2017).

There are some distinctions between this research and the previous ones. Firstly, there is an elaboration of each of the seven prescribed stages of the 7ELearning Cycle model implementation exposing the students' level of understanding presented in the discussion. In addition, there is the use of different learning materials, namely temperature and heat which is very suitable for the object of measuring concept understanding(Danos et al., 2019). Then, the learning circumstances where the subjects of this research study are also relatively different.

Learning cycle is a learning model centered on learners (Yerdelen & Ali, 2016). Learning cycle consists of a series of stages of activities organized in such a way that learners can master the competencies that must be achieved in learning with an active role(Ngalimun, 2014; Ratiyani ~~et al.~~, 2014). Learning cycle in the classroom practice focuses on the experience and knowledge of the early learners(Ghaliyah et al., 2015),based on the opinions,it can be concluded that the model of learning cycle centered on learners so that learners can actively find their own concept. In order for the learners' concept can be well-organized, an organized procedureis needed.

The development of learning cycle model has been developed from learning cycle 3e (Exploration, Explanation, Elaboration), learning cycle 5e (Engagement, Exploration, Explanation, Elaboration, and Evaluation), and learning cycle 7e (elicit, engage, explore, explain, elaborate, extend, and evaluate). The latest development is the learning cycle 7e.

Colour

Some studies suggest that learning cycle 7e can foster motivation and learning achievement (Febriana et al., 2014; Sumiyati et al., 2016), improve language comprehension (Yerdelen & Ali, 2016), effective to achieve goals quickly(Bozorgpoun, 2016), improve the ability of mathematical connections(Rosalina Rawa et al., 2016), and foster conceptual understanding (Nurmalasari et al., 2014).

In some of the research results, conceptual understanding of is very important in learning since by mastering the concepts of the materials, the hardest problem can be solved easily (Alan & Afriansyah, 2017; Suroso, 2016). Many learners do not produce good results in learning. Learners are not aware of efficient and effective ways of learning because they only try to memorize lessons. Though physics is not a material to be memorized since it requires reasoning and understanding of the concept(Lestari et al., 2015). As a result, if they are given a test, the learners will have difficulties (Yolanda et al., 2016). Therefore, understanding the concept is needed by every learner. By understanding the concept, it is expected for the learners to get good learning outcomes. So that the researchers consider it is necessary to conduct research to see the effectiveness of the learning cycle 7e model in improving students' conceptual understanding in the temperature and heat material.

The results of the earlier quantitative and qualitative research on ~~the~~ understanding of the thermal concepts and phenomena show that the majority of children do not master the concepts of heat and temperature and the related

The results of the demonstration were able to stimulate the students in order to answer each question of the demonstration. Besides, it could attract students' attention to focus on the learning process.

The third stage was to Explore. This was thestage of collecting information. The procedure can be seen in the following figure4,

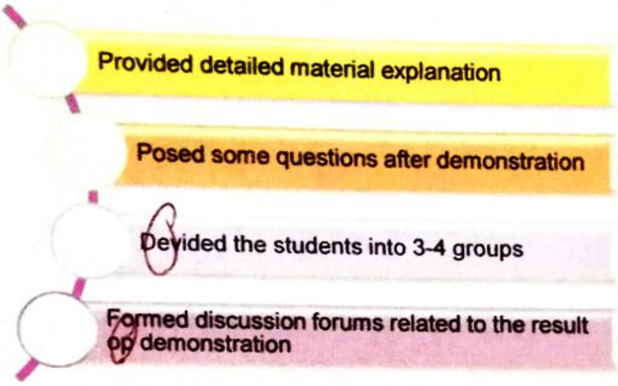

Figure 4. The Third Stage: Explore.

It was expected that based on the information-gathering stage the students were able to understand the material in detail.

The fourthstage was to Explain. The students were required to explain the results of the discussion by using their way tounderstand the material indicating the level of student' understanding, has appeared in the following figure5,

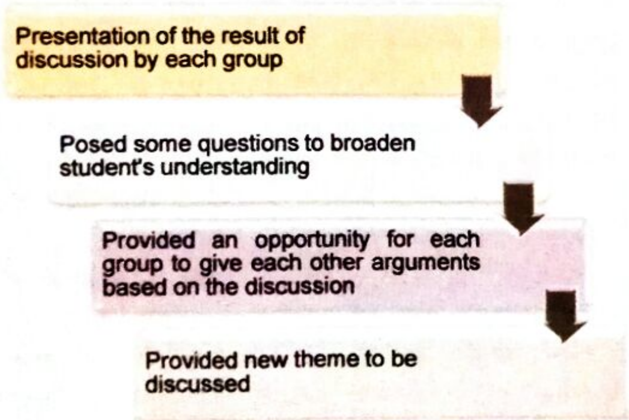

Figure 5. The Fourth Stage: Explain.

The fifth stage was Elaborate. Elaborate was the proficiency stage for the researcher and the students to connect previously learned concepts with daily life. It can be seen in figure 6.

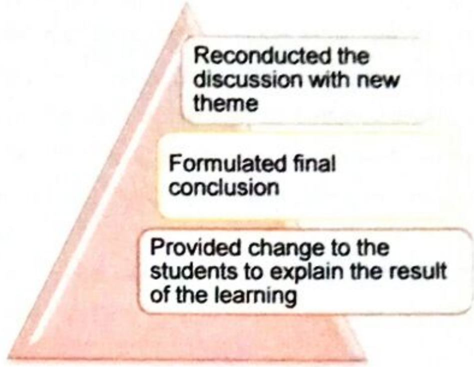

Figure 6. The Fifth Stage: Elaborate.

In this stage, the students re-conducted the discussion to acquire new findingsin order to overcome different problems and concepts and to produce theconclusionthatwas correct and clear.

The sixth stage was to Extend. The result of the students' findings was extended to enable the students to be more active and interested in searching for new concepts as displayed in figure 7.

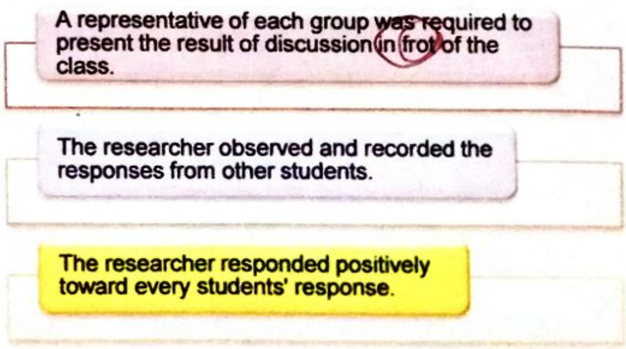

Figure 7. The sixth Stage: Extend.

The seventh stage was to Evaluate. The students were given opportunities to conclude everything related to the material that had been studied. Then, an evaluation was carried out in order to gain adeeper understanding of the concept of the temperature material by giving thetask to the students. One of the conceptual understanding problems can be seen in the following figure8.

Look at the following images:

The three images above are liquid which are heated with the same amount of heat. If the density of each liquid is different, namely ρ1 <ρ 2 <ρ 3, then the correct statement regarding the temperature rise is...

a. Figure 1 has the fastest temperature rise

b. Figure 2 has the fastest temperature rise

c. Figure 3 has the fastest temperature rise

d. Figure 1 has the lowest temperature rise

e. Figure 2 has the lowest temperature rise

Figure 8. The Seventh Stage: Evaluate.

In the final step of the seventh stage, the researcher conveyed information about the next material that will be studied so that the students should learn before the material is delivered.

The learning process through the 7E Learning Cycle model requires time accuracy considering its numerous stages. Time is one of the keyfactors in implementing this learning model. Furthermore, to achieve the learning objectives, this learning model should be done in complete seven stages, if only two stages were done or skipping even a stage, then the implementation of this learning model will not be optimum.

The control classes

The learning process in the control class wasconducted using Direct Learning Model whichis commonly used by physics teachers. The students responded passively and only listened to the researcher explained. It resulted in a lack of understanding of the concepts of the material; consequently, the students were having difficulty in solving some of the physics problems on temperature and heat materials.

Please give detail of conducting the lesson (The way, material etc) ppt 8...

The research questions

Based on the research design presented, we formulated two research questions.

With the first research question, we ask if the students of the experimental class (who took part in a 7E teaching intervention) would be able to better understand the thermal concepts and phenomena, compared to the children in the control class (who participated in a Direct Learning Model)

With the second research question, we ask we ask whether students of both groups progress after the two didactic interventions.

Data analysis

Research Instrument and its development the students' understanding of the concepts were measured through pre-test and post-test using objective test in the form of multiple choices equipped with the reason for the answers. Each test consisted of 15 items. Since the original version of the tests was the only multiple-choice format, then modification was carried out by asking the students to provide a reason for choosing the answer.

Source of the question / level of the question / process validity / reliability / Category of question?

To investigate the effectiveness of learning toward the students' understanding of the concepts, the Effect Size test was used. Effect Size is a measurement to determine the effect of one variable on another. Effect Size can be counted using a particular formula(Cohen, 1998), and further explanation of it is also available(Anwar et al., 2019; Hake, 1998).

$$d = \frac{m_A - m_B}{\left[\frac{(sd_A^2 + sd_B^2)}{2}\right]^{1/2}}$$

Definition:

d	= *effect size*
m_A	=mean gain of the experimental class
m_B	= mean gain of control class
sd_A	=standard deviation of experimental class
sd_B	= standard deviation of control class

The value of Effect Size can be seenin Table 1, as follows:

Table 1. Effect Size Criteria.

Effect Size	Category
d < 0.2	Low
0.2 ≤ d < 0.8	Average
d ≥ 0.8	High

RESULT AND DISCUSSION

Check table serious mistake

The data display of pre-test and post-test score recapitulation of the control and experimental class can be seen in table 2 below.

Table 2. The Pre-Test and Post-Test Score of the Control and Experimental Class

Indicator of Concept Understanding	Pretest				Posttest			
	Experimental Class*		Control Class**		Experimental Class*		Control Class**	
	Highest Score	Lowest Score	Highest Score	Lowest Score	Highest Score	Lowest Score	Highest Score	Lowest Score
Interpreting	69	70	40	41	95	83	72	62
Modeling	72	70	37	40	94	80	70	63
Predicting	72	69	35	30	89	82	65	60
Explaining	70	67	30	32	90	80	66	61
Classifying	64	65	31	29	97	79	62	58
Comparing	62	64	28	28	94	78	68	59
Summarizing	60	64	30	31	92	78	66	57
The Highest and Lowest Total Score	469	469	231	231	651	560	469	420
The Highest and Lowest Average Score	67	67	33	33	93	80	67	60
Total Score	1.986,4		1.880		3.113,2		2.820	
Number of Students	40		40		40		40	
Total Average Score	49,66		47		77,83		70,5	

*Learning cycle 7e model **Conventional model

is it significant difference?

The pretest and posttest shown in Table 2 were measured through a multiple-choice test of concept understanding (example figure 8). The scores measured in this study are cognitive scores according to the blooms' taxonomy that includes cognitive 2, 3, 4 and 5 (C2, C3, C4, C5). There are seven indicators of understanding the concept applied in this study. Table 2 shows that the results of the concept of understanding tests in each indicator change. On the test of understanding the concepts (interpreting), the highest and lowest scores in the experimental class and the control class experienced an increase, both as a result of pretest and posttest. However, the highest and lowest scores in the experimental class are higher compared to the scores in the control class.

On the concept understanding test (modeling), the highest and lowest scores in the experimental class and the control class experienced an increase, both the results of the pretest and posttest. However, the highest and lowest scores in the experimental class are higher than the scores in the control class.

On the concept understanding test (predicting), the highest and lowest scores in the experimental class and the control class experienced an increase, both the results of the pretest and posttest. However, the highest and lowest scores in the experimental class are higher than the scores in the control class.

On the concept understanding test (explaining) the highest and lowest scores in the experimental class and the control class experienced an increase, both the results of the pretest and posttest. However, the highest and lowest scores in the experimental class are higher than the scores in the control class.

On the concept understanding test (classifying) the highest and lowest scores in the experimental class and the control class experienced an increase, both the results of the pretest and posttest. However, the highest and lowest scores in the experimental class are higher than the scores in the control class.

On the concept understanding test (comparing) the highest and lowest scores in the experimental class and the control class experienced an increase, both the results of the

Based on the description of learning management, the learning cycle 7e model is a student-centered model. The teacher only acts as a facilitator in learning while the conventional model is still a teacher-centered model. The curriculum in Indonesia is the 2013 curriculum which emphasizes student-centered learning. In addition, other countries such as Finland, England, the United States, and other developed countries also implement student-centered learning which is more effective than teacher-centered learning.

The effectiveness of the application of the learning model is analyzed with effect size formula. Further description is shown in Table 3.

Table 3. The Result of Effect Size.

Class	Mean Gain	Standard Deviation	Effect Size	Category
Experiment	28,17	36,64	0,5	Average
Control	23,50	137,72		

check value!

Table 3 shows that the gain of effect size is 0.5 in the average category. This shows that the use of the 7E Learning Cycle model could effectively improve students' understanding of concepts in Physics subjects.

Based on the recapitulation of the post-test scores, both the experimental and the control class of the students' conceptual understanding have increased significantly. This might be caused by the fact that the7E Learning Cycle model has such distinctive characteristics that the students not only listen to the teachers but can also play an active role in exploring and enriching their understanding of the concepts learned.

The importance of understanding the concept of learning in school requires researchers to use various ways to analyze and improve understanding of concepts, including: increasing mastery of concepts through interactive multimedia(Husein et al., 2015), improving understanding of concepts through 7e learning cycle for junior high school students(Nurmalasari et al., 2014), improving understanding of concepts by utilizing PhET Simulation (Saregar, 2016), increasing understanding of concepts through the application of guided inquiry learning model(Setyawati et al., 2016), increasing understanding of concepts through the application of experiential learning models (Wahyuningsih, 2014)and understanding analysis of concepts through TTCI and CRI instruments (Yolanda et al., 2016).

This study supports Nurmalasari's research that the learning cycle 7e model can improve concept understanding. In the Nurmalasari study, the learning cycle 7e model was applied to the junior high school students, but in this study, it was applied to senior high schools students. It means that the learning cycle 7e model can improve concept understanding to both junior and senior high school students

The findings of this study indicate that the use of the learning cycle model 7e was able to improve the mastery of the concept of the learners effectively. In this paper, the procedures of the learning cycle model 7e in the classroom are discussed in detail and thoroughly.

CONCLUSION

In short, it can be concluded that the use of 7E Learning Cycle Model is effective in improving students' conceptual understanding. In other words, the learning process through 7E Learning Cycle Model was more effective compared to the conventional model in improving the students' concept understanding, especially on temperature and heat subject matte. This is because each learning process truly integrates the 7 stages of the 7e learning cycle model with the 7 indicators of conceptual understanding that must be achieved by students, so that the use of the learning cycle 7e model is effective and is able to increase students' conceptual understanding.

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Anwar, C., Saregar, A., Yuberti, Zellia, N., Widayanti, Diani, R., & Wekke, I. S. (2019). Effect Size Test of Learning Model ARIAS and PBL: Concept Mastery of Temperature and Heat on Senior High School Students. *EURASIA Journal of Mathematics, Science and Technology Education*, *15*(3), 1–9. https://doi.org/https://doi.org/10.29333/ejmste/103032

Comments for feedback to the author(s):

The idea of this study is to obtain the effectiveness of the students' understanding of Thermal Phenomena Using 7E Learning Cycle. Researcher clearly showed the 7E learning Cycle of the study. However, the manuscript had too many errors and not ready for submission. This study started with literature review but it presented with a low quality of review by just refer to previous research studies with no conclusion or self-opinions/ideas.

Then, the methodology for quantitative study need to refine including descriptive and inferential statistics such as t-test and Mann-Whitney test with proper null hypothesis. In addition, the evaluation part need to be improve by providing clear information on sampling (What is X means?), quantitative evaluation design, instruments (MCQ), and analysis of the study. Besides that, little information about how the control group being conducted to reduce research bias of the researcher setting and how to reduce the Hawthorne effect.

Moreover, researcher mentioned about using MCQ as instrument in page 3 and then a much more detailed information is needed for explaining instruments that used in the study and provide reliability and validity information of the instruments must be given under the section of the instruments.

For the data analysis part, researcher must check the Table 2 data, is it correct? Is something statistically significant? How do you determine if an increase is statistically significant? Such as t-test and Mann-Whitney test.

Furthermore, research refinement and educational implication for your study which is very important for current research trend need to be added. Then, researcher must follow APA style in the citation (how and when to use *et al.*?) and references and you may refer to scanned copy for more information. Therefore, it is suggested that the authors refer to the papers in WOS database. For example,

Tho, S. W., & Yeung, Y. Y. (2016). Technology-enhanced science learning through remote laboratory: System design and pilot implementation in tertiary education. *Australasian Journal of Educational Technology, 32*(3), 96-111.

Tho, S. W., & Yeung, Y. Y. (2018). An implementation of remote laboratory for secondary science education. *Journal of Computer Assisted Learning, 34*(5), 629-640.

Lastly, I suggest the researcher to make significant revisions on each section of the study. Finally, I suggest researcher to write short sentence and get a native help for language issues of the study by future resending your manuscript for English proofreading.

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Comment [U1]: Need proofreading

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Comment [U2]: What do you mean?

