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Effect Size Test of Learning Model ARIAS and PBL: Concept Mastery of Temperature and Heat on Senior High School Students

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ABSTRACT
The study aims to find out first, whether there is a difference between the learning model of Assurance, Relevance, Interest, Assessment, and Satisfaction (ARIAS) and Problem Based Learning (PBL) on the concept mastery of temperature and heat. Second, it also aims to investigate the effectiveness of ARIAS and PBL learning model on the concept mastery of temperature and heat. The study uses Quasi-Experiment method with Nonequivalent Control Group Design, and sample selection with Cluster Random Sampling technique. This technique consists of two classes, i.e., experimental class I applying ARIAS learning model and experimental class II applying PBL model. The technique of data collection uses test instruments (pretest and posttest). The result of t test with 5% significant level indicates that t calculate = 2.03 > t table = 1.99, thus, it is concluded that (1) there is a difference using the learning model of ARIAS and PBL on concept mastery. The result of Effect Size test is a score of 0.45 with the medium category. Based on the result, it can be concluded that (2) using the learning model of ARIAS is more effective than PBL on the concept mastery of temperature and heat in high school students.

Keywords: misconception of physics learning, ARIAS, PBL, concept mastery, the effectiveness of learning

INTRODUCTION

A major problem encountered in the learning process is that learning in the classroom is still focused on listening and memorizing activities rather than on the interpretation and meaning, as well as building knowledge (Suardani, Swasta, & Widiyanti, 2014; Taale, 2013; Gambari, Shittu & Taiwo, 2016; Gorev et al., 2017; Thibaut et al., 2018). One of the efforts to overcome this problem is through learning innovation approach so that learning is more interesting and increases students' learning interest (Aina, 2015; Hanson, 2016; Kurihara, 2016; Suryati, Masrukan, & Wardono, 2013; Wekke & Hamid, 2013). A serious effort has been made in the domain of Natural Sciences, especially in the subject of Physics (Piyatissa, Johar & Tarofder, 2018; Yanga & Yenb, 2016; Wijayanti, Sukarmin, & Wiyono, 2015).

Physics is a universal science which underlies the development of modern technology as well as plays an important role in various disciplines and advancement of the human mind (Becerra-Labra, Gras-Martí, & Martínez Torregrosa, 2012; Garaeva & Ahmetzyanov, 2018; Gazzola, Otero & Llanos, 2015; Make & Yonas, 2018; Purwanti & Manurung, 2015; Saregar, 2016; Setyorini, Sukiswo, & Subali, 2011; Luneeva & Zakirova, 2017; Kalimullin & Utemov, 2017; Ke, Borakova & Valiullina, 2017; Cao, Kurbanova & Salikhova, 2017).

However, learning Physics in a classroom still faces several problems, such as Students' belief that physics is difficult and uninteresting (Basuki, Doyan, & Harjono, 2015). Besides, the learning methods are still conventional

Contribution of this paper to the literature

- ARIAS learning model is more effective compared to Problem-Based learning model in improving the physics concepts understanding
- This study reviews the actual reasons behind the concepts understanding improvement of the ARIAS learning model

such as lecture method (Gok & Silay, 2008). This causes students to be less excited and get bored (Khoiriyah & Rusimamto, 2016). Moreover, students also often get only one-way information, without being reinforced in understanding the concept of the ongoing subject material (Jayakumar, 2016; Kweka & Ndibalema, 2018; Lebdiana, Sulhadi, & Hindarto, 2013).

Concept mastery is important in studying physics (Hapsoro & Susanto, 2012; Linuwih & Sukwati, 2014; Owagbemi, 2018; Saregar, Diani, & Kholid, 2017; Saregar, Latifah, & Sari, 2016). However, students' concept mastery of physics is still lacking (Husein, Herayanti, & Gunawan, 2015). Thus teachers need to emphasize the concept mastery of physics in their learning (Adhim & Jatmiko, 2015; Iwuchukwu, Ineji & Inyang, 2018; Lestari & Rahayu, 2015). One of the materials of physics which requires a strong concept mastery is the material of temperature and heat (P, H, & Wisodo, 2016; Rimadani, Parno, & Diantoro, 2016).

