

Influence of Learning Model Using Laboratory and Numeric Ability to Student Learning Result on Thermochemical Material

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Abstract

This study aims to determine the influence of learning models and numerical ability of students' chemistry learning outcomes on Thermochemical materials, as well as the interaction between learning models through the use of laboratory and numerical ability. The study was conducted on the students of grade XI IPA SMA N 1 Stabat consisting of 9 classes and 2 classes as samples taken by purposive sampling. Experimental research with factorial 2×2 factorial ANOVA design. Learning result data obtained from result of thermochemical learning result and student numerical ability data obtained through numerical ability test which have all been validated. The data analysis technique used two way analysis of variance (ANOVA). The result of the research shows that the influence of the learning model using the laboratory on the students' learning outcomes on thermochemical materials with $F_{count} > F_{table}$ is $4.015 > 3.99$, there is the effect of high numerical ability and low numerical ability to the chemistry learning result on thermochemical material with $F_{count} > F_{table}$ value is $23.717 > 3.99$ and there is interaction between learning model using laboratory with numerical ability to result of thermochemical learning with value $F_{count} > F_{table}$ that is $11.142 > 3.99$.

Keywords: ANOVA 2x2, learning outcomes, numerical ability, Problem Based Learning Model (PBL)

1. Introduction

The main problem in learning in formal education (school) which is still widely found in Indonesia today is about the low learning outcomes of learners. Especially in SMA Negeri 1 Stabat still found the results of student learning is still low. The result of daily test and the average of midterm's examination is still at the value of 68, far below the value of mastery learning by 75. Likewise in the learning of chemistry that has not reached the completeness of learning is expected

To improve students' learning outcomes, there is a need for learning that is interesting for students, among others, by using learning and media models in accordance with the material being taught. One of the learning models that can be used on thermochemical materials is a problem-based learning model known as Problem Based Learning (PBL). Thermochemical material is a learning material related to heat related problem (calor) which is close to life. According to Winarno et al. (2018) problem-based learning is learning where students learn about a subject through experience solving problems openly. To improve problem-solving skills, this learning model is considered the most appropriate teaching method. Likewise, according to Hmelo-Silver (2004), Savery (2006) states that PBL is a learning model in which students learn through problem-facilitated problem-solving that focuses on complex issues that have one correct answer. Meanwhile, according to (Becker & Maunsaiyat, 2004; Blumberg, 2000; Chen et al., 2001) states that Problem-based learning is described as a student-centered, inquiry-based approach and build problem-solving skills. In addition to learning models, effective use of laboratories can also support success in chemistry learning. The use of instructional media, especially the use of laboratory in the teaching and learning process can generate new desires and interests, generate motivation and stimulation of learning activities, and bring psychological influences on students. In learning, there are various learning media that can be used by teachers to attract students' attention in the class, such as: animation, module, concept map, comic, real laboratory, virtual laboratory and others (Arsyad, 2009). The use of laboratory media in this study is distinguished by virtual labs and real laboratories.

Learning media Virtual lab is a computer-based media that contains simulation activities in chemical laboratories and activities indirectly while Real laboratory is learning through direct observation where real learning laboratory

is equipped with tools and real materials to conduct experiments, in Real lab these students are really confronted with real objects (Kusnadi et al., 2013).

There are various studies that link between the use of Virtual lab and Real labs such as research conducted by Tatli and Ayas (2013), which describes that “Virtual chemistry labs are slightly more effective than Real labs, both of which show the achievement and ability of students to recognize laboratory equipment”. Another study was conducted by Aprilia (2015) which states that there is an influence of the PBL learning model using Real media labs and Virtual labs. From mean of cognitive learning achievement of students using learning PBL Virtual laboratories (71.25%) better than student using PBL learning with Real lab (58.75%). In addition, this study was also supported by Kusnadi et al. (2013) which showed a difference in the learning outcomes of chemistry by using a virtual laboratory (73.9%) slightly higher than that of Real lab (70.8%). Sugiharti, and SK Hasibuan, 2017) show that there is influence of inquiry learning model by using real laboratory and virtual laboratory on students’ chemical learning result on reaction rate material with $F_{count} > F_{table}$ i.e. $28.6367 > 3.99$