Keywords:*Conceptual understanding; Direct Learning; 7E Learning Cycle model*

INTRODUCTION

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7ELearning Cycle model is the improvement of the 5E Learning Cycle model(Ghaliyah et al., 2015).The cycles of the applied learning model are emphasized in the understanding of the scientific physicsconcepts and correcting the knowledge misconception. Furthermore, it is also expected to be able to enhance the students' memorization process that is focused on the knowledge and knowledge transfer (Yerdelen & Ali, 2016). The model of the learning cycle Approach (LCA) is a model that is deemed effective for physics students (Olaoluwa & Olufunke, 2015). It can help them to elaborate their understanding toward certain aspects in scientific research (Hodson, 2012; Putra et al., 2018). One of the physics materials that is considered quite difficult for students to understand is temperatureandheat(Sayyadi et al., 2016).

The constructivism basis of the 7E Learning Model possesses some weaknesses and strengths. One of the notable strengths of the 7E Learning Cycle is that it could make the students active since the students are thinking maximally to acquire the knowledge. On the other hand, the weakness of7ELearning Cycle is the length of time needed in its applicationsince the students are trained to explore their knowledge, and they are also given enough freedom to express their ideas. In order to minimize the weakness of this model, proper preparation is certainly needed by the teacher acting as a facilitator (Rawaet al., 2016).

The previous researchers showed that the Learning Cycle could be used to improve students' understanding (Nurmalasari et al., 2014). It can also be used to improve students' learning achievement (Sumiyati er al, 2016). To understand a concept means to be able to express the material having been learned into a simplified version to overcome the problems of the interconnected concept. The cognitive process of concepts understanding consists of interpreting, modeling, classifying, summarizing, predicting, comparing, and explaining (Setyawati et al., 2016).One of the factors that determine the outcome of the learning process is the students' achievements measured by how much they are able to master the learning material (Parasamya & Wahyuni, 2017).

There are some distinctions between this research and the previous ones. Firstly, there is an elaboration of each of the seven prescribed stages of the 7ELearning Cycle model implementation exposing the students' level of understanding presented in the discussion. In addition, there is the use of different learning materials, namely temperature and heat which is very suitable for the object of measuring concept understanding(Danos et al., 2019). Then, the learning circumstances where the subjects of this research study are also relatively different.

Learning cycle is a learning model centered on learners (Yerdelen & Ali, 2016). Learning cycle consists of a series of stages of activities organized in such a way that learners can master the competencies that must be achieved in learning with an active role(Ngalimun, 2014; Ratiyani et al., 2014). Learning cycle in the classroom practice focuses on the experience and knowledge of the early learners(Ghaliyah et al., 2015),based on the opinions,it can be concluded that the model of learning cycle centered on learners so that learners can actively find their own concept. In order for the learners' concept can be well-organized, an organizedprocedureis needed.

The development of learning cycle model has been developed from learning cycle 3E (Exploration, Explanation, Elaboration), learning cycle 5E (Engagement, Exploration, Explanation, Elaboration, and Evaluation), and learning cycle 7E (elicit, engage, explore, explain, elaborate, extend, and evaluate). The latest development is the learning cycle 7E.

Some studies suggest that learning cycle 7E can foster motivation and learning achievement (Febriana et al., 2014; Sumiyati et al., 2016), improve language comprehension (Yerdelen & Ali, 2016), effective to achieve goals quickly(Bozorgpouri, 2016), improve the ability of mathematical connections(Rawa et al., 2016), and foster conceptual understanding (Nurmalasari et al., 2014).

In some of the research results, conceptual understanding of is very important in learning sincebymastering the concepts of the materials, the hardest problem can be solved easily (Alan & Afriansyah, 2017; Suroso, 2016). Many learners do not produce good results in learning. Learners are not aware of efficient and effective ways of learning because they only try to memorize lessons. Though physics is not a material to be memorizedsince it requires reasoning and understanding of the concept(Lestari et al., 2015). As a result, if they are given a test, the learners will have difficulties (Yolanda et al., 2016). Therefore, understanding the concept is needed by every learner.By understanding the concept, it is expected for the learners to get good learning outcomes.So that the researchers consider it is necessary to conduct research to see the effectiveness of the learning cycle 7e model in improving students' conceptual understanding in the temperature and heat material.

The results of the earlier quantitative and qualitative research on the understanding of the thermal concepts and phenomena showed that the majority of children do not master the concepts of heat and temperature and the related phenomena even after receiving formal instruction

Comment [U3]: You must elaborate the distinction in METHODS. Why? Related to conceptual undestanding

Comment [U4]: This should have been stated before 7E.

on these subjects. By analyzing this bibliographic spectrum, we can specify some constant and strong obstacles in the reasoning and explanations of students.

There is a confusion between the concepts "heat" and "temperature," and often they think that temperature is a measure of the heat, temperature is an intrinsic property of matter, they are hot and cold objects by nature, the warm and the cold d are two separate entities, all materials if they are placed long in an environment with a temperature given, will reach the same temperature,confusion with the meaning of words like 'heat', 'heat flow' or 'heat capacity', mixing hot and cold water lead to correct qualitative judgements but incorrect quantitative judgements,difficulty explaining how a thermometer works (Gönen & Kocakaya, 2010; Kampeza et al., 2016; Ravanis, 2013; Tytler, 2000)

METHODS

Design of Study

The design used in this research was Quasi-experimental with *Non-equivalent Control Class Design*(Sugiyono, 2014; Tanti et al., 2017). The research was conducted at the X (Ten)IPA 1 and X (Ten) IPA 2 class of SMAN 1 Kotabumi North Lampung**.** The study was implemented in three phases (pre-test, teaching interventions in an experimental group and a control group and post-test). The data of the study consisted of student's responses to objective tests in the form of multiple choices equipped with the reason for the answers.Multiple choices testcan show the concept understanding's characteristics on students(Pratiwi, 2016), and the ability of students in answering the question. Before the instruments were used, the questions were tested to find out the validity level, reliability, difficulty level, discrimination power, and destruction functions. The questions that have been tested are used to obtain student learning outcomes for grade XI of SMA Negeri 1 Kotabumi (Senior High School 1 Kotabumi).

Participants

The sampling technique employed was Cluster Sampling (Suharsimi, 2010). The samples of this research were male and female students (age range 15-16 years old). The chosen studentshad similar socio-economic characteristics and were randomly divided into two groups, thus forming the experimental class (hereafter E.C.) and control class (hereafter C.C.) respectively.

Teaching Interventions

The Experimental Class

The learning stage of 7E Learning Cycle modelcan be seen in Figure 1:

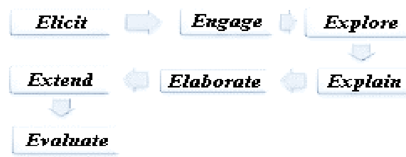


Figure 1. The Stages of 7E Learning Cycle Model.

The Researchers applied the sevenstages of 7E Learning Cycle model during the teaching and learning activity. The first stage was Elicit to raise the student's initial knowledge by asking questions as displayed in Figure 2;

Zero Kelvin is Known as the absolute zero temperature. What is the definition of absolute zero temperature ?

Figure 2. The first Stage: Elicit.

The students responded enthusiastically when they were givensuchaquestion. They were willing to present the answer in front of the class. Thus, it brought about the impact of active classroom atmosphere at the beginning of the learning process.

The second stage was to Engage. It was involving the students with the surrounding events related to the temperature material by carrying out the demonstration as displayed in figure 3.

Comment [U5]: Need more details. To whom? What is the general trend (for example UN data)?

Comment [U6]: this should be in the begining section

Comment [U8]: Are you sure this question is "initial knowledge question"?

Comment [U9]: This is a claim that requires proof (it should be in the results), not in the method.

Comment [U7]: How was this technique applied?

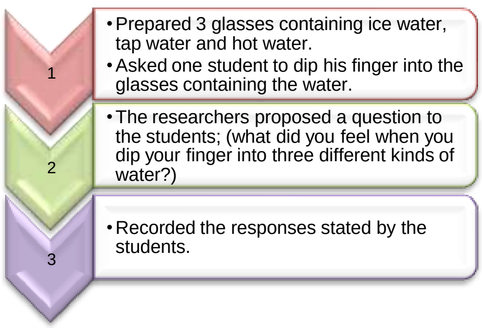


Figure 3. The Second Stage: Engage.

The results of the demonstration were able to stimulate the students in order to answer each question of the demonstration. Besides, it could attract students' attention to focus on the learning process.

The third stage was to Explore. This was thestage of collecting information. The procedure can be seen in the following figure4,

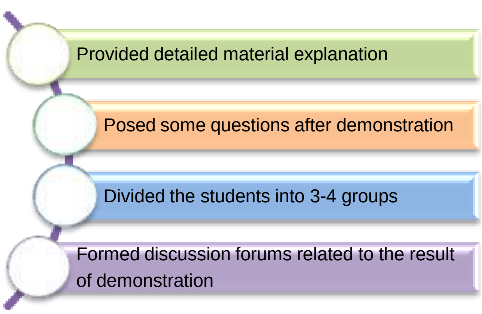


Figure 4. The Third Stage: Explore.

It was expectedthat based on the information-gathering stage the students were able to understand the material in detail.

The fourthstage was to Explain. The students were required to explain the results of the discussion by using their way tounderstand the material indicating the level of student' understanding, has appeared in the following figure5,

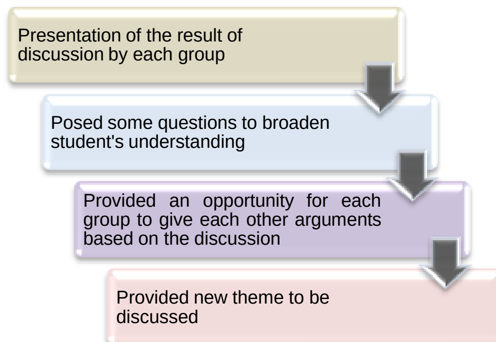


Figure 5. The Fourth Stage: Explain.

The fifth stage was Elaborate. Elaborate was the proficiency stage for the researchers and the students to connect previously learned concepts with daily life. It can be seen in figure 6.

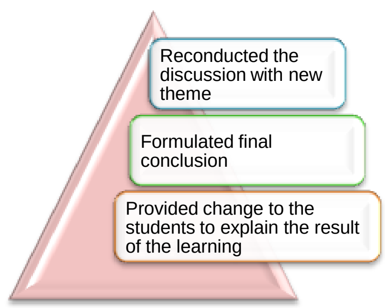


Figure 6. The Fifth Stage: Elaborate.

In this stage, the students re-conducted the discussion to acquire new findingsin order to overcome different problems and concepts and to produce theconclusionthatwas correct and clear.

The sixth stage was to Extend. The result of the students' findings was extended to enable the students to be more active and interested in searching for new concepts as displayed in figure 7.

Comment [U10]: This is the results, which should not be stated here. Instead, it requires the explanation of supporting data

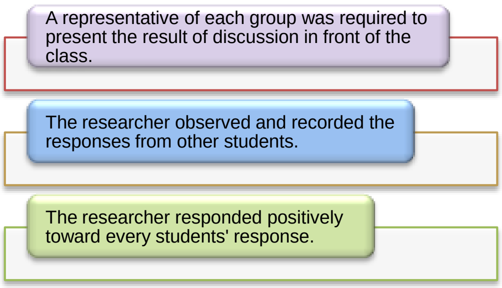


Figure 7. The sixth Stage: Extend.

The seventh stage was to Evaluate. The students were given opportunities to conclude everything related to the material that had been studied. Then, an evaluation was carried out in order to gain adeeper understanding of the concept of the temperature material by giving thetask to the students. One of the conceptual understanding problems can be seen in the following figure8,

Look at the following Images:

The three images above are liquid which are heated with the same amount of heat. If the density of each liquid is different, namely ρ1 <ρ 2 <ρ 3, then the correct statement regarding the temperature rise is...

a. Figure 1 has the fastest temperature rise
b. Figure 2 has the fastest temperature rise
c. Figure 3 has the fastest temperature rise
d. Figure 1 has the lowest temperature rise
e. Figure 2 has the lowest temperature rise

Figure 8. The Seventh Stage: Evaluate.

COMMENT:

In the final step of the seventh stage, the researcher conveyed information about the next material that will be studied so the students should learn before the material is delivered.

The learning process through the 7E Learning Cycle model requires time accuracy considering its numerous stages. Time is one of the keyfactors in implementing this learning model. Furthermore, to achieve the learning objectives, this learning model should be done in complete seven stages, if only two stages were done or skipping even a stage, then the implementation of this learning model will not be optimum.

The control classes

The learning process in the control class wasconducted using Direct Learning Model whichis commonly used by physics teachers. Researcher only deliverd the lesson by writing the material on the whitwboard. The whole process of learning was focused on the teacher/researcher (teacher center). The students responded passively and only listened to the researcher explained. It resulted in a lack of understanding of the concepts of the material; consequently, the students were having difficulty in solving some of the physics problems on temperature and heat materials.

The research questions

Based on the research design presented, we formulated two research questions.

With the first research question, we ask if the students of the experimental class (who took part in a 7E teaching intervention) would be able to better understand the thermal concepts and phenomena, compared to the children in the control class (who participated in a Direct Learning Model.

With the second research question, we ask we ask whether students of both groups progress after the two didactic interventions.

Data analysis

Research Instrument and its development the students' understanding of the concepts were measured through pre-test and post-test using objective test in the form of multiple choices equipped with the reason for the answers. Each test consisted of 15 items. Since the original version of the tests was the only multiple-choice format, then modification was carried out by asking the students to provide a reason for choosing the answer.

To investigate the effectiveness of learning toward the students' understanding of the concepts, the Effect Size test was used. Effect Size is a measurement to determine

Comment [U11]: They are completely separate concepts. **Density** is how much mass there is in a unit volume. **Specific heat** is how much **heat** it takes to raise the temperature of a unit mass by a unit degree of temperature.

Is there a relationship between the density of a substance with specific heat?

Are things that are of small density and so are the specific heat small?

You experience misconceptions

Comment [U12]: Based on the questions in Figure 8, I am not sure about the truth of the concept of the questions you developed.

the effect of one variable on another. Effect Size can be counted using a particular formula(Cohen, 1998), and further explanation of it is also available(Anwar et al., 2019; Hake, 1998).

$$d = \frac{m_A - m_B}{\left[\frac{(sd_A^2 + sd_B^2)}{2}\right]^{1/2}}$$

Definition:

d	= *effect size*
m_A	=mean gain of the experimental class
m_B	= mean gain of control class
sd_A	=standard deviation of experimental class
sd_B	= standard deviation of control class

The value of Effect Size can be seeninTable 1, as follows:

Table 1. Effect Size Criteria.

Effect Size	**Category**
d < 0.2	Low
0.2 ≤ d < 0.8	Average
d ≥ 0.8	High

RESULT AND DISCUSSION

The data display of pre-test and post-test score recapitulation of the control and experimental class can be seen in table 2,

Table 2. The Pre-Test and Post-Test Score of the Control and Experimental Class

Indicator of Concept Understanding	Pretest				Posttest			
	Experimental Class*		Control Class**		Experimental Class*		Control Class**	
	Highest Score	Lowest Score	Highest Score	Lowest Score	Highest Score	Lowest Score	Highest Score	Lowest Score
Interpreting	71	70	41	40	95	83	72	62
Modeling	72	70	40	38	94	80	70	63
Predicting	70	69	35	32	89	82	65	60
Explaining	70	68	32	30	90	80	66	61
Classifying	65	64	31	29	97	79	62	58
Comparing	64	62	30	28	94	78	68	59
Summarizing	62	60	31	30	92	78	66	57
The Highest and Lowest Total Score	474	463	240	227	651	560	469	420
The Highest and Lowest Average Score	68	66	34	32	93	80	67	60
Total Score	1.986,4		1.880		3.113,2		2.820	
Number of Students	40		40		40		40	
Total Average Score	49,66		47		77,83		70,5	

*Learning cycle 7e model **Conventional model

Comment [U13]: These two classes are NOT EQUAL, it seems that the ability of the control class is much lower than that of the experiment (which also affects the N-gain; intellectually high people more easily improve their learning outcomes

The pretest and posttest shown in Table 2 were measured through a multiple-choice test of concept understanding (example figure 8). The scores measured in this study are cognitive scores according to the blooms' taxonomy that includes cognitive 2, 3, 4 and 5 (C2, C3, C4, C5). There are seven indicators of understanding the concept applied in this study. Table 2 shows that the results of the concept of understanding tests in each indicator change. On the test of understanding the concepts (interpreting), the highest and lowest scores in the experimental class and the control class experienced an increase, both as a result of pretest and posttest. However, the highest and lowest scores in the experimental class are higher compared to the scores in the control class.On the concept understanding test (modeling), the highest and lowest scores in the experimental class and the control class experienced an increase, both the results of the pretest and posttest. However, the highest and lowest scores in the experimental class are higher than the scores in the control class.This significant increase is obtained from the results of Independent-Sample T Test that is shown in table 3:

Table 3. Independent-Sample T Test Results

Independent-Sample T Test	**Pretest**	**Posttest**
Criteria	Sig.(2-tailed) > 0,05	Sig.(2-tailed) < 0,05
Sig.(2-tailed)	0,229	0,000

Decision	H_0 is accepted	H_a is accepted

Based on table 3, it is shown that in pretest we got Sig.(2-tailed) of 0,229. It means Sig.(2-tailed) > 0,05 so the averagepretest scores in the experimental class is equal to the average pretest scores in the control class. And based on posttest results we got Sig.(2-tailed) of 0,000, it means the average pretest scores in the experimental class is not equal to the average pretest scores in the control class.