Temperature and heat are the physics materials with the most misconception in the practice (P. P. Lestari & Linuwih, 2014). Some students assume that temperature and heat are the same (K & Komalasari, 2012). In the teaching of temperature and heat materials, some teachers experience constraints on how to embed the correct concept in students, in order to minimize misconception (Yolanda, Syuhendri, & Andriani, 2016).

The proper understanding of the concept of science can be undertaken, one of them by using a variety of learning models (Hamzah & Mohamad, 2012; Jiang & McComas, 2015; Martin & Ratna, 2015). Some learning models which can be applied in the learning of physics, among others: Project Based Learning (Munawaroh, Subali, & Sopyan, 2012), Inquiry (Sugiarti, Susanto, & Khanafiyah, 2015), Discovery Learning (Syafi'i, Handayani, & Khanafiyah , 2014), Problem Based Learning (PBL) (Mayasari & Adawiyah, 2015) and ARIAS Learning Model (Wibowo & Joko, 2014).

The learning models of ARIAS and PBL have been proven to improve concept mastery (Fauzan, Gani, & Syukri, 2017; Kadek, Kusuma, Riastini, & Pudjawan, 2017; Leliavia, Muhdhar, & Suwono, 2017). In accordance with the previous study, ARIAS learning model can improve the concept mastery (Andriyani & Soeprodjo, 2013; Hermawati, Lisa, & Elvia, 2014; Kadek et al., 2017; Kriana, Waluyo, & Concern, 2014). ARIAS learning model is the result of the development of ARCS model by Keller and Kopp in the effort to design learning which can influence the achievement motivation and learning outcomes (Rahayu, Waluyo, & Sugiman, 2014).

In addition to ARIAS learning model, Problem Based Learning (PBL) model can also improve the concept mastery (Alan & Afriansyah, 2017; Fauzan et al., 2017; Handika & Wangid, 2013; Mayasari & Adawiyah, 2015). Problem Based Learning is an innovative learning model which can optimize students' thinking ability, through systematic group or teamwork processes (Fauzan et al., 2017, Kim, 2016; Yoon, Woo, Treagust, & Chandrasegaran, 2014).

The study attempts to report the results of research related to which learning model is more effectively used to improve the concept mastery of temperature and heat materials on high school students, between the learning model of ARIAS with Problem Based Learning (PBL). The implementation of both ARIAS and PBL models are learning models which directly expose the students to the reality of everyday life so that the concept mastery of students can be trained.

RESEARCH METHODS

The study was conducted at Senior High School YP Unila of Bandar Lampung in the even semester of academic year 2015/2016. The research subjects consist of two classes, i.e., X MIPA 2 as the experimental class I (ARIAS) and X MIPA 4 as the experimental class II (Problem Based Learning). The materials learned in the study are temperature and heat. The sampling in the study used Cluster Random Sampling technique.

The study uses Quasi-Experiment Design method. The Quasi-experiment design used is Nonequivalent Control Group Design. The research variables used is the independent variable in the form of ARIAS learning model (X_1) and Problem Based Learning model (X_2), while the dependent variable is the Concept Mastery of Temperature and Heat (Y).

The technique of data collection in the study is in the form of test. The form of the written test questions used as pretest and posttest is plural choice. The test is used to obtain the data of students' concept mastery as the answer to the problems formulated. Before the test instrument is used, validity test, reliability test, distinguishing power,

difficulty level and distractor were done. The data analysis used in the study is a prerequisite analysis test in the form of normality test and homogeneity test.

The statistical analysis used to determine whether there is a difference between learning model of ARIAS and PBL, tested the hypothesis using t-test, and to find out the effectiveness of learning model on concept mastery using Effect Size test, some of the following formula can be used (Hake, 2002).

$$d = (M_A - M_B)/[(Sd_A^2 + Sd_B^2)/2]^{1/2}$$

with:

d = Effect Size,

M_A = the average Gain of experimental class I,

M_B = the average Gain of experimental class II,

Sd_A^2 = the standard deviation of experimental class I,

Sd_B^2 = the standard deviation of experimental class II.