Chemistry is one of the subjects given in SMA/MA. Chemistry studies mostly contain abstract concepts and are memorative, calculating, thus requiring a good understanding of the concepts (Aprialisa & Mahdian, 2010). Thermochemical material other than related to life also uses a lot of calculation concepts so that students are expected to better use numerical skills in thermochemical learning. Numerical ability is a special ability in counting, so that numerical ability affects the ability of students to understand and solve the problem of calculation. However, the numerical ability of students is different. There are students who have high numerical ability and low. Students who have high numerical ability will work better in numeracy while students with low numerical skills will have difficulty in counting (Cahyono et al., 2016). Numerical ability is intended to make numerical operation speed accuracy (Addition, Reduction, Multiplication and Division). Numerical abilities in this case include: numerical justification, numerical logic, numerical computation, numerical estimation, and data representation (Abed et al., 2016). Irawan and Kencanawaty (2016) mentioned that numerical ability is the ability possessed by a person to use numbers to calculate and change the problem of story description into figures which can then be calculated.

Research by Fatoke et al. (2013) shows that learning problem solving and numerical ability of students can improve chemical performance. So it is recommended that teachers should consider the numerical ability of students in the teaching-learning process to effectively deliver their lessons in order to improve students’ performance in chemistry. The result of numerical ability study has also been done by Ayodele (2014) that numerical ability of students is one of the predictors in chemistry learning where teacher instructional, time and numerical ability of students when calculated accounted for 63.9% of total variance ($R = 0.639$, $p < 0.05$).

2. Methodology

2.1 Design of the study

This study aims to determine the influence of learning models and numerical ability of students’ chemistry learning outcomes on Thermochemical materials, as well as the interaction between learning models through the use of laboratory and numerical ability.

2.2 Participants

The population in this study were all student of class XI IPA at SMAN 1 Stabat curriculum of 2013, with the number of 9 class with the number of 35 student per class.

The sampling technique is done two times, namely taking a sample class and student sample, the sampling classes are conducted with purposive sampling technique, and so did the sampling of students in class were also conducted with purposive sampling technique, and so did the sampling students in class were also conducted with a purposive sampling based on the value of pretest relatively homogeogeneous and also based test against numeric abilities of student, to measure the level of numerical ability of students so that each class is divided into two parts which have a high numerical ability and students who have a low numerical abilities. After the determination of the sample were obtained 2 class. The first sample used as the firs experimental class given PBL learning model using real media, while the second sample used as the experimental class second treated Problem Based Learning model study using virtual media.

2.3 Measures and Covariates

This study uses a test instrument. The test instrument is an objective test (multiple choice questions). Instrument test used in this research is test result of student’s chemistry learning that is pretest and posttest. Pretest is given to the sample before treatment (treatment) in order to know the homogeneity and normality or similarity characteristic of the student’s early ability. Posttest is given after completion of treatment process (treatment) with

the aim to know student learning outcomes.

2.4 Research Design

The research design used is 2 x 2 factorial design. There are two factors studied namely PBL learning model using laboratory media (A) and numerical ability factor (B). Factor A there are two levels of learning model using virtual media collaboration and real laboratory. For factor B there are two levels of high and low numerical ability.

Table 1. Factorial design of research 2 x 2

Numerical Ability (B)	Learning Model	
	Problem Based Learning (A)	
	PBL Virtual Lab (A ₁)	PBL Real Lab (A ₂)
High (B ₁)	A ₁ B ₁	A ₂ B ₁
Low (B ₂)	A ₁ B ₂	A ₂ B ₂

Description:

A₁B₁ = Combination treatment of Problem Based Learning model with virtual media and numerical ability of high students.

A₁B₂ = Combination treatment of Problem Based Learning model with virtual media and low student numerical ability.

A₂B₁ = Combination treatment of Problem Based Learning model with real media and high student numerical ability.

A₂B₂ = Combination treatment of Problem Based Learning model with real media and low student numerical ability.