On the concept understanding test (predicting), the highest and lowest scores in the experimental class and the control class experienced an increase, both the results of the pretest and posttest. However, the highest and lowest scores in the experimental class are higher than the scores in the control class.

On the concept understanding test (explaining) the highest and lowest scores in the experimental class and the control class experienced an increase, both the results of the pretest and posttest. However, the highest and lowest scores in the experimental class are higher than the scores in the control class.

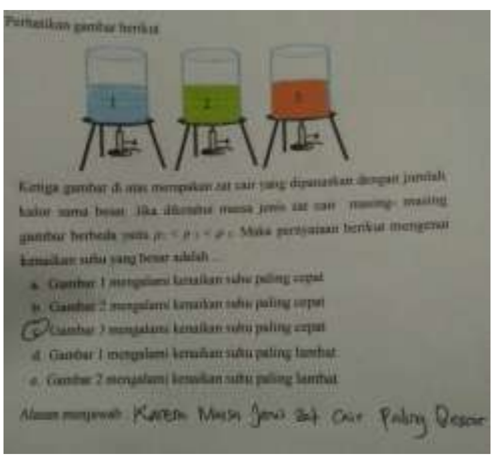
On the concept understanding test (classifying) the highest and lowest scores in the experimental class and the control class experienced an increase, both the results of the pretest and posttest. However, the highest and lowest scores in the experimental class are higher than the scores in the control class.

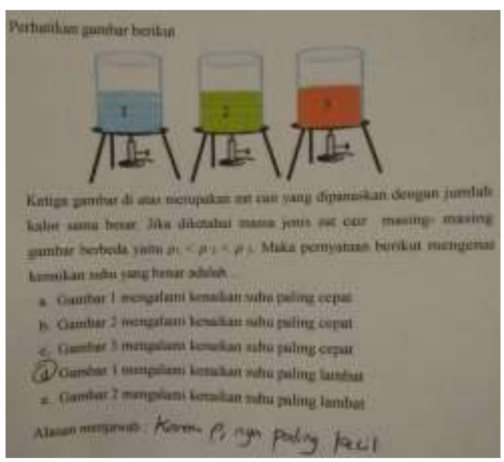
On the concept understanding test (comparing) the highest and lowest scores in the experimental class and the control class experienced an increase, both the results of the pretest and posttest. However, the highest and lowest scores in the experimental class are higher than the scores in the control class.

On the concept understanding test (summarizing) the highest and lowest scores in the experimental class and the control class experienced an increase, both the results of the pretest and posttest. However, the highest and lowest scores in the experimental class are higher than the scores in the control class.

In general, the results of concept understanding tests on each indicator experienced an increase in both the experimental class and the control class. However, before applying the learning cycle 7e model, there was no significant difference in the understanding of the concepts of the experimental class students. However, after the implementation of the learning cycle 7e model, the scores of the experimental class were significantly improved. Based on the results of the analysis of each student's answers, the understanding of their concepts had not been trained when answering the conceptual understanding questions in the form of multiple choices when they choose the answer (Figure 9). In contrast to the results after applying the learning cycle 7e model and the conventional model, there are significant differences in the understanding of the concepts in the experimental class and the control class. In the experimental class, the answer is more appropriate than the control class (Figure 10).

Comment [U14]: There is no process data (how learning takes place), so claims for improvement are not supported by process data.

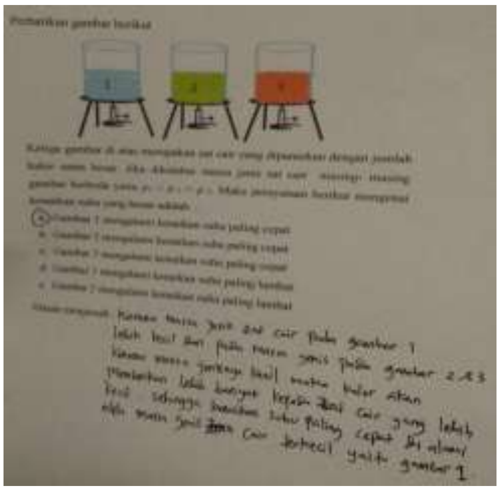


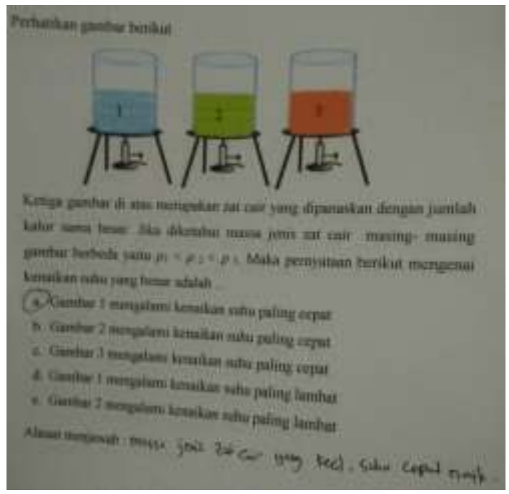


(a) Learning Cycle 7e Model (b) Conventional Model

Figure9.Before the Application of Learning Cycle 7e and the Conventional Model

Comment [U15]: See my comment on Fig 8





(c) Learning Cycle 7e Model (d) Conventional Model

Figure 10.After the Application of Learning Cycle 7e and the Conventional Model

Comment [U16]: See my comment on Fig 8

In addition to the results of cognitive scores, the management of learning is also the key to the successful implementation of the learning model. The following is the explanation of the learning management in this study.

Learning Management

The scoring percentage given by the physics teacher while the researcher was applying the learning model can be seen in the following figure 11,

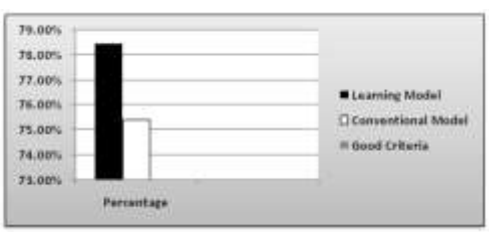


Figure 11. Graphic Percentage of Learning Management.

Based on figure 11, the gain percentage shows that the learning management through 7e Learning Cycle was 78.46% compared to the conventional learning amounting 75.38%. The percentage falls into satisfying criteria.Improvement can occur because the teacher applied the learning cycle 7e systematically. In the class that the learning cycle 7e model was applied, the teacher started the lesson by eliciting knowledge and involving students through engaging demonstrations. In the class that the conventional model was applied, the teacher started the lesson by psychologically preparing the students through stories without demonstrations or involving the students.

The core activity in learning cycle 7e model begins with the grouping to discuss the continuation of the demonstration by changing the object of the demonstration and discussion finding solutions to the questions given by the teacher (explore). Then each group conducts a presentation by explaining the results of the discussion (explain), the teacher gives feedback to each group to expand the discussion material in the group through question and answer between groups (elaborate & extend). In the class that applies conventional models, the core activity begins with the teacher explaining the material then the teacher forms a group to observe events related to the material in daily life. Then students are asked to communicate the material through assignments.

The closing activity in the learning cycle 7e model is ended by asking each group to conclude the results of the discussion and the teacher concludes the overall results of the discussion. The closing activity in the conventional model is ended by giving homework.

Based on the description of learning management, the learning cycle 7e model is a student-centered model. The teacher only acts as a facilitator in learning while the conventional model is still a teacher-centered model. The curriculum in Indonesia is the 2013 curriculum which emphasizes student-centered learning. In addition, other countries such as Finland, England, the United States, and other developed countries also implement student-centered learning which is more effective than teacher-centered learning.

The effectiveness of the application of the learning model is analyzed with effect size formula. Further description is shown in Table 3.

Table 4. The Result of Effect Size.

Class	Mean Gain	Standard Deviation	Effect Size	Category
Experiment	28,17	36,64	0,5	Average
Control	23,50	137,72		

Table 4 shows that the gain of effect size is 0.5 in the average category. This shows that the use of the 7E Learning Cycle model could effectively improve students' understanding of concepts in Physics subjects.

Based on the recapitulation of the post-test scores, both the experimental and the control class of the students' conceptual understanding have increased significantly. This might be caused by the fact that the7E Learning Cycle model has such distinctive characteristics that the students not only listen to the teachers but can also play an active role in exploring and enriching their understanding of the concepts learned.

The importance of understanding the concept of learning in school requires researchers to use various ways to analyze and improve understanding of concepts, including: increasing mastery of concepts through interactive multimedia(Husein et al., 2015), improving understanding of concepts through 7e learning cycle for junior high school students(Nurmalasari et al., 2014), improving understanding of concepts by utilizing PhET Simulation (Saregar, 2016), increasing understanding of concepts through the application of guided inquiry learning model(Setyawati et al., 2016), increasing understanding of concepts through the application of experiential learning models (Wahyuningsih, 2014)and understanding analysis of concepts through TTCI and CRI instruments (Yolanda et al., 2016).

This study supports Nurmalasari's research that the learning cycle 7e model can improve concept understanding. In the Nurmalasari study, the learning cycle 7e model was applied to the junior high school students, but in this study, it was applied to senior high schools students. It means that the learning cycle 7e model can improve concept understanding to both junior and senior high school students

The findings of this study indicate that the use of the learning cycle model 7e was able to improve the mastery of the concept of the learners effectively. In this paper, the procedures of the learning cycle model 7e in the classroom are discussed in detail and thoroughly.

CONCLUSION

In short, it can be concluded that the use of 7E Learning Cycle Model is effective in improving students' conceptual understanding. In other words, the learning process through 7E Learning Cycle Model was more effective compared to the conventional model in improving the students' concept understanding, especially on temperature and heat subject matte. This is because each learning process truly integrates the 7 stages of the 7e learning cycle model with the 7 indicators of conceptual understanding that must be achieved by students, so that the use of the learning cycle 7e model is effective and is able to increase students' conceptual understanding.

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JPII 8 (4) (2019) PAGES

Jurnal Pendidikan IPA Indonesia

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THE 7E LEARNING CYCLE APPROACH TO UNDERSTAND THERMAL PHENOMENA

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DOI: ...

Accepted: ... 2018. Approved: ... 2018. Published: December 2019

ABSTRACT

Conceptual understanding is often a problem in science learning, and this issue has become the point of science education experts, including in Indonesia. Lately, ten articles in Indonesia and six articles in other countries have discussed the model of the 7E Learning Cycle. It was mentioned that this model is able to increase learners' conceptual understanding. This research intended to reveal the effectivity of physics learning using the 7E Learning Cycle in improving students' understanding of temperature and heat concepts. The research design is quasi-experimental with a non-equivalent control group design. The sample was senior high school students. Objective test in the form of multiple choices equipped with reason was employed as the data collection instrument. Based on the data analysis, the value of Effect Size was 0.5 and belonged to the medium category. In other words, the use of the 7E Learning Cycle model is sufficient to improve the learners' understanding of temperature and heat concepts. This could be seen from the success of the learning process that integrates the whole seven stages with the seven indicators of conceptual understanding in detail. Thus, the 7E Learning Cycle could be effectively applied and can increase the students' conceptual understanding.

Keywords: conceptual understanding in physics, direct learning; 7E learning cycle model

INTRODUCTION

The outcome of the physics learning process, among others, is to enable students to comprehend the relevance of physics concepts to be applied in their daily life (Husein et al., 2017; Latifah et al., 2019; Pratiwi & Supardi, 2014). The students' inability to connect one concept to another is a common problem occurring in physics classes (Sagala et al., 2019b; Tanti et al., 2017)non-equivalent control group design with samples were senior high school students grade XI at SMAN 1 Jambi City. The research used the Colorado Learning Atttudes About Science Survey (CLASS. They are more likely to memorize than to understand the concepts (Maharani et al., 2019). nempel

In this case, physics teachers should emphasize the students' understanding of the concepts based on the knowledge acquired in the

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previous level to the next (Widayanti et al., 2018; Yulianti & Gunawan, 2019; Lestari et al., 2017; Wahyuningsih, 2014). The use of varied learning model is needed (Saregar et al., 2018) in order to be an intermediary so that the material taught could be understood by students (Pitan & Atiku, 2017; Sagala et al.,2019a; Widayanti & Yuberti, 2018; Yıldırım & Akamca, 2017)it is crucial for undergraduates to be more pro-active about their future careers. This study investigates the structural influence of career guidance activities on university students' employability in Nigeria. Data was collected from 600 final-year undergraduates from four universities in the South-West geopolitical zone, with the use of an adapted questionnaire. The quantitative data were subjected to exploratory and confirmatory factor analysis to ensure factorial validity of the research instrument, and subsequently structural equation modelling (SEM. Furthermore, at the final stage, it is expected to increase the students' mastery of the concepts (Saregar, 2016).

Some of the research results showed that conceptual understanding is fundamental in learning since concept mastery is the key to solve even the hardest problem (Alan & Afriansyah, 2017; Surosos, 2016). Many learners do not attain favorable learning outtakes. They are not aware of efficient and effective ways of learning because they only try to memorize lessons while Physics does not mean to be memorized as it requires reasoning and understanding of the concept (Lestari et al., 2017; Yuberti et al., 2019). As a result, if they are given a test, the learners will have difficulties (Yolanda et al., 2016). Therefore, conceptual understanding is highly required for the learners to get proper learning outcomes.

Many researchers have conducted many ways to improve students' conceptual understanding. One of which is through learning models and one of the learning models that has been proven in improving students' conceptual understanding is the constructivism (Balta & Sarac, 2016). There are various types of constructivism learning models, such as problem-solving, mind mapping, and 7E learning cycle. In this research, the 7E Learning Cycle model was selected since it provides chances for learners to build their knowledge (Febriana et al., 2014).

7E Learning Cycle model is the improvement of the 5E Learning Cycle model (Ghaliyah et al., 2015). The cycles of the applied learning model are emphasized in the understanding of the scientific physics concepts and misconception correction. Furthermore, it is also expected to be able to ameliorate the students' memorization process that is focused on the knowledge and knowledge transfer (Balta & Sarac, 2016). The learning cycle Approach (LCA) is a model that is deemed adequate for physics students (Olaoluwa & Olufunke, 2015) as it can help them to elaborate their understanding of certain aspects of scientific research (Hodson, 2014; Putra et al., 2018). One of the physics materials that is considered quite difficult for students to understand is temperature and heat (Sayyadi et al., 2016).

The constructivism basis of the 7E Learning Cycle possesses some weaknesses and strengths. One of the notable strengths of the 7E Learning Cycle is its ability to encourage the students to be active and think maximally to acquire the knowledge. On the other hand, the weakness of the 7E Learning Cycle is the length of time needed as the students are trained to explore their knowledge, and they are also given enough freedom to express their ideas. In order to minimize the weakness of this model, proper preparation is certainly required by the teacher acting as a facilitator (Rawa et al., 2016).

The previous researchers showed that the learning cycle could be used to enhance learners' understanding (Nurmalasari et al., 2014) and learning achievement (Sumiyati et al., 2016). Conceptual understanding means expressing the materials learned into a simplified version to overcome the problems of the interconnected concept. The cognitive process of conceptual understanding consists of interpreting, modeling, classifying, summarizing, predicting, comparing, and explaining (Setyawati et al., 2014). One of the factors that determine the the learning process outcome is the students' achievements measured by how much they can master the learning material (Parasamya et al., 2017).

There are some distinctions between this research and the previous ones. Firstly, there is an elaboration of each of the seven prescribed stages of the 7E Learning Cycle model implementation, exposing the pupils' level of understanding presented in the discussion. Besides, this study uses different learning materials, namely temperature and heat, which is very suitable for the object of measuring concept understanding (Damar, 2013). Then, the learning circumstances of this research are also relatively different.

The learning cycle is a learning model centered on learners (Balta & Sarac, 2016). It comprises a series of activities arranged in such a way that learners could master the established competencies in learning with an active role (Ngalimun, 2014; Ratiyani et al., 2014). The 5E Learning Cycle as five stages that consist of Engagement, Exploration, Explanation, Elaboration, and Evaluation. Besides the teaching Model, teaching Material is also required. Teaching Material is a material of learning that is constructed systematically and used by teacher in learning process. The teaching Material could be combined with Technology Information and Communication in order to be a digital teaching Material. The aim of the research is to understand the digital teaching material development and also to check the improvement of student\u2019s study result and the result of study after using digital teaching material and its application in Learning Cycle 5E. The Result of the research shows that the validation test result which uses three validators, shows that 51.6% is in Very Good Category. The student\u2019s result study activity average is 71% in the first meeting and 79,5% in the second meeting. While the average score of the study result of student is 78.13in the first meeting and 82,00 in the second meeting. The learning cycle in the classroom practice focuses on the experience and knowledge of the early learners (Ghaliyah et al., 2015). Is sum, in attaining well-organized students' concept, an organized procedure is needed.

The learning cycle model has been developed from 3E (Exploration, Explanation, Elaboration), 5E (Engagement, Exploration, Explanation, Elaboration, and Evaluation), and 7E (Elicit, Engage, Explore, Explain, Elaborate, Extend, and Evaluate). Some studies suggest that the 7E learning cycle can foster motivation and learning achievement (Febriana et al., 2014; Sumiyati et al., 2016), improve language comprehension (Balta & Sarac, 2016), is sufficient to achieve goals quickly (Bozorgpouri, 2016), improve the ability of mathematical connections (Rawa et al., 2016), and foster conceptual understanding (Nurmalasari et al., 2014). Thus, the researchers consider it is necessary to conduct research to see the effectivity of the 7E Learning Cycle in improving the students' conceptual understanding of the temperature and heat topic.