The following formula can also be used (Nurhayati, Fadilah, & Mutmainnah, 2014).

$$ES = \frac{\bar{X}_x - \bar{X}_y}{SD_y}$$

with:

ES = Effect Size,

$\bar{X}_x$ = the average of experimental class I,

$\bar{X}_y$ = the average of experimental class II,

SD_y = the standard deviation of experimental class II.

The following formula can also be used (Ari Sumirat, 2014).

$$ES = t \sqrt{\frac{1}{N_1} + \frac{1}{N_2}}$$

with:

t = t-test score,

N_1 = the number of experimental class I students,

N_2 = the number of experimental class II students.

With the criteria of effect size as follows:

ES < 0.2   Low

$0.2 \leq ES \leq 0.8$ Medium

ES > 0.8   High

The study uses the formula of Hake to determine the score of Effect Size.

RESULTS AND DISCUSSION

Research Results

Prior to hypothesis testing, normality and homogeneity tests should be done with significance level (α) = 0.05.

The increase of the average mastery of experimental group I in **Table 1** can be seen from the average scores of pretest and posttest of 46.5 and 76.25. Whereas the increase of the average mastery of experimental group II in **Table 2** can be seen from the average scores of pretest and posttest of 50.62 and 73.12. Thus, it can be concluded that the learning of experimental group I which uses ARIAS learning model is better than experimental group II which uses the PBL model.

Table 1. The recapitulation of pretest and posttest scores in the experimental class I

Pretest	Description	Posttest
65	Highest Score	90
30	Lowest Score	55
1860	The total score of experimental class I	3060
46.50	Average score	76.50

Table 2. The recapitulation of pretest and posttest scores in the experimental class II

Pretest	Description	Posttest
65	Highest Score	90
30	Lowest Score	55
1860	Total score of experimental class II	3060
46.50	Average score	76.50

Table 3. The Recapitulation of Normality Test Results of experimental class I

Test results	L_h	L_{table}	Conclusion
Pre-post	0.11	0.14	Normal
ex. I	0.09	0.14	Normal
Pre-post	0.12	0.14	Normal
ex. II	0.13	0.14	Normal

Table 4. The Recapitulation of Homogeneity Test Results

Test results	$F_{calculate}$	F_{table}	Conclusion
Pretest	1.16	1.69	Homogeneous
Posttest	1.60	1.69	Homogeneous

Table 5. Hypothesis Test

Instrument	$T_{calculate}$	T_{table}	Description
N-Gain	2.03	1.99	$T_{calculate} > T_{table} = H_0$ is Rejected

Table 6. The Effect Size data of experimental class I and experimental class II

Mean of Ex. I	Mean of Ex. II	Effect Size	Criteria
30	24	0.45	Medium

Based on the **Table 3** of experimental class I, $L_{calculate} = 0.11$ is obtained, which is the largest value with the number of samples = 40 and significant level α = 0.05, then $L_{table} = 0.14$ also obtained. Based on the calculation results, it can be seen that at a significant level of 0.05, $L_{calculate} < L_{table}$, which means hypothesis H_0 is accepted. Thus, it can be concluded that the sample came from a normally distributed population. From the results of normality test for experimental class II, $L_{calculate} = 0.12$ is obtained, which is is the largest value with the number of samples = 40 and significant level α = 0.05, then $L_{table} = 0.14$ also obtained. Based on the calculation results, it can be seen that at a significant level of 0.05, $L_{calculate} < L_{table}$, which means hypothesis H_0 is accepted. Thus, it can be concluded that the sample came from a normally distributed population.

Based on **Table 4**, the pretest results of the experimental class I and the experimental class II are $F_{calculate} = 1.16$ and $F_{Table} = 1.69$. Whereas the posttest results of the experimental class I and the experimental class II are $F_{calculate} = 1.60$ and the same $F_{Table} = 1.69$. The table shows that $F_{calculate} < F_{table}$. It indicates that there is no significant difference, which means that the data are homogeneous or the same.

Based on **Table 5**, the scores of $t_{calculate} > t_{table}$ (2.03 > 1.99), which means H_0 is rejected. Thus, it can be concluded that there are differences in the learning model of ARIAS and Problem Based Learning (PBL) on the concept mastery of temperature and heat in the students of class X MIPA in Senior High School YP Unila of Bandar Lampung.