The results of the earlier quantitative and qualitative research on the understanding of the thermal concepts and phenomena showed that the majority of children do not master the concepts and the related phenomena even after receiving formal instruction on these subjects (Karabulut & Bayraktar, 2018). There is a confusion between the concepts "heat" and "temperature," and often they think that temperature is a measure of the heat.

Temperature is an intrinsic property of matter; it is hot and cold objects by nature. The warm and the cold are two separate entities, all materials if placed protractedly in an environment will reach the same temperature. Confusion with the meaning of words like 'heat', 'heat flow' or 'heat capacity', mixing hot and cold water has led to correct qualitative judgments but incorrect quantitative judgements, and difficulty in explaining how a thermometer works (Gönen & Kocakaya, 2009; Kampeza et al., 2016; Ravanis, 2013).

METHODS

Design of Study

The design used in this research was Quasi-experimental with *Non-equivalent Control Class Design* (Suharsimi, 2010; Sugiyono, 2010; Tanti et al., 2017). The research was conducted at the X IPA 1 and X IPA 2 class of SMAN 1 Kotabumi, North Lampung. The study was implemented in three phases (pre-test, teaching interventions in an experimental group and a control group, and post-test). The data of the study consisted of student responses to objective tests in the form of reasoned-multiple choices, which are able to show the characteristics of students' conceptual understanding (Pratiwi, 2016) and the ability of students to answer the question. Before the instruments were used, the questions were tested to find out the validity level, reliability, difficulty level, discriminating power, and destruction functions.

The subject of this research was learners of grade X IPA in SMA Negeri 1 Kotabumi (amounted to 240 students). Employing the cluster random sampling technique, the researchers chose 80 students from class X IPA 1 and X IPA 2.

The samples of this research were male and female students (age range 15-16 years old). The chosen students had similar socio-economic characteristics and were randomly split into two groups, thus forming the experimental class (hereafter E.C.) and control class (hereafter C.C.), respectively.

Teaching Interventions (The Experimental Class)

The learning stage of 7E Learning Cycle can be seen in Figure 1.

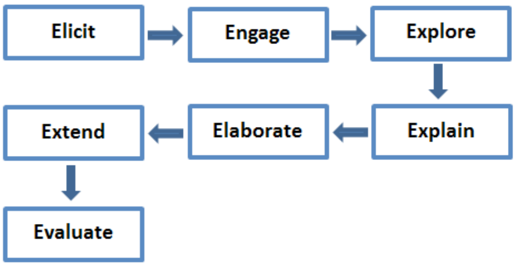


Figure 1. The Stages of the 7E Learning Cycle

Researchers applied the seven stages of the 7E Learning Cycle model during the teaching and learning activity. The first stage was Elicit to raise the student's initial knowledge by asking questions as displayed in Figure 2.

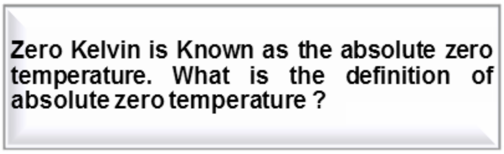


Figure 2. The First Stage: Elicit.

The second stage was to Engage. It was involving the students with the surrounding events related to the temperature material by carrying out the demonstration, as displayed in figure 3.

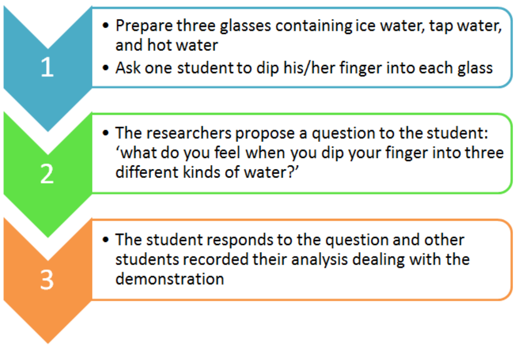


Figure 3. The Second Stage: Engage

The third stage was to Explore. This was the stage of collecting information. The procedure can be observed in the following figure 4.

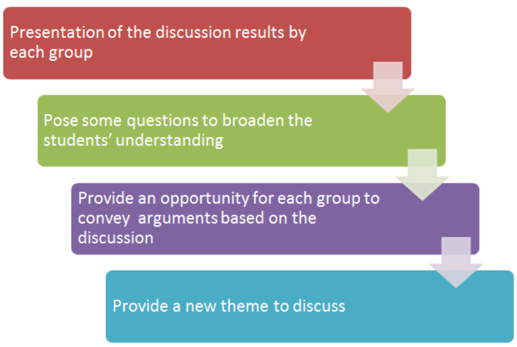


Figure 4. The Third Stage: Explore

It was expected that based on the information-gathering stage, the students were able to grasp the materials in detail.

The fourth stage was to Explain. The students were required to explain the results of the discussion by using their way to understand the material indicating the level of student' understanding, has appeared in the following Figure 5.

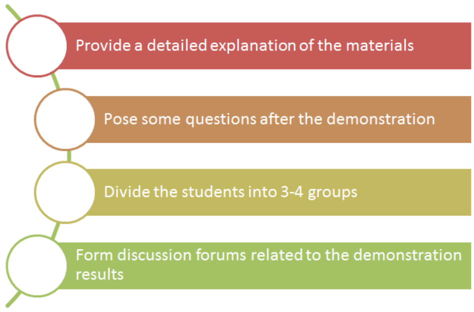


Figure 5. The Fourth Stage: Explain

The fifth stage was Elaborate. Elaborate was the proficiency stage for the researchers and the students to connect previously learned concepts with daily life. It can be seen in figure 6.

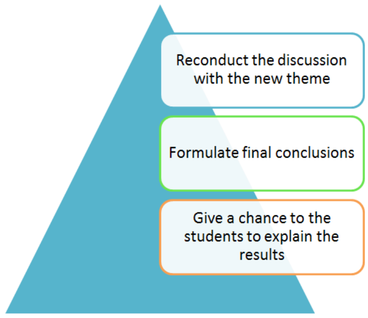


Figure 6. The Fifth Stage: Elaborate

In this stage, the students re-conducted the discussion to acquire new findings in order to overcome different problems and concepts and to produce the correct and clear conclusion.

The sixth stage was to Extend. The students' findings was extended to enable them to be more active and interested in searching for new concepts, as displayed in figure 7.

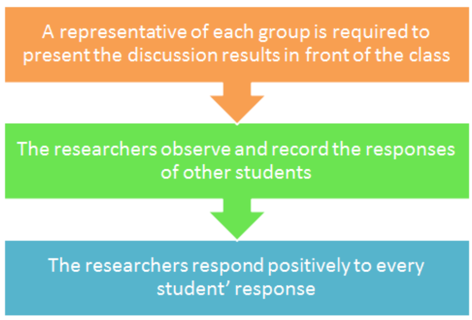


Figure 7. The sixth stage: Extend

The seventh stage was to Evaluate. The students were given opportunities to conclude everything related to the materials that had been studied. Then, an evaluation was carried out to obtain a profound understanding of the concept of the temperature by giving the task to the students. One of the conceptual understanding problems can be viewed in the following Figure 8.

Look at the following Images:

The three containers are filled with liquid and heated with the same amount of heat. If the volume of each liquid is the same, and the density is different, namely $\rho_1 < \rho_2 < \rho_3$. Then the correct statement regarding the temperature rise is ...

a. Figure 1 has the most significant temperature rise

b. Figure 2 has the most significant temperature rise

c. Figure 3 has the most significant temperature rise

d. Figure 1 has the lowest temperature rise

e. Figure 2 has the lowest temperature rise

Figure 8. The Seventh Stage: Evaluate

In the final step of the seventh stage, the researcher conveyed information about the next materials that will be studied so the students should learn before the materials are delivered.

The learning process through the 7E Learning Cycle requires time accuracy considering its numerous stages. Time is one of the key factors in implementing this learning model. Furthermore, to achieve the learning objectives, this learning model should be done in complete seven stages. If only two stages were done or a stage is skipped, then the implementation of this learning model will not be optimum.

Teaching Interventions (The Control Class)

The learning process in the control class was conducted using Direct Learning Model, which is commonly used by physics teachers. The researcher only delivered the lesson by writing the materials on the whiteboard. The whole process of learning was focused on the teacher/researcher (teacher center). The students responded passively and only listened to the researcher explained. It resulted in a lack of conceptual understanding; consequently, the students faced difficulty in solving some of the physics problems on the topic.

Based on the research design presented, we formulated two research problems: (1) how is the experimental class students' understanding of the thermal concept compared to the control class students'?; and (2) how is both groups' progress after the two educational interventions are performed?

The students' understanding of the concepts were measured through pre-test and post-test using objective test in the form of reasoned-multiple choices. Each test consisted of 15 items. Since the original version of the tests was the only multiple-choice format, then modification was carried out by asking the students to provide a reason for choosing the answer.

To go into the effectiveness of learning toward the learners' mastery of the concepts, the Effect Size test was used. It is a measurement to determine the effect of one variable on another. The effect Size can be counted using a particular formula (Cohen, 1998), and further explanation of it is also available (Anwar et al., 2019; Hake, 1998).

$$d = \frac{m_A - m_B}{\left[\frac{sd_A^2 + sd_B^2}{2}\right]^{½}}$$

Definition:

d = *effect size*

m_A = mean gain of the experimental class

m_B = mean gain of the control class

sd_A = standard deviation of experimental class

sd_B = standard deviation of the control class

The value of Effect Size can be seen in Table 1, as follows.

Table 1. Effect Size Criteria

Effect Size	Category
$d < 0.2$	Low
$0.2 \leq d < 0.8$	Average
$d \geq 0.8$	High

RESULTS AND DISCUSSION

The data display of pre-test and post-test score recapitulation of the control and experimental class can be seen in Table 2.

Table 2. The Pre-Test and Post-Test Score of the Control and Experimental Class

Indicator of Conceptual Understanding	Pretest				Posttest			
	Experimental Class*		Control Class**		Experimental Class*		Control Class**	
	Highest Score	Lowest Score	Highest Score	Lowest Score	Highest Score	Lowest Score	Highest Score	Lowest Score
Interpreting	71	41	70	40	95	72	83	62
Modeling	72	40	70	38	94	70	80	63
Predicting	70	35	69	32	89	65	82	60
Explaining	70	32	68	30	90	66	80	61
Classifying	65	31	64	29	97	62	79	58
Comparing	64	30	62	28	94	68	78	59
Summarizing	62	31	60	30	92	66	78	57
The Highest and Lowest Total Score	474	240	463	227	651	469	560	420
The Highest and Lowest Average Score	68	34	66	32	93	67	80	60
Total Score	1.986,4		1.880		3.113,2		2.820	
Number of Students	40		40		40		40	
Total Average Score	49,66		47		77,83		70,5	

*Learning cycle 7e model **Conventional model

The pretest and posttest shown in Table 2 were measured through a multiple-choice test (example figure 8). The scores measured in this study included cognitive scores according to the blooms' taxonomy comprising cognitive 2, 3, 4, and 5 (C2, C3, C4, C5). There were seven indicators of conceptual understanding applied in this study. Table 2 indicates the outcomes of conceptual understanding tests in each indicator change. On the Interpreting, the highest and lowest scores in the experimental and the control class experienced an elevation, both as a result of pretest and posttest. Nonetheless, the highest and lowest scores in the experimental class were higher compared to the scores in the control class.

On the Modeling, the highest and lowest scores in the experimental and the control class experienced an increase, both the results of the pretest and posttest. However, the highest and lowest scores in the experimental class were higher than the scores in the control class. This significant increase was obtained from the results of Independent-Sample T-test that is shown in table 3.

Table 3. The Independent-Sample T-Test Results

Independent-Sample T-Test	Pretest	Posttest
Criteria	Sig.(2-tailed) > 0,05	Sig.(2-tailed) < 0,05
Sig. (2-tailed)	0,229	0,000
Decision	H_o is accepted	H_a is accepted

Table 3 informs that in the pretest, we got Sig. (2-tailed) of 0,229. It means Sig. (2-tailed) > 0,05; thus, the average pretest scores in the experimental class was equal to the average pretest scores in the control class. Furthermore, based on posttest results, we got Sig. (2-tailed) of 0,000, it means the average pretest scores in the experimental class was not equal to the average pretest scores in the control class.

On the Predicting, the highest and lowest scores in the experimental and the control class experienced an enhancement at both the results of the pretest and posttest. However, the highest and lowest scores in the experimental class were greater than the scores in the control class.

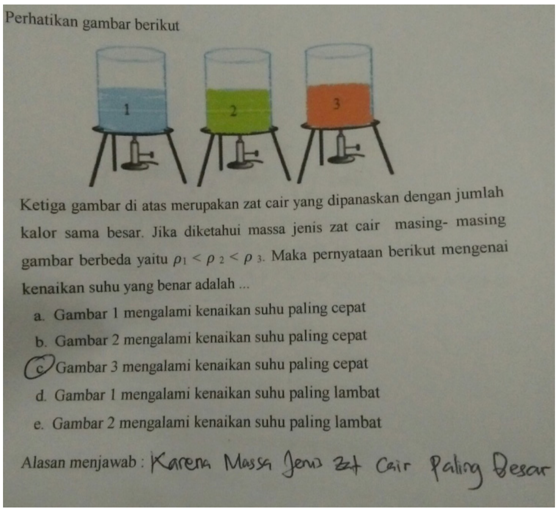
On the Explaining, the highest and lowest scores in the experimental class and the control class experienced an increase, both the results of the pretest and posttest. Nevertheless, the highest and lowest scores in the experimental class are higher than the scores in the control class.

On the Classifying, the highest and lowest scores in the experimental cand the control class experienced an upswing, both the results of the pretest and posttest. However, the highest and lowest scores in the experimental class were higher than the scores in the control class.

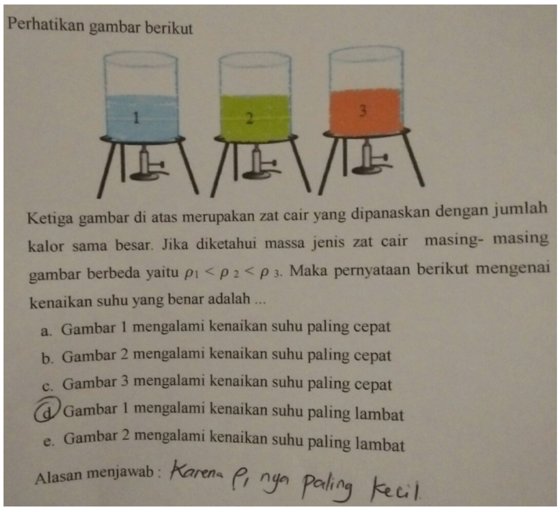
On the Comparing, the highest and lowest scores in the experimental class and the control class experienced an increase, both the results of the pretest and posttest. Nevertheless, the highest and lowest scores in the experimental class were higher than the scores in the control class.

On the Summarizing, the highest and lowest scores in the experimental class and the control class experienced an increase, both the results of the pretest and posttest. However, the highest and lowest scores in the experimental class were more significant than the scores in the control class.

In general, the results of concept understanding tests on each indicator experienced an increase in both the experimental class and the control class. Yet, before applying the 7E Learning Cycle, there was no notable difference of the experimental class learners' understanding of the concepts. Nonetheless, after the implementation of the 7E Learning Cycle model, the scores of the experimental class students were significantly improved. Based on the analysis result of each student's answers, their conceptual understanding had not been trained when answering the conceptual questions in the form of multiple choices when they chose the answer (Figure 9). The results changed after applying the 7E Learning Cycle and the conventional model, as there were significant differences between the conceptual understanding of the experimental and the control class. The answer of experimental class students was more appropriate than the control class students (Figure 10).

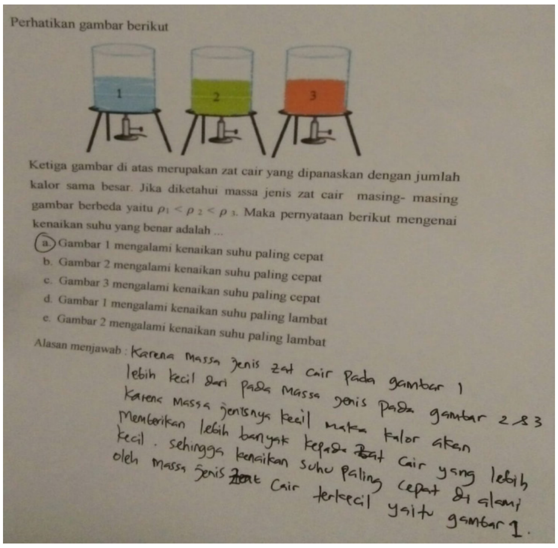


(a) The 7E Learning Cycle

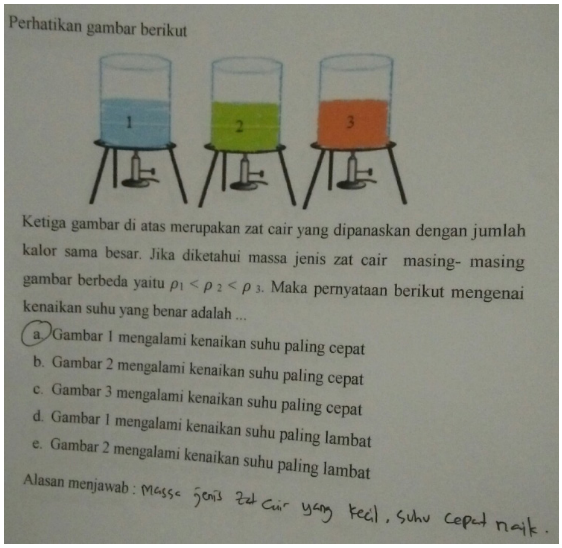


(b) The Conventional Model

Figure 9. The Student Answer before the Implementation of the 7E Learning Cycle and the Conventional Model



(a) The 7E Learning Cycle



(b) The Conventional Model

Figure 10. The Student Answer after the Application of the 7E Learning Cycle and the Conventional Model

In addition to the cognitive score results, the management of learning is also the key to the learning model's successful implementation. The following is an explanation of the learning management in this study.

Learning Management

The scoring percentage given by the physics teacher while the researcher was applying the learning model can be seen in the following figure 11.

Figure 11. Graphic Percentage of Learning Management

Based on Figure 11, the gain percentage showed that the learning management through 7E Learning Cycle was 78.46% compared to the conventional learning which amounted to 75.38%. The percentage fell into satisfying criteria, and this improvement occurred due to sistematic implementation of the 7E Learning Cycle by the teacher. In the class where the 7E Learning Cycle was applied, the teacher started the lesson by eliciting knowledge and involving students through engaging demonstrations. In the Elicit step, the students responded enthusiastically when the teacher gave a question to raise students' initial knowledge. They were willing to present the answer in front of the class and thus brought about the impact of an active classroom atmosphere at the beginning of the learning process. In the class where the conventional model was applied, the teacher started the lesson by psychologically preparing the students through stories without demonstrations or involving the students.

The core activity in the 7E Learning Cycle began with the grouping to discuss the continuation of the demonstration by changing the object of the demonstration and discussion to find solutions to the questions given by the teacher (explore). Then, each group conducted a presentation by explaining the results of the discussion (Explain). On the other hand, the teacher gave feedback to each group to expand the discussion materials in the group through question and answer between groups (Elaborate & Extend). In the class applying the conventional model, the core activity began with the teacher explaining the materials then forming a group to observe events related to the materials in daily life. Next, the students were asked to communicate the materials through assignments.

The closing activity in the 7E Learning Cycle was asking each group to conclude the discussion results, and the teacher concluded the overall results of the discussion. Diversely, the closing activity in the conventional learning was giving homework.

Based on the learning management description, the 7E Learning Cycle is student-centered while the teacher only acts as a facilitator. Contrarily, the conventional model is still teacher-centered. Thus, the 7E Learning Cycle is in line with the current 2013 curriculum applied in Indonesia which emphasizes student-centered learning. Other countries such as Finland, England, the United States, and other developed countries also implement student-centered learning, which is more effective than teacher-centered learning.

The effectiveness of the learning model implementation was analyzed with effect size formula. A further description is presented in Table 3.

Table 4. The Results of Effect Size

Class	Mean Gain	Standard Deviation	Effect Size	Category
Experimental	28,17	36,64	0,5	Average
Control	23,50	137,72		

Table 4 shows that the gain of effect size was 0.5 and belonged to the average category. This shows that the use of the 7E Learning Cycle model could effectively improve the students' understanding of Physics concepts.

Based on the recapitulation of the post-test scores, the students' conceptual understanding, in both the experimental and the control class, increased significantly. This might be caused by the fact that the 7E Learning Cycle model has such distinctive characteristics that the students not only listen to the teachers but can also play an active role in exploring and enriching their comprehension of the concepts studied.

The importance of conceptual understanding in school requires researchers to use various ways to analyze it including: (1) the use of interactive multimedia (Husein et al., 2017); (2) the realization of the 7E Learning Cycle for junior high school students (Nurmalasari et al., 2014); (3) the utilization of PhET Simulation (Saregar, 2016); (4) the application of guided inquiry learning model (Setyawati et al., 2014); (5) the application of experiential learning models (Wahyuningsih, 2014); and (6) the use of TTCI and CRI instruments (Yolanda et al., 2016).

This study supports Nurmalasari et al.'s (2014) research that the 7E Learning Cycle could improve students' conceptual understanding. In the study, the 7E Learning Cycle was applied to the junior high school students, but in this study, it was applied to senior high schools students. It means that the model could improve both junior and senior high school students' conceptual understanding.

CONCLUSION

In short, the use of the 7E Learning Cycle is successful in enhancing students' conceptual understanding. In other words, the learning process through 7E Learning Cycle Model is more effective compared to the conventional model in escalating the students' concept understanding, especially on temperature and heat topic. This is because each learning process truly integrates the seven stages of the 7E Learning Cycle with the seven indicators that must be achieved.

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JPII 8 (4) (2019)

Jurnal Pendidikan IPA Indonesia

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APPROACHING THE UNDERSTANDING OF THERMAL PHENOMENA USING 7E LEARNING CYCLE

Abstract

Conceptual understanding is often a problem in science learning, and this problem has become the focus of science education experts including in Indonesia. Lately, ten articles in Indonesia and six articles in other countries have discussed the model of 7E Learning Cycle. It was mentioned that this model is able to increase the understanding of learners' concept. This research is aimed to reveal the effectiveness of physics learning using 7E Learning Cycle model after being reviewed with control classes in improving students' understanding of temperature and heat concepts. The research design is quasi-experimental with non-equivalent control group design. The sample was senior high school students. Objective test in the form of multiple choices equipped with reason was employed as the instrument to collect the data. Based on the data analysis, it was obtained that the value of Effect Size was as much as 0.5 with the medium category. It can be concluded that the use of 7E Learning Cycle learning model is effective to improve learners' understanding of temperature and heat concepts. This can be seen from the success of the learning process that integrates the whole 7 stages of the 7e learning cycle model with the 7 indicators of conceptual understanding in detail. So that the use of the 7E learning cycle model could be effectively used and is able to increase students' conceptual understanding.

Keywords: *Conceptual understanding in physics; Direct Learning; 7E Learning Cycle model*

INTRODUCTION

The outcome of the physics learning process, among others, is to enable the students to understand the relevance of physics concepts so the students can apply the knowledge in their daily life (Husein et al., 2017; Latifah et al., 2019; Pratiwi & Supardi, 2014). Students' inability to connect one concept to another is a common problem occurring in physics classes (Sagala et al., 2019b; Tanti et al., 2017). Students are more likely to memorize than to understand the concepts (Maharani et al., 2019). In this case, physics teachers should emphasize the students' understanding of the concepts (Lestari et al., 2017; Wahyuningsih, 2014) based on the knowledge acquired in the previous level to the next (Widayanti et al., 2018; Yulianti & Gunawan, 2019). The use of varied learning model is needed (Saregar et al., 2018) in order to be an intermediary so that the material taught could be understood by students (Pitan & Atiku, 2017; Sagala et al.,2019a; Widayanti & Yuberti, 2018; Yıldırım & Akamca, 2017). Furthermore, at the final stage, it is expected to increase the students' mastery of the concepts (Saregar, 2016).

Some of the research results showed that conceptual understanding is very important in learning, since by mastering the concepts, the hardest problem can be solved easily (Alan & Afriansyah, 2017; Surosos, 2016). Many learners do not produce good results in learning. Learners are not aware of efficient and effective ways of learning because they only try to memorize lessons. Physics is not a material to be memorized since it requires reasoning and understanding of the concept (Lestari et al., 2017; Yuberti et al., 2019). As a result, if they are given a test, the learners will have difficulties (Yolanda et al., 2016). Therefore, understanding the concept is needed by every learner. By understanding the concept, it is expected for the learners to get good learning outcomes.

Many researchers have conducted many ways to improve students' concept understanding. One of which is througfh learning models, and one of learning models that proved in improving students' conceptual understanding is constructivism learning model (Balta & Sarac, 2016). There are various types of constructivism learning models such as problem-solving learning model, mind mapping, and 7E learning cycle. In this research, the 7E Learning Cycle model was selected since it provides opportunities for students to build their knowledge (Febriana et al., 2014).

7E Learning Cycle model is the improvement of the 5E Learning Cycle model (Ghaliyah et al., 2015). The cycles of the applied learning model are emphasized in the understanding of the scientific physics concepts and correcting the knowledge misconception. Furthermore, it is also expected to be able to enhance the students' memorization process that is focused on the knowledge and knowledge transfer (Balta & Sarac, 2016). The model of the learning cycle Approach (LCA) is a model that is deemed effective for physics students (Olaoluwa & Olufunke, 2015). It can help them to elaborate their understanding toward certain aspects in scientific research (Hodson, 2014; Putra et al., 2018). One of the physics materials that is considered quite difficult for students to understand is temperature and heat (Sayyadi et al., 2016).

The constructivism basis of the 7E Learning Model possesses some weaknesses and strengths. One of the notable strengths of the 7E Learning Cycle is that it could make the students active since the students are thinking maximally to acquire the knowledge. On the other hand, the weakness of 7E Learning Cycle is the length of time needed in its applicationsince the students are trained to explore their knowledge, and they are also given enough freedom to express their ideas. In order to minimize the weakness of this model, proper preparation is certainly needed by the teacher acting as a facilitator (Rawa et al., 2016).

The previous researchers showed that the Learning Cycle could be used to improve students' understanding (Nurmalasari et al., 2014). It can also be used to improve students' learning achievement (Sumiyati et al., 2016). To understand a concept means to be able to express the material having been learned into a simplified version to overcome the problems of the interconnected concept. The cognitive process of concepts understanding consists of interpreting, modeling, classifying, summarizing, predicting, comparing, and explaining (Setyawati et al., 2014). One of the factors that determine the outcome of the learning process is the students' achievements measured by how much they are able to master the learning material (Parasamya et al., 2017).

There are some distinctions between this research and the previous ones. Firstly, there is an elaboration of each of the seven prescribed stages of the 7E Learning Cycle model implementation exposing the students' level of understanding presented in the discussion. In addition, there is the use of different learning materials, namely temperature and heat which is very suitable for the object of measuring concept understanding (Damar, 2013). Then, the learning circumstances where the subjects of this research study are also relatively different.

Learning cycle is a learning model centered on learners (Balta & Sarac, 2016). Learning cycle consists of a series of stages of activities organized in such a way that learners can master the competencies that must be achieved in learning with an active role (Ngalimun, 2014; Ratiyani et al., 2014). Learning cycle in the classroom practice focuses on the experience and knowledge of the early learners (Ghaliyah et al., 2015), based on the opinions, it can be concluded that the model of learning cycle centered on learners so that learners can actively find their own concept. In order for the learners' concept can be well-organized, an organized procedureis needed.

The development of learning cycle model has been developed from learning cycle 3E (Exploration, Explanation, Elaboration), learning cycle 5E (Engagement, Exploration, Explanation, Elaboration, and Evaluation), and learning cycle 7E (elicit, engage, explore, explain, elaborate, extend, and evaluate). The latest development is the learning cycle 7E.

Some studies suggest that learning cycle 7E can foster motivation and learning achievement (Febriana et al., 2014; Sumiyati et al., 2016), improve language comprehension (Balta & Sarac, 2016, effective to achieve goals quickly (Bozorgpouri, 2016), improve the ability of mathematical connections (Rawa et al., 2016), and foster conceptual understanding (Nurmalasari et al., 2014). So that the researchers consider it is necessary to conduct research to see the effectiveness of the learning cycle 7e model in improving students' conceptual understanding in the temperature and heat material.

The results of the earlier quantitative and qualitative research on the understanding of the thermal concepts and phenomena showed that the majority of children do not master the concepts of heat and temperature and the related phenomena even after receiving formal instruction on these subjects (Karabulut & Bayraktar, 2018). There is a confusion between the concepts "heat" and "temperature," and often they think that temperature is a measure of the heat, temperature is an intrinsic property of matter, they are hot and cold objects by nature, the warm and the cold d are two separate entities, all materials if they are placed long in an environment with a temperature given, will reach the same temperature, confusion with the meaning of words like 'heat', 'heat flow' or 'heat capacity', mixing hot and cold water lead to correct qualitative judgements but incorrect quantitative judgements, difficulty explaining how a thermometer works (Gönen & Kocakaya, 2009; Kampeza et al., 2016; Ravanis, 2013).

METHODS

Design of Study

The design used in this research was Quasi-experimental with *Non-equivalent Control Class Design* ((Sugiyono, 2010; Suharsimi, 2010; Tanti et al., 2017). The research was conducted at the X (Ten) IPA 1 and X (Ten) IPA 2 class of SMAN 1 Kotabumi North Lampung**.** The study was implemented in three phases (pre-test, teaching interventions in an experimental group and a control group and post-test). The data of the study consisted of student's responses to objective tests in the form of multiple choices equipped with the reason for the answers. Multiple choices test can show the concept understanding's characteristics on students (Pratiwi, 2016), and the ability of students in answering the question. Before the instruments were used, the questions were tested to find out the validity level, reliability, difficulty level, discrimination power, and destruction functions. The questions that have been tested are used to obtain student learning outcomes for grade X of SMA Negeri 1 Kotabumi (Senior High School 1 Kotabumi).

Participants

The subject of this research was students of grade X (Ten) IPA in SMA Negeri 1 Kotabumi (amounted to 240 students). With cluster random sampling technique, we chose 80 students from class X (Ten) IPA 1 and X (Ten) IPA 2.

The samples of this research were male and female students (age range 15-16 years old). The chosen students had similar socio-economic characteristics and were randomly divided into two groups, thus forming the experimental class (here after E.C.) and control class (here after C.C.) respectively.

Teaching Interventions

The Experimental Class

The learning stage of 7E Learning Cycle modelcan be seen in Figure 1:

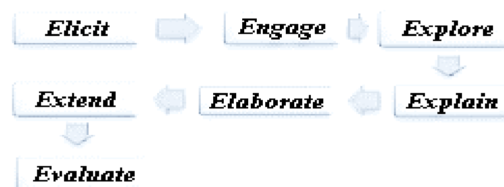


Figure 1. The Stages of 7E Learning Cycle Model.

The Researchers applied the sevenstages of 7E Learning Cycle model during the teaching and learning activity. The first stage was Elicit to raise the student's initial knowledge by asking questions as displayed in Figure 2;

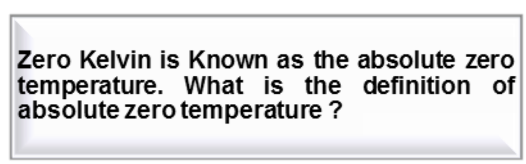


Figure 2. The first Stage: Elicit.

The second stage was to Engage. It was involving the students with the surrounding events related to the temperature material by carrying out the demonstration as displayed in figure 3.

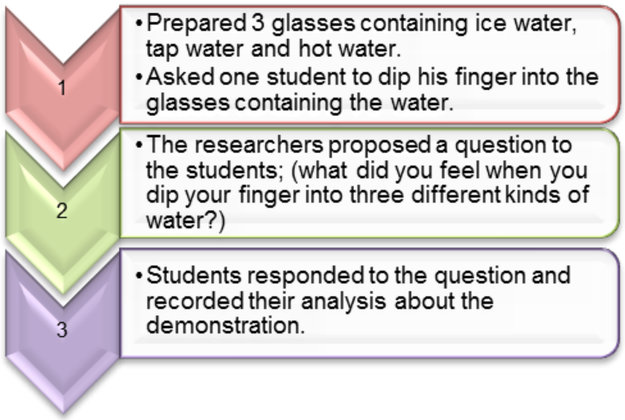


Figure 3. The Second Stage: Engage.

The third stage was to Explore. This was thestage of collecting information. The procedure can be seen in the following figure 4,

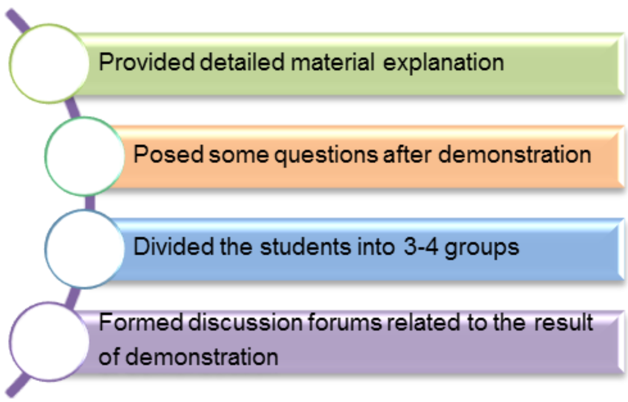


Figure 4. The Third Stage: Explore.

It was expected that based on the information-gathering stage the students were able to understand the material in detail.

The fourthstage was to Explain. The students were required to explain the results of the discussion by using their way tounderstand the material indicating the level of student' understanding, has appeared in the following figure 5,

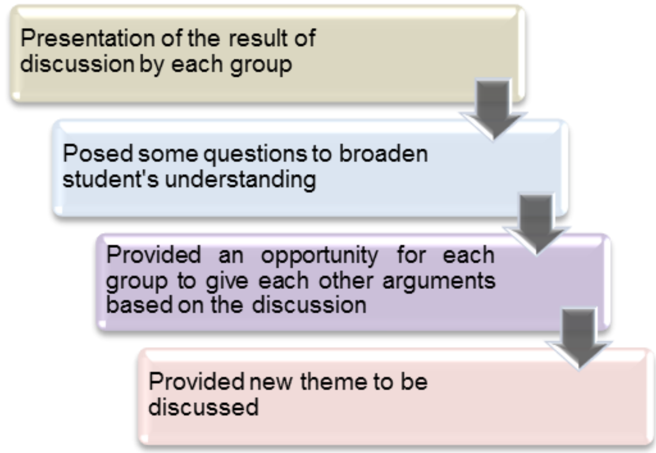


Figure 5. The Fourth Stage: Explain.