Based on **Table 6**, it is known that the score of Effect Size = 0.45 with medium criteria.

DISCUSSION

Students' concept mastery can be seen from the pretest and posttest scores. Pretest is given at the beginning of class before the temperature and heat materials are taught. From the data of study results in the experimental class I, the lowest score of 30 and the highest score of 65 with the average score of 47.5 are obtained. Whereas in the experimental class II, the lowest score of 35 and the highest score of 70 with the average score of 50.62 are obtained. Judging from the pretest average scores of both experimental class I and experimental class II, the students' concept

mastery of temperature and heat materials is still low, and both classes have the same initial capability of temperature and heat materials.

The learning given to the experimental group I and the experimental group II is adapted to the steps of both learning models which will be applied, i.e., the learning model of ARIAS and Problem Based Learning (PBL).

Students' learning using ARIAS learning model has better concept mastery, because in the process students feel more interested and motivated. Moreover, with ARIAS learning model, students can observe their own experiences, both in the past and in the future, around their environment and understand it.

Students' motivation develops into curiosity, as well as self-confidence and learning interest in improving the concept mastery of temperature and heat materials they learn. With this model of learning, learning becomes more interesting, fun and improves students' mastery. This is in accordance with the research results of Lastri et al. (Lastri, Arif, & Nurhidayati, 2015).

The results of pretest and posttest data analysis in both groups indicate that students' concept mastery is homogenous. Thus, in testing whether there is difference in concept mastery between the experimental group I and experimental group II, the statistical test used is parametric test, which is t-test. The use of ARIAS learning model affects students' concept mastery. The result of t-test with 5% significant level shows $t_{calculate}$ = 2.03 and t_{table} = 1.99. It means $t_{calculate} > t_{table}$, thus, it can be concluded that there is difference in the use of physics learning model of ARIAS with Problem-based learning (PBL) on students' concept mastery.

From the calculation result with the formula of Effect Size, score of 0.45 is obtained with medium category. Because the effect size score is positive, the experimental group I is more effective than the experimental group II. It indicates that the use of ARIAS learning model is more effective in improving the students' concept mastery on temperature and heat materials, than the use of Problem Based Learning (PBL) model.

The concept mastery of experimental group I with ARIAS learning model is higher than in experimental group II with PBL model. This is in accordance with the study (Lastri et al., 2015; Purnamasari & Nurfitri, 2013) which suggests that ARIAS learning model can improve students' learning outcomes. Other results (Khoiriyah & Rusimamto, 2016) suggest that the use of ethnomatematics-based ARIAS learning model can improve the capability of problem solving with the process skills of students. The results of the study (Kriana et al., 2014) indicate that ARIAS learning model is effective in improving the activities and learning outcomes of students (Saminan, Hamid, & Risha, 2017; Wardana & Edoh, 2017).

Similarly, the results of the study (Rahayu et al., 2014) also indicate that mathematics learning model of ARIAS assisted with problem card is effective in mathematical communication ability of students. The difference with this study lies in the variables, which focus on students' concept mastery. This study is supported by previous study.

This study has some limitations, in which the implementation of learning using the learning model of ARIAS and PBL is not maximum. The presentation of learning by researchers has not been fully met as planned. Less optimum class control made the classroom atmosphere less conducive that the concentration of students is disrupted.

CONCLUSIONS AND SUGGESTIONS

Conclusions

1. There is a difference between the implementation of physics learning model of ARIAS and Problem Based Learning (PBL) on the concept mastery of temperature and heat in the students of class X MIPA in Senior High School YP Unila of Bandar Lampung of academic year 2015/2016.
2. The implementation of physics learning model of ARIAS is more effective than Problem Based Learning (PBL).

Recommendation

Based on the results of the study, it is recommended that educators should apply such learning models that have been adjusted to the learning material for optimum students' ability and competence. Other researchers can continue using ARIAS and PBL learning models in other physics materials. Nevertheless, they should first re-analyze to adjust the implementation, especially in terms of time allocation and supporting facilities including learning media and students' characteristics in the school in which the device is applied.

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