The fifth stage was Elaborate. Elaborate was the proficiency stage for the researchers and the students to connect previously learned concepts with daily life. It can be seen in figure 6.

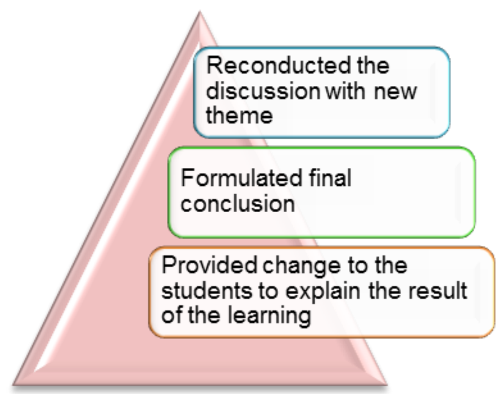


Figure 6. The Fifth Stage: Elaborate.

In this stage, the students re-conducted the discussion to acquire new findingsin order to overcome different problems and concepts and to produce the conclusion that was correct and clear.

The sixth stage was to Extend. The result of the students' findings was extended to enable the students to be more active and interested in searching for new concepts as displayed in figure 7.

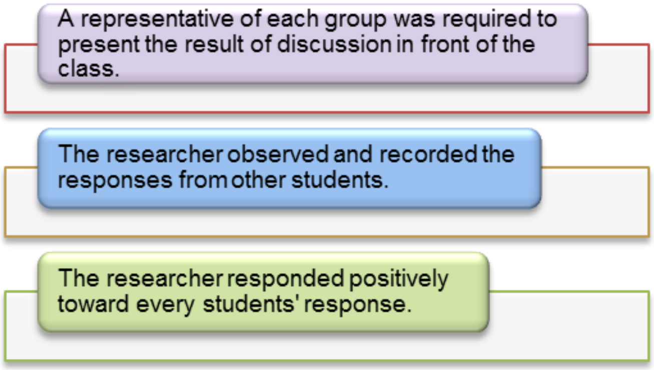
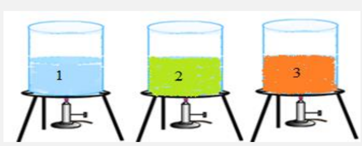


Figure 7. The sixth Stage: Extend.

The seventh stage was to Evaluate. The students were given opportunities to conclude everything related to the material that had been studied. Then, an evaluation was carried out in order to gain a deeper understanding of the concept of the temperature material by giving the task to the students. One of the conceptual understanding problems can be seen in the following figure 8,

Look at the following Images:



The three images above are liquid which are heated with the same amount of heat. If the volume of each liquid is same and the density is different, namely $\rho_1 < \rho_2 < \rho_3$. then the correct statement regarding the temperature rise is...

a. Figure 1 has the biggest temperature rise

b. Figure 2 has the biggest temperature rise

c. Figure 3 has the biggest temperature rise

d. Figure 1 has the lowest temperature rise

e. Figure 2 has the lowest temperature rise

Reason:………………………

Figure 8. The Seventh Stage: Evaluate

In the final step of the seventh stage, the researcher conveyed information about the next material that will be studied so the students should learn before the material is delivered.

The learning process through the 7E Learning Cycle model requires time accuracy considering its numerous stages. Time is one of the key factors in implementing this learning model. Furthermore, to achieve the learning objectives, this learning model should be done in complete seven stages, if only two stages were done or skipping even a stage, then the implementation of this learning model will not be optimum.

The control classes

The learning process in the control class was conducted using Direct Learning Model which is commonly used by physics teachers. Researcher only deliverd the lesson by writing the material on the whitwboard. The whole process of learning was focused on the teacher/researcher (teacher center). The students responded passively and only listened to the researcher explained. It resulted in a lack of understanding of the concepts of the material; consequently, the students were having difficulty in solving some of the physics problems on temperature and heat materials.

The research questions

Based on the research design presented, we formulated two research questions.

With the first research question, we ask if the students of the experimental class (who took part in a 7E teaching intervention) would be able to better understand the thermal concepts and phenomena, compared to the children in the control class (who participated in a Direct Learning Model.

With the second research question, we ask we ask whether students of both groups progress after the two didactic interventions.

Data analysis

Students' understanding of the concepts were measured through pre-test and post-test using objective test in the form of multiple choices equipped with the reason for the answers. Each test consisted of 15 items. Since the original version of the tests was the only multiple-choice format, then modification was carried out by asking the students to provide a reason for choosing the answer.

To investigate the effectiveness of learning toward the students' understanding of the concepts, the Effect Size test was used. Effect Size is a measurement to determine the effect of one variable on another. Effect Size can be counted using a particular formula (Cohen, 1998), and further explanation of it is also available (Anwar et al., 2019; Hake, 1998).

$$d = \frac{m_A - m_B}{\left[\frac{(sd_A^2 + sd_B^2)}{2}\right]^{1/2}}$$

Definition:

d	= *effect size*
m_A	= mean gain of the experimental class
m_B	= mean gain of control class
sd_A	= standard deviation of experimental class
sd_B	= standard deviation of control class

The value of Effect Size can be seenin Table 1, as follows:

Table 1. Effect Size Criteria.

Effect Size	**Category**
d < 0.2	Low
0.2 ≤ d < 0.8	Average
d ≥ 0.8	High

RESULT AND DISCUSSION

The data display of pre-test and post-test score recapitulation of the control and experimental class can be seen in table 2,

Table 2. The Pre-Test and Post-Test Score of the Control and Experimental Class

Indicator of Concept Understanding	Pretest				Posttest			
	Experimental Class*		Control Class**		Experimental Class*		Control Class**	
	Highest Score	Lowest Score	Highest Score	Lowest Score	Highest Score	Lowest Score	Highest Score	Lowest Score
Interpreting	71	41	70	40	95	72	83	62
Modeling	72	40	70	38	94	70	80	63
Predicting	70	35	69	32	89	65	82	60
Explaining	70	32	68	30	90	66	80	61
Classifying	65	31	64	29	97	62	79	58
Comparing	64	30	62	28	94	68	78	59
Summarizing	62	31	60	30	92	66	78	57
The Highest and Lowest Total Score	474	240	463	227	651	469	560	420
The Highest and Lowest Average Score	68	34	66	32	93	67	80	60
Total Score	1.986,4		1.880		3.113,2		2.820	
Number of Students	40		40		40		40	
Total Average Score	49,66		47		77,83		70,5	

*Learning cycle 7e model **Conventional model

The pretest and posttest shown in Table 2 were measured through a multiple-choice test of concept understanding (example figure 8). The scores measured in this study are cognitive scores according to the blooms' taxonomy that includes cognitive 2, 3, 4 and 5 (C2, C3, C4, C5). There are seven indicators of understanding the concept applied in this study. Table 2 shows that the results of the concept of understanding tests in each indicator change. On the test of understanding the concepts (interpreting), the highest and lowest scores in the experimental class and the control class experienced an increase, both as a result of pretest and posttest. However, the highest and lowest scores in the experimental class are higher compared to the scores in the control class. On the concept understanding test (modeling), the highest and lowest scores in the experimental class and the control class experienced an increase, both the results of the pretest and posttest. However, the highest and lowest scores in the experimental class are higher than the scores in the control class. This significant increase is obtained from the results of Independent-Sample T Test that is shown in table 3:

Table 3. Independent-Sample T Test Results

Independent-Sample T Test	Pretest	Posttest
Criteria	Sig.(2-tailed) > 0,05	Sig.(2-tailed) < 0,05
Sig.(2-tailed)	0,229	0,000
Decision	H_o is accepted	H_a is accepted

Based on table 3, it is shown that in pretest we got Sig.(2-tailed) of 0,229. It means Sig.(2-tailed) > 0,05 so the average pretest scores in the experimental class is equal to the average pretest scores in the control class. And based on posttest results we got Sig.(2-tailed) of 0,000, it means the average pretest scores in the experimental class is not equal to the average pretest scores in the control class.

On the concept understanding test (predicting), the highest and lowest scores in the experimental class and the control class experienced an increase, both the results of the pretest and posttest. However, the highest and lowest scores in the experimental class are higher than the scores in the control class.

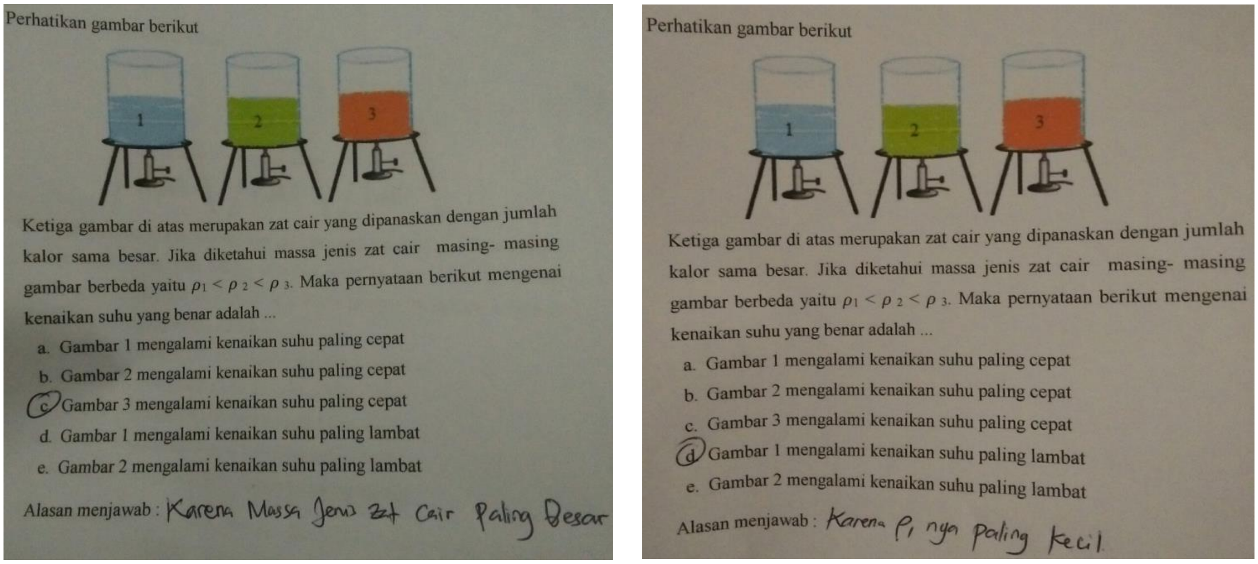
On the concept understanding test (explaining) the highest and lowest scores in the experimental class and the control class experienced an increase, both the results of the pretest and posttest. However, the highest and lowest scores in the experimental class are higher than the scores in the control class.

On the concept understanding test (classifying) the highest and lowest scores in the experimental class and the control class experienced an increase, both the results of the pretest and posttest. However, the highest and lowest scores in the experimental class are higher than the scores in the control class.

On the concept understanding test (comparing) the highest and lowest scores in the experimental class and the control class experienced an increase, both the results of the pretest and posttest. However, the highest and lowest scores in the experimental class are higher than the scores in the control class.

On the concept understanding test (summarizing) the highest and lowest scores in the experimental class and the control class experienced an increase, both the results of the pretest and posttest. However, the highest and lowest scores in the experimental class are higher than the scores in the control class.

In general, the results of concept understanding tests on each indicator experienced an increase in both the experimental class and the control class. However, before applying the learning cycle 7e model, there was no significant difference in the understanding of the concepts of the experimental class students. However, after the implementation of the learning cycle 7e model, the scores of the experimental class were significantly improved. Based on the results of the analysis of each student's answers, the understanding of their concepts had not been trained when answering the conceptual understanding questions in the form of multiple choices when they choose the answer (Figure 9). In contrast to the results after applying the learning cycle 7e model and the conventional model, there are significant differences in the understanding of the concepts in the experimental class and the control class. In the experimental class, the answer is more appropriate than the control class (Figure 10).



Perhatikan gambar berikut

1 2 3

Ketiga gambar di atas merupakan zat cair yang dipanaskan dengan jumlah kalor sama besar. Jika diketahui massa jenis zat cair masing- masing gambar berbeda yaitu $\rho_1 < \rho_2 < \rho_3$. Maka pernyataan berikut mengenai kenaikan suhu yang benar adalah ...

a. Gambar 1 mengalami kenaikan suhu paling cepat
b. Gambar 2 mengalami kenaikan suhu paling cepat
c. Gambar 3 mengalami kenaikan suhu paling cepat
d. Gambar 1 mengalami kenaikan suhu paling lambat
e. Gambar 2 mengalami kenaikan suhu paling lambat

Alasan menjawab : Karena Massa Jenis zat Cair Paling Besar

Perhatikan gambar berikut

1 2 3

Ketiga gambar di atas merupakan zat cair yang dipanaskan dengan jumlah kalor sama besar. Jika diketahui massa jenis zat cair masing- masing gambar berbeda yaitu $\rho_1 < \rho_2 < \rho_3$. Maka pernyataan berikut mengenai kenaikan suhu yang benar adalah ...

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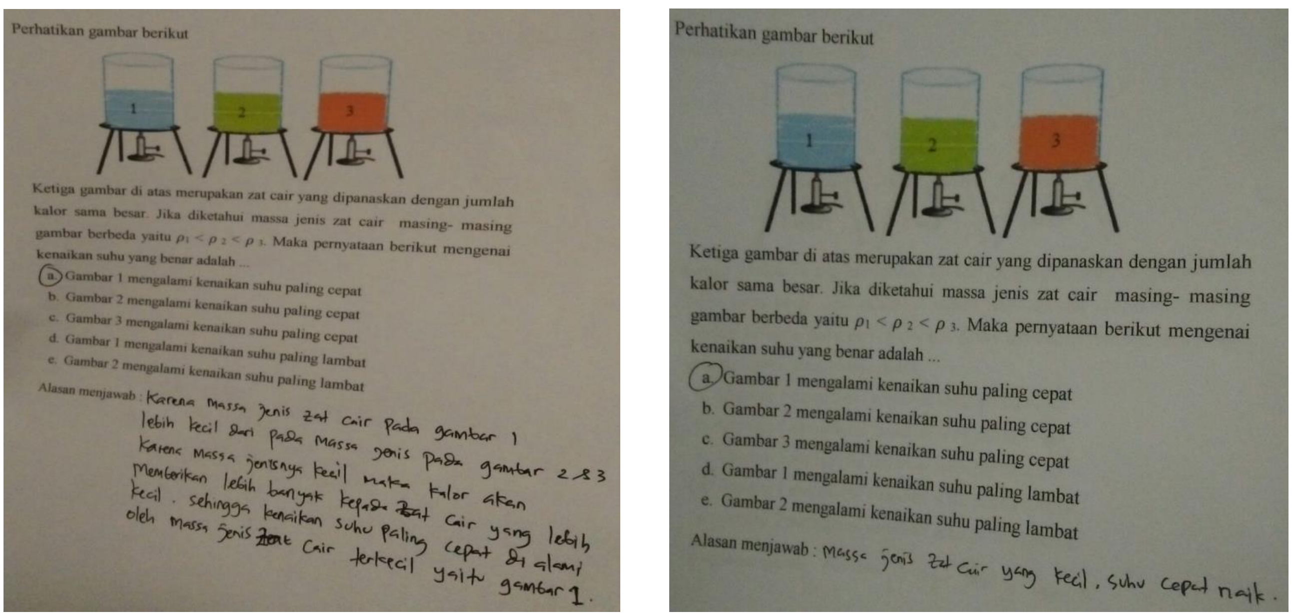
d. Gambar 1 mengalami kenaikan suhu paling lambat
e. Gambar 2 mengalami kenaikan suhu paling lambat

Alasan menjawab : Karena ρ_1 nya paling kecil.

(a) Learning Cycle 7e Model (b) Conventional Model

Figure 9. Before the Application of Learning Cycle 7e and the Conventional Model



Perhatikan gambar berikut

1 2 3

Ketiga gambar di atas merupakan zat cair yang dipanaskan dengan jumlah kalor sama besar. Jika diketahui massa jenis zat cair masing- masing gambar berbeda yaitu $\rho_1 < \rho_2 < \rho_3$. Maka pernyataan berikut mengenai kenaikan suhu yang benar adalah ...

a. Gambar 1 mengalami kenaikan suhu paling cepat
b. Gambar 2 mengalami kenaikan suhu paling cepat
c. Gambar 3 mengalami kenaikan suhu paling cepat
d. Gambar 1 mengalami kenaikan suhu paling lambat
e. Gambar 2 mengalami kenaikan suhu paling lambat

Alasan menjawab : Karena massa jenis zat cair pada gambar 1 lebih kecil dari pada massa jenis pada gambar 2 & 3 Karena massa jenisnya kecil maka kalor akan Memberikan lebih banyak kepada ~~zat~~ cair yang lebih kecil. sehingga kenaikan suhu paling cepat di alami oleh massa jenis ~~zat~~ cair terkecil yaitu gambar 1.

Perhatikan gambar berikut

1 2 3

Ketiga gambar di atas merupakan zat cair yang dipanaskan dengan jumlah kalor sama besar. Jika diketahui massa jenis zat cair masing- masing gambar berbeda yaitu $\rho_1 < \rho_2 < \rho_3$. Maka pernyataan berikut mengenai kenaikan suhu yang benar adalah ...

a. Gambar 1 mengalami kenaikan suhu paling cepat
b. Gambar 2 mengalami kenaikan suhu paling cepat
c. Gambar 3 mengalami kenaikan suhu paling cepat
d. Gambar 1 mengalami kenaikan suhu paling lambat
e. Gambar 2 mengalami kenaikan suhu paling lambat

Alasan menjawab : Massa jenis zat cair yang kecil, suhu cepat naik.

(c) Learning Cycle 7e Model (d) Conventional Model

Figure 10. After the Application of Learning Cycle 7e and the Conventional Model

In addition to the results of cognitive scores, the management of learning is also the key to the successful implementation of the learning model. The following is the explanation of the learning management in this study.

Learning Management

The scoring percentage given by the physics teacher while the researcher was applying the learning model can be seen in the following figure 11,

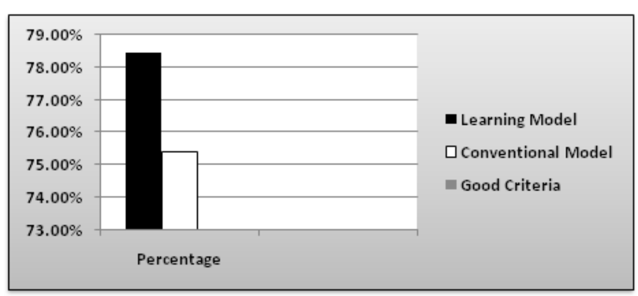


Figure 11. Graphic Percentage of Learning Management.

Based on figure 11, the gain percentage shows that the learning management through 7e Learning Cycle was 78.46% compared to the conventional learning amounting 75.38%. The percentage falls into satisfying criteria. Improvement can occur because the teacher applied the learning cycle 7e systematically. In the class that the learning cycle 7e model was applied, the teacher started the lesson by eliciting knowledge and involving students through engaging demonstrations. Like in the elicit step, when the teacher gave a question to raise students' initial knowledge, students responded enthusiastically. They were willing to present the answer in front of the class. Thus, it brought about the impact of active classroom atmosphere at the beginning of the learning process. In the class that the conventional model was applied, the teacher started the lesson by psychologically preparing the students through stories without demonstrations or involving the students.

The core activity in learning cycle 7e model begins with the grouping to discuss the continuation of the demonstration by changing the object of the demonstration and discussion finding solutions to the questions given by the teacher (explore). Then each group conducts a presentation by explaining the results of the discussion (explain), the teacher gives feedback to each group to expand the discussion material in the group through question and answer between groups (elaborate & extend). In the class that applies conventional models, the core activity begins with the teacher explaining the material then the teacher forms a group to observe events related to the material in daily life. Then students are asked to communicate the material through assignments.

The closing activity in the learning cycle 7e model is ended by asking each group to conclude the results of the discussion and the teacher concludes the overall results of the discussion. The closing activity in the conventional model is ended by giving homework.

Based on the description of learning management, the learning cycle 7e model is a student-centered model. The teacher only acts as a facilitator in learning while the conventional model is still a teacher-centered model. The curriculum in Indonesia is the 2013 curriculum which emphasizes student-centered learning. In addition, other countries such as Finland, England, the United States, and other developed countries also implement student-centered learning which is more effective than teacher-centered learning.

The effectiveness of the application of the learning model is analyzed with effect size formula. Further description is shown in Table 3.

Table 4. The Result of Effect Size.

Class	Mean Gain	Standard Deviation	Effect Size	Category
Experiment	28,17	36,64	0,5	Average
Control	23,50	137,72		

Table 4 shows that the gain of effect size is 0.5 in the average category. This shows that the use of the 7E Learning Cycle model could effectively improve students' understanding of concepts in Physics subjects.

Based on the recapitulation of the post-test scores, both the experimental and the control class of the students' conceptual understanding have increased significantly. This might be caused by the fact that the 7E Learning Cycle model has such distinctive characteristics that the students not only listen to the teachers but can also play an active role in exploring and enriching their understanding of the concepts learned.

The importance of understanding the concept of learning in school requires researchers to use various ways to analyze and improve understanding of concepts, including: increasing mastery of concepts through interactive multimedia (Husein et al., 2017), improving understanding of concepts through 7e learning cycle for junior high school students (Nurmalasari et al., 2014), improving understanding of concepts by utilizing PhET Simulation (Saregar, 2016), increasing understanding of concepts through the application of guided inquiry learning model (Setyawati et al., 2014), increasing understanding of concepts through the application of experiential learning models (Wahyuningsih, 2014)and understanding analysis of concepts through TTCI and CRI instruments (Yolanda et al., 2016).

This study supports Nurmalasari's research that the learning cycle 7e model can improve concept understanding. In the Nurmalasari study, the learning cycle 7e model was applied to the junior high school students, but in this study, it was applied to senior high schools students. It means that the learning cycle 7e model can improve concept understanding to both junior and senior high school students

The findings of this study indicate that the use of the learning cycle model 7e was able to improve the mastery of the concept of the learners effectively. In this paper, the procedures of the learning cycle model 7e in the classroom are discussed in detail and thoroughly.

CONCLUSION

In short, it can be concluded that the use of 7E Learning Cycle Model is effective in improving students' conceptual understanding. In other words, the learning process through 7E Learning Cycle Model was more effective compared to the conventional model in improving the students' concept understanding, especially on temperature and heat subject matte. This is because each learning process truly integrates the 7 stages of the 7e learning cycle model with the 7 indicators of conceptual understanding that must be achieved by students, so that the use of the learning cycle 7e model is effective and is able to increase students' conceptual understanding.

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APPROACHING THE UNDERSTANDING OF THERMAL PHENOMENA USING 7E LEARNING CYCLE

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JPII 8 (4) (2019)

Jurnal Pendidikan IPA Indonesia

http://journal.unnes.ac.id/index.php/jpii

APPROACHING THE UNDERSTANDING OF THERMAL PHENOMENA USING 7E LEARNING CYCLE

Abstract

Conceptual understanding is often a problem in science learning, and this problem has become in important issues of science education experts including in Indonesia. Lately, ten articles in Indonesia and six articles in other countries have discussed the model of 7E Learning Cycle. It was mentioned that this model is able to increase the understanding of learners' concept. This research is aimed to reveal the effectiveness of physics learning using 7E Learning Cycle model after being reviewed with control classes in improving students' understanding of temperature and heat concepts. The research design is quasi-experimental with non-equivalent control group design. The sample was senior high school students. Objective test in the form of multiple choices equipped with reason was employed as the instrument to collect the data. Based on the data analysis, it was obtained that the value of Effect Size was as much as 0.5 with the medium category. It can be concluded that the use of 7E Learning Cycle learning model is effective to improve learners' understanding of temperature and heat concepts. This can be seen from the success of the learning process that integrates the whole 7 stages of the 7e learning cycle model with the 7 indicators of conceptual understanding in detail. So that the use of the 7E learning cycle model could be effectively used and is able to increase students' conceptual understanding.

Keywords: *Conceptual understanding in physics; Direct Learning; 7E Learning Cycle model*

INTRODUCTION

The outcome of the physics learning process, among others, is to enable the students to understand the applicability of physics concepts so the students can apply the knowledge in their daily life (Husein et al., 2017; Latifah et al., 2019; Pratiwi & Supardi, 2014). Students' inability to connect one concept to another is a common problem occurring in physics classes (Sagala et al., 2019b; Tanti et al., 2017). Students are more likely to memorize than to understand the concepts (Maharani et al., 2019). In this case, physics teachers should emphasize the students' understanding of the concepts (Lestari et al., 2017; Wahyuningsih, 2014) based on the knowledge acquired in the previous level to the next (Widayanti et al., 2018; Yulianti & Gunawan, 2019). The use of varied learning model is needed (Saregar et al., 2018) in order to be an intermediary so that the material taught could be understood by students (Pitan & Atiku, 2017; Sagala et al.,2019a; Widayanti & Yuberti, 2018; Yıldırım & Akamca, 2017). Furthermore, at the final stage, it is expected to increase the students' mastery of the concepts (Saregar, 2016).

Some of the research results showed that conceptual understanding is very important in learning, since by mastering the concepts, the hardest problem can be solved easily (Alan & Afriansyah, 2017; Surosos, 2016). Many learners do not produce good results in learning. Learners are not aware of efficient and effective ways of learning because they only try to memorize lessons. Physics is not a material to be memorized since it requires reasoning and understanding of the concept (Lestari et al., 2017; Yuberti et al., 2019). As a result, if they are given a test, the learners will have difficulties (Yolanda et al., 2016). Therefore, understanding the concept is needed by every learner. By understanding the concept, it is expected for the learners to get good learning outcomes.

Many researchers have conducted many ways to improve students' concept understanding. One of which is througfh learning models, and one of learning models that proved in improving students' conceptual understanding is constructivism learning model (Balta & Sarac, 2016). There are various types of constructivism learning models such as problem-solving learning model, mind mapping, and 7E learning cycle. In this research, the 7E Learning Cycle model was selected since it provides opportunities for students to build their knowledge (Febriana et al., 2014).

7E Learning Cycle model is the improvement of the 5E Learning Cycle model (Ghaliyah et al., 2015). The cycles of the applied learning model are emphasized in the understanding of the scientific physics concepts and correcting the knowledge misconception. Furthermore, it is also expected to be able to enhance the students' memorization process that is focused on the knowledge and knowledge transfer (Balta & Sarac, 2016). The model of the learning cycle Approach (LCA) is a model that is deemed effective for physics students (Olaoluwa & Olufunke, 2015). It can help them to elaborate their understanding toward certain aspects in scientific research (Hodson, 2014; Putra et al., 2018). One of the physics materials that is considered quite difficult for students to understand is temperature and heat (Sayyadi et al., 2016).

The constructivism basis of the 7E Learning Model possesses some weaknesses and strengths. One of the notable strengths of the 7E Learning Cycle is that it could make the students active since the students are thinking maximally to acquire the knowledge. On the other hand, the weakness of 7E Learning Cycle is the length of time needed in its applicationsince the students are trained to explore their knowledge, and they are also given enough freedom to express their ideas. In order to minimize the weakness of this model, proper preparation is certainly needed by the teacher acting as a facilitator (Rawa et al., 2016).

The previous researchers showed that the Learning Cycle could be used to improve students' understanding (Nurmalasari et al., 2014). It can also be used to improve students' learning achievement (Sumiyati et al., 2016). To understand a concept means to be able to express the material having been learned into a simplified version to overcome the problems of the interconnected concept. The cognitive process of concepts understanding consists of interpreting, modeling, classifying, summarizing, predicting, comparing, and explaining (Setyawati et al., 2014). One of the factors that determine the outcome of the learning process is the students' achievements measured by how much they are able to master the learning material (Parasamya et al., 2017).

There are some distinctions between this research and the previous ones. Firstly, there is an elaboration of each of the seven prescribed stages of the 7E Learning Cycle model implementation exposing the students' level of understanding presented in the discussion. In addition, there is the use of different learning materials, namely temperature and heat which is very suitable for the object of measuring concept understanding (Damar, 2013). Then, the learning circumstances where the subjects of this research study are also relatively different.

Learning cycle is a learning model centered on learners (Balta & Sarac, 2016). Learning cycle consists of a series of stages of activities organized in such a way that learners can master the competencies that must be achieved in learning with an active role (Ngalimun, 2014; Ratiyani et al., 2014). Learning cycle in the classroom practice focuses on the experience and knowledge of the early learners (Ghaliyah et al., 2015), based on the opinions, it can be concluded that the model of learning cycle centered on learners so that learners can actively find their own concept. In order for the learners' concept can be well-organized, an organized procedureis needed.

The development of learning cycle model has been developed from learning cycle 3E (Exploration, Explanation, Elaboration), learning cycle 5E (Engagement, Exploration, Explanation, Elaboration, and Evaluation), and learning cycle 7E (elicit, engage, explore, explain, elaborate, extend, and evaluate). The latest development is the learning cycle 7E.

Some studies suggest that learning cycle 7E can foster motivation and learning achievement (Febriana et al., 2014; Sumiyati et al., 2016), improve language comprehension (Balta & Sarac, 2016, effective to achieve goals quickly (Bozorgpouri, 2016), improve the ability of mathematical connections (Rawa et al., 2016), and foster conceptual understanding (Nurmalasari et al., 2014). So that the researchers consider it is necessary to conduct research to see the effectiveness of the learning cycle 7e model in improving students' conceptual understanding in the temperature and heat material.

The results of the earlier quantitative and qualitative research on the understanding of the thermal concepts and phenomena showed that the majority of children do not master the concepts of heat and temperature and the related phenomena even after receiving formal instruction on these subjects (Karabulut & Bayraktar, 2018). There is a confusion between the concepts "heat" and "temperature," and often they think that temperature is a measure of the heat, temperature is an intrinsic property of matter, they are hot and cold objects by nature, the warm and the cold d are two separate entities, all materials if they are placed long in an environment with a temperature given, will reach the same temperature, confusion with the meaning of words like 'heat', 'heat flow' or 'heat capacity', mixing hot and cold water lead to correct qualitative judgements but incorrect quantitative judgements, difficulty explaining how a thermometer works (Gönen & Kocakaya, 2009; Kampeza et al., 2016; Ravanis, 2013).

METHODS

Design of Study

The design used in this research was Quasi-experimental with *Non-equivalent Control* Class *Design* ((Sugiyono, 2010; Suharsimi, 2010; Tanti et al., 2017). The research was conducted at the X (Ten) IPA 1 and X (Ten) IPA 2 class of SMAN 1 Kotabumi North Lampung**.** The study was implemented in three phases (pre-test, teaching interventions in an experimental group and a control group and post-test). The data of the study consisted of student's responses to objective tests in the form of multiple choices equipped with the reason for the answers. Multiple choices test can show the concept understanding's characteristics on students (Pratiwi, 2016), and the ability of students in answering the question. Before the instruments were used, the questions were tested to find out the validity level, reliability, difficulty level, discrimination power, and destruction functions. The questions that have been tested are used to obtain student learning outcomes for grade X of SMA Negeri 1 Kotabumi (Senior High School 1 Kotabumi).

Participants

The subject of this research was students of grade X (Ten) IPA in SMA Negeri 1 Kotabumi (amounted to 240 students). With cluster random sampling technique, we chose 80 students from class X (Ten) IPA 1 and X (Ten) IPA 2.

The samples of this research were male and female students (age range 15-16 years old). The chosen students had similar socio-economic characteristics and were randomly divided into two groups, thus forming the experimental class (here after E.C.) and control class (here after C.C.) respectively.

Teaching Interventions

The Experimental Class

The learning stage of 7E Learning Cycle modelcan be seen in Figure 1:

Figure 1. The Stages of 7E Learning Cycle Model.

The Researchers applied the sevenstages of 7E Learning Cycle model during the teaching and learning activity. The first stage was Elicit to raise the student's initial knowledge by asking questions as displayed in Figure 2;

> **Zero Kelvin is Known as the absolute zero temperature. What is the definition of absolute zero temperature ?**

Figure 2. The first Stage: Elicit.

The second stage was to Engage. It was involving the students with the surrounding events related to the temperature material by carrying out the demonstration as displayed in figure 3.

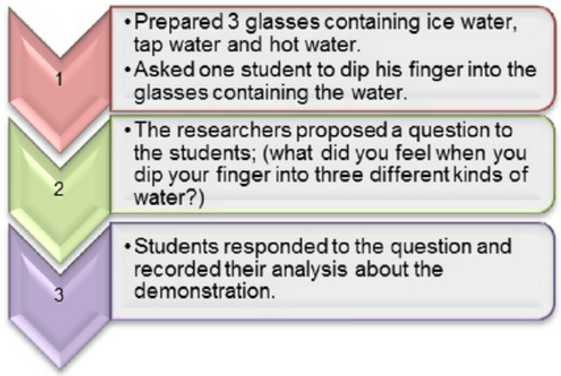


Figure 3. The Second Stage: Engage.

The third stage was to Explore. This was thestage of collecting information. The procedure can be seen in the following figure 4,

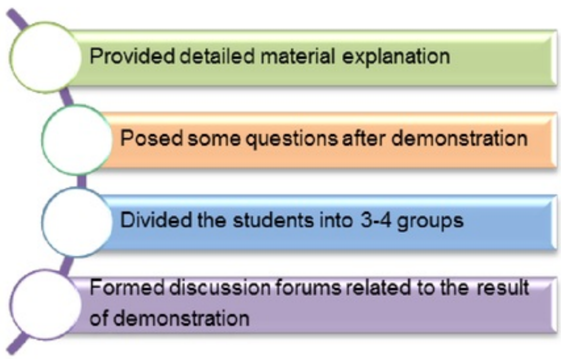


Figure 4. The Third Stage: Explore.

It was expected that based on the information-gathering stage the students were able to understand the material in detail.

The fourthstage was to Explain. The students were required to explain the results of the discussion by using their way tounderstand the material indicating the level of student' understanding, has appeared in the following figure 5,

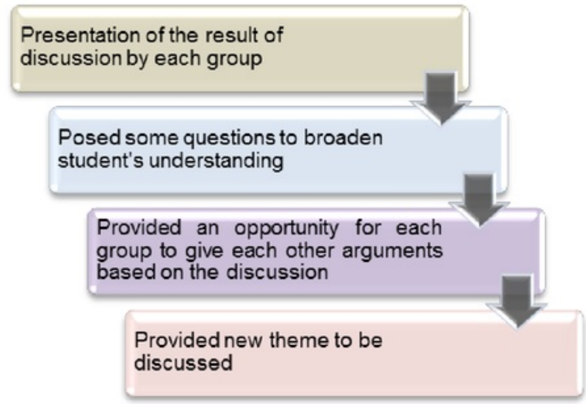


Figure 5. The Fourth Stage: Explain.

The fifth stage was Elaborate. Elaborate was the proficiency stage for the researchers and the students to connect previously learned concepts with daily life. It can be seen in figure 6.

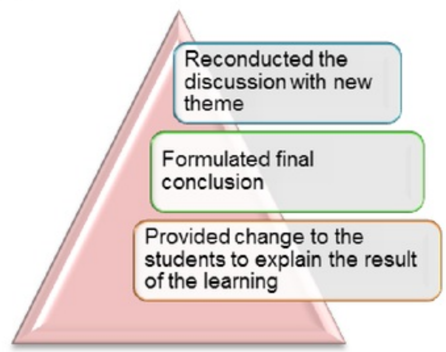


Figure 6. The Fifth Stage: Elaborate.

In this stage, the students re-conducted the discussion to acquire new findingsin order to overcome different problems and concepts and to produce the conclusion that was correct and clear.

The sixth stage was to Extend. The result of the students' findings was extended to enable the students to be more active and interested in searching for new concepts as displayed in figure 7.

A representative of each group was required to present the result of discussion in front of the class.

The researcher observed and recorded the responses from other students.

The researcher responded positively toward every students' response.

Figure 7. The sixth Stage: Extend.

The seventh stage was to Evaluate. The students were given opportunities to conclude everything related to the material that had been studied. Then, an evaluation was carried out in order to gain a deeper understanding of the concept of the temperature material by giving the task to the students. One of the conceptual understanding problems can be seen in the following figure 8,

Look at the following Images:

The three images above are liquid which are heated with the same amount of heat. If the volume of each liquid is same and the density is different, namely $\rho_1 < \rho_2 < \rho_3$. then the correct statement regarding the temperature rise is...

a. Figure 1 has the biggest temperature rise

b. Figure 2 has the biggest temperature rise

c. Figure 3 has the biggest temperature rise

d. Figure 1 has the lowest temperature rise

e. Figure 2 has the lowest temperature rise

Reason:……………………….

Figure 8. The Seventh Stage: Evaluate

In the final step of the seventh stage, the researcher conveyed information about the next material that will be studied so the students should learn before the material is delivered.

The learning process through the 7E Learning Cycle model requires time accuracy considering its numerous stages. Time is one of the key factors in implementing this learning model. Furthermore, to achieve the learning objectives, this learning model should be done in complete seven stages, if only two stages were done or skipping even a stage, then the implementation of this learning model will not be optimum.

The control classes

The learning process in the control class was conducted using Direct Learning Model which is commonly used by physics teachers. Researcher only deliverd the lesson by writing the material on the whitwboard. The whole process of learning was focused on the teacher/researcher (teacher center). The students responded passively and only listened to the researcher explained. It resulted in a lack of understanding of the concepts of the material; consequently, the students were having difficulty in solving some of the physics problems on temperature and heat materials.

The research questions

Based on the research design presented, we formulated two research questions.

With the first research question, we ask if the students of the experimental class (who took part in a 7E teaching intervention) would be able to better understand the thermal concepts and phenomena, compared to the children in the control class (who participated in a Direct Learning Model.

With the second research question, we ask we ask whether students of both groups progress after the two didactic interventions.

Data analysis

Students' understanding of the concepts were measured through pre-test and post-test using objective test in the form of multiple choices equipped with the reason for the answers. Each test consisted of 15 items. Since the original version of the tests was the only multiple-choice format, then modification was carried out by asking the students to provide a reason for choosing the answer.

To investigate the effectiveness of learning toward the students' understanding of the concepts, the Effect Size test was used. Effect Size is a measurement to determine the effect of one variable on another. Effect Size can be counted using a particular formula (Cohen, 1998), and further explanation of it is also available (Anwar et al., 2019; Hake, 1998).

$$d = \frac{m_A - m_B}{\left[\frac{(sd_A^2 + sd_B^2)}{2}\right]^{1/2}}$$

Definition:

d	= *effect size*
m_A	= mean gain of the experimental class
m_B	= mean gain of control class
sd_A	= standard deviation of experimental class
sd_B	= standard deviation of control class

The value of Effect Size can be seenin Table 1, as follows:

Table 1. Effect Size Criteria.

Effect Size	**Category**
$d < 0.2$	Low
$0.2 \leq d < 0.8$	Average
$d \geq 0.8$	High

RESULT AND DISCUSSION

The data display of pre-test and post-test score recapitulation of the control and experimental class can be seen in table 2,

Table 2. The Pre-Test and Post-Test Score of the Control and Experimental Class

Indicator of Concept Understanding	Pretest				Posttest			
	Experimental Class*		Control Class**		Experimental Class*		Control Class**	
	Highest Score	Lowest Score	Highest Score	Lowest Score	Highest Score	Lowest Score	Highest Score	Lowest Score
Interpreting	71	41	70	40	95	72	83	62
Modeling	72	40	70	38	94	70	80	63
Predicting	70	35	69	32	89	65	82	60
Explaining	70	32	68	30	90	66	80	61
Classifying	65	31	64	29	97	62	79	58
Comparing	64	30	62	28	94	68	78	59
Summarizing	62	31	60	30	92	66	78	57
The Highest and Lowest Total Score	474	240	463	227	651	469	560	420
The Highest and Lowest Average Score	68	34	66	32	93	67	80	60
Total Score	1.986,4		1.880		3.113,2		2.820	
Number of Students	40		40		40		40	
Total Average Score	49,66		47		77,83		70,5	

*Learning cycle 7e model **Conventional model

The pretest and posttest shown in Table 2 were measured through a multiple-choice test of concept understanding (example figure 8). The scores measured in this study are cognitive scores according to the blooms' taxonomy that includes cognitive 2, 3, 4 and 5 (C2, C3, C4, C5). There are seven indicators of understanding the concept applied in this study. Table 2 shows that the results of the concept of understanding tests in each indicator change. On the test of understanding the concepts (interpreting), the highest and lowest scores in the experimental class and the control class experienced an increase, both as a result of pretest and posttest. However, the highest and lowest scores in the experimental class are higher compared to the scores in the control class. On the concept understanding test (modeling), the highest and lowest scores in the experimental class and the control class experienced an increase, both the results of the pretest and posttest. However, the highest and lowest scores in the experimental class are higher than the scores in the control class. This significant increase is obtained from the results of Independent-Sample T Test that is shown in table 3:

Table 3. Independent-Sample T Test Results

Independent-Sample T Test	Pretest	Posttest
Criteria	Sig.(2-tailed) > 0,05	Sig.(2-tailed) < 0,05
Sig.(2-tailed)	0,229	0,000
Decision	H_0 is accepted	H_a is accepted

Based on table 3, it is shown that in pretest we got Sig.(2-tailed) of 0,229. It means Sig.(2-tailed) > 0,05 so the average pretest scores in the experimental class is equal to the average pretest scores in the control class. And based on posttest results we got Sig.(2-tailed) of 0,000, it means the average pretest scores in the experimental class is not equal to the average pretest scores in the control class.

On the concept understanding test (predicting), the highest and lowest scores in the experimental class and the control class experienced an increase, both the results of the pretest and posttest. However, the highest and lowest scores in the experimental class are higher than the scores in the control class.

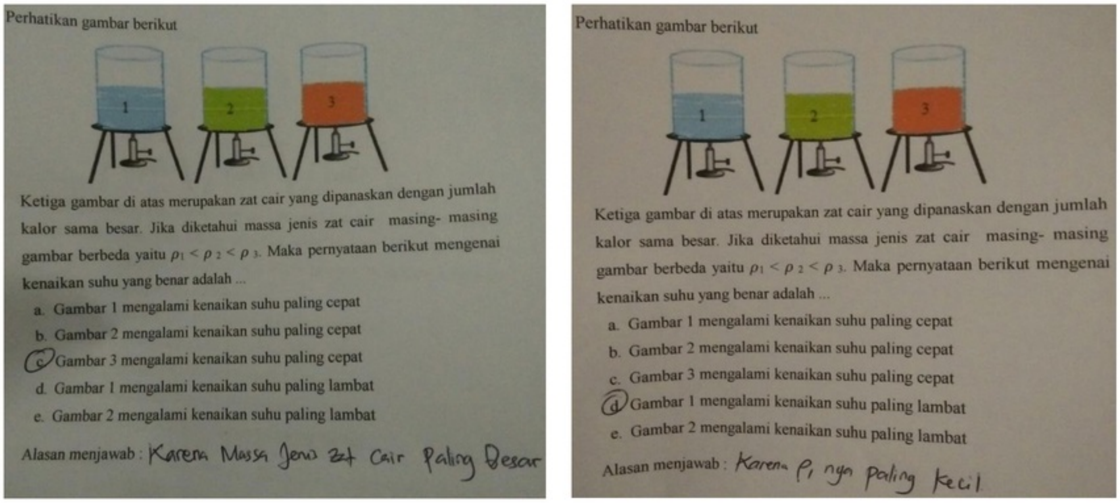
On the concept understanding test (explaining) the highest and lowest scores in the experimental class and the control class experienced an increase, both the results of the pretest and posttest. However, the highest and lowest scores in the experimental class are higher than the scores in the control class.

On the concept understanding test (classifying) the highest and lowest scores in the experimental class and the control class experienced an increase, both the results of the pretest and posttest. However, the highest and lowest scores in the experimental class are higher than the scores in the control class.

On the concept understanding test (comparing) the highest and lowest scores in the experimental class and the control class experienced an increase, both the results of the pretest and posttest. However, the highest and lowest scores in the experimental class are higher than the scores in the control class.

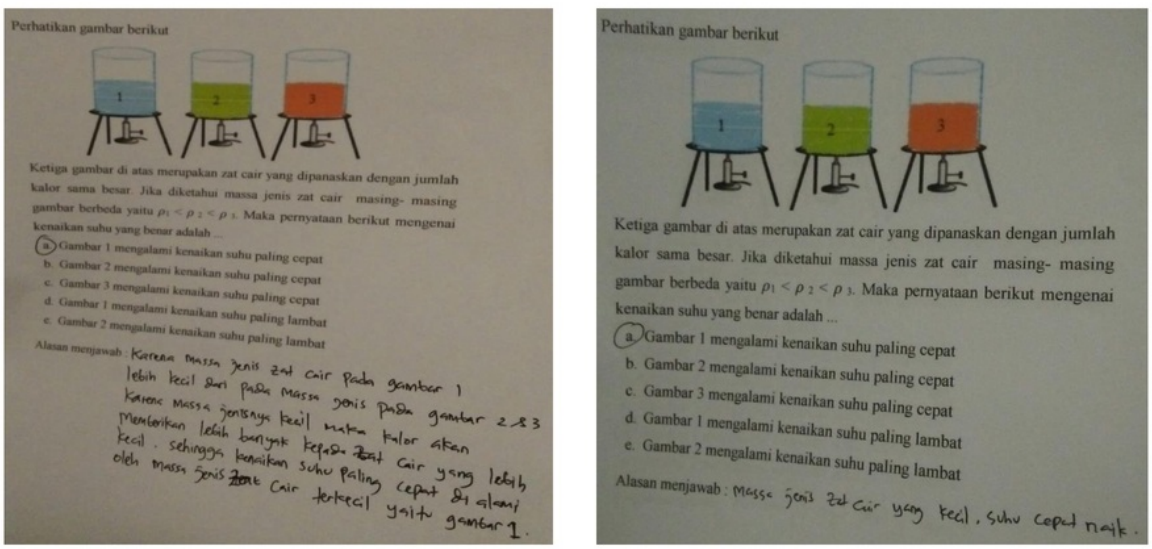
On the concept understanding test (summarizing) the highest and lowest scores in the experimental class and the control class experienced an increase, both the results of the pretest and posttest. However, the highest and lowest scores in the experimental class are higher than the scores in the control class.

In general, the results of concept understanding tests on each indicator experienced an increase in both the experimental class and the control class. However, before applying the learning cycle 7e model, there was no significant difference in the understanding of the concepts of the experimental class students. However, after the implementation of the learning cycle 7e model, the scores of the experimental class were significantly improved. Based on the results of the analysis of each student's answers, the understanding of their concepts had not been trained when answering the conceptual understanding questions in the form of multiple choices when they choose the answer (Figure 9). In contrast to the results after applying the learning cycle 7e model and the conventional model, there are significant differences in the understanding of the concepts in the experimental class and the control class. In the experimental class, the answer is more appropriate than the control class (Figure 10).



(a) Learning Cycle 7e Model (b) Conventional Model

Figure 9. Before the Application of Learning Cycle 7e and the Conventional Model



(c) Learning Cycle 7e Model (d) Conventional Model

Figure 10. After the Application of Learning Cycle 7e and the Conventional Model

In addition to the results of cognitive scores, the management of learning is also the key to the successful implementation of the learning model. The following is the explanation of the learning management in this study.

Learning Management

The scoring percentage given by the physics teacher while the researcher was applying the learning model can be seen in the following figure 11,

Figure 11. Graphic Percentage of Learning Management.

Based on figure 11, the gain percentage shows that the learning management through 7e Learning Cycle was 78.46% compared to the conventional learning amounting 75.38%. The percentage falls into satisfying criteria. Improvement can occur because the teacher applied the learning cycle 7e systematically. In the class that the learning cycle 7e model was applied, the teacher started the lesson by eliciting knowledge and involving students through engaging demonstrations. Like in the elicit step, when the teacher gave a question to raise students' initial knowledge, students responded enthusiastically. They were willing to present the answer in front of the class. Thus, it brought about the impact of active classroom atmosphere at the beginning of the learning process. In the class that the conventional model was applied, the teacher started the lesson by psychologically preparing the students through stories without demonstrations or involving the students.

The core activity in learning cycle 7e model begins with the grouping to discuss the continuation of the demonstration by changing the object of the demonstration and discussion finding solutions to the questions given by the teacher (explore). Then each group conducts a presentation by explaining the results of the discussion (explain), the teacher gives feedback to each group to expand the discussion material in the group through question and answer between groups (elaborate & extend). In the class that applies conventional models, the core activity begins with the teacher explaining the material then the teacher forms a group to observe events related to the material in daily life. Then students are asked to communicate the material through assignments.

The closing activity in the learning cycle 7e model is ended by asking each group to conclude the results of the discussion and the teacher concludes the overall results of the discussion. The closing activity in the conventional model is ended by giving homework.

Based on the description of learning management, the learning cycle 7e model is a student-centered model. The teacher only acts as a facilitator in learning while the conventional model is still a teacher-centered model. The curriculum in Indonesia is the 2013 curriculum which emphasizes student-centered learning. In addition, other countries such as Finland, England, the United States, and other developed countries also implement student-centered learning which is more effective than teacher-centered learning.

The effectiveness of the application of the learning model is analyzed with effect size formula. Further description is shown in Table 3.

Table 4. The Result of Effect Size.

Class	Mean Gain	Standard Deviation	Effect Size	Category
Experiment	28,17	36,64	0,5	Average
Control	23,50	137,72		

Table 4 shows that the gain of effect size is 0.5 in the average category. This shows that the use of the 7E Learning Cycle model could effectively improve students' understanding of concepts in Physics subjects.

Based on the recapitulation of the post-test scores, both the experimental and the control class of the students' conceptual understanding have increased significantly. This might be caused by the fact that the 7E Learning Cycle model has such distinctive characteristics that the students not only listen to the teachers but can also play an active role in exploring and enriching their understanding of the concepts learned.

The importance of understanding the concept of learning in school requires researchers to use various ways to analyze and improve understanding of concepts, including: increasing mastery of concepts through interactive multimedia (Husein et al., 2017), improving understanding of concepts through 7e learning cycle for junior high school students (Nurmalasari et al., 2014), improving understanding of concepts by utilizing PhET Simulation (Saregar, 2016), increasing understanding of concepts through the application of guided inquiry learning model (Setyawati et al., 2014), increasing understanding of concepts through the application of experiential learning models (Wahyuningsih, 2014)and understanding analysis of concepts through TTCI and CRI instruments (Yolanda et al., 2016).

This study supports Nurmalasari's research that the learning cycle 7e model can improve concept understanding. In the Nurmalasari study, the learning cycle 7e model was applied to the junior high school students, but in this study, it was applied to senior high schools students. It means that the learning cycle 7e model can improve concept understanding to both junior and senior high school students

The findings of this study indicate that the use of the learning cycle model 7e was able to improve the mastery of the concept of the learners effectively. In this paper, the procedures of the learning cycle model 7e in the classroom are discussed in detail and thoroughly.

CONCLUSION

In short, it can be concluded that the use of 7E Learning Cycle Model is effective in improving students' conceptual understanding. In other words, the learning process through 7E Learning Cycle Model was more effective compared to the conventional model in improving the students' concept understanding, especially on temperature and heat subject matte. This is because each learning process truly integrates the 7 stages of the 7e learning cycle model with the 7 indicators of conceptual understanding that must be achieved by students, so that the use of the learning cycle 7e model is effective and is able to increase students' conceptual understanding.

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