3. Results

Data collected in this study include: numerical ability data and students' chemical learning outcomes. These numerical data capabilities are grouped into two categories: high numerical ability for students with numerical ability scores \geq average numerical score of all students. Low numerical ability categories for students with numerical ability scores \leq average numerical score of all students. Overall data of high and low numerical ability is shown in Table 2.

Table 2. Data distribution of high and low numerical capabilities

Numerical Ability	Total	Experiment Class	
		Class I	Class II
		Frequency	
High	31	16	15
Low	39	19	20
Total	70	35	35

From the data processing presented obtained that for students who are taught by PBL learning model using Virtual Lab media and high numerical ability obtained average learning outcomes (84.43 ± 2.80), for class which is taught by PBL learning model using Virtual Lab media and low numerical ability obtained by average learning outcomes (73.73 ± 5.26). For classes taught by PBL model using Real Lab media and high numerical ability obtained average learning outcomes (83.73 ± 4.06) For classes taught by PBL model using Real Lab and low numerical ability obtained average learning outcomes (74.15 ± 1.38). The average details of the chemistry learning results obtained by the students for each treatment combination are presented in Table 3.

Table 3. Meaning of student chemical learning outcomes combined treatment of learning models and numerical thinking abilities

Numerical Ability (B)	Learning Models Using Laboratory Media (A)	
	PBL Virtual Lab (A ₁)	PBL Real Lab (A ₂)
High (B ₁)	(84.43 ± 2.80)	(83.73 ± 4.06)
Low (B ₂)	(73.73 ± 5.26)	(74.15 ± 1.38)

Hypothesis testing is done by Analysis of Varians (ANOVA) 2 lane at $\alpha = 0,05$ with criterion if $F_{count} > F_{table}$ then H_0 rejected. Based on hypothesis test of data of student learning result, it is concluded that there is interaction between numerical ability (B) with learning model by using laboratory media (A) on thermochemical learning result. A list of learning results that were given a combination of treatment of learning models using laboratory media and numerical abilities is shown in Table 4.

Table 4. ANOVA list of chemical values of students given a combination of learning model treatment using laboratory media and numerical ability

Source of Diversity	Df	SSW	MS	F_{count}	F_{table}
Factor A	1	34.30	34.30	4.015	3.99
Factor B	1	202.62	202.62	23.717	3.99
Interaction AB	1	95.19	95.19	11.142	3.99
Error	66	563.87	8.54	-	-
Total	69	895.98	-	-	-

Note. Df= degree of freedom; SSW= sum of square, MS= mean squares.

4. Discussion

Hypothesis 1

$F_{count} (A) > F(0.05) (1; 66)$ where $4.015 > 3.99$ then H_0 is rejected, there is influence of learning model of PBL by using media to student learning result on thermochemical material. This influence shows that the class that is learned by PBL learning model using virtual lab media has higher average learning result score that is 84.43 compared to learning model using real lab that is 83.73. Sahyar et al.'s (2017) study found that Problem Solving Ability Students who learned to use Problem-Based Learning Models were better than conventional learning. The results (Gulmah S, 2017) found that PBL models gave better learning outcomes (26.57 ± 5.81) than Direct Instruction model (24.04 ± 2.86) and this study concludes that students with high mathematical ability are very suitable to be taught with PBL model. Furthermore, Sugiharti and Hasibuan (2017) study found that there is influence of learning model by using real laboratory and virtual laboratory on students' chemistry learning on reaction rate material with $F_{count} > F_{table}$ value $F 28.6367 > 3.99$. While research Kusnadi et al. (2013) states that learning using virtual lab media more effectively indicated by the average score of cognitive students of 73.9 compared with the average cognitive value of students using real lab of 70.8. Furthermore, according to Tatli et al. (2013) states that some researchers argue that experimenting with virtual labs is more effective than doing real laboratory experiments.

Hypothesis 2

$F(B) > F(0.05) (1: 66)$ where $23.717 > 3.99$ then H_0 is rejected, meaning there is influence of high numerical ability and low numerical ability to student learning outcomes on thermochemical material. Data on student learning outcomes on thermochemical materials concluded that students who have high numerical ability to provide higher average learning outcomes compared with students who have low numerical ability. The average of student learning outcomes with high numerical ability is 78.62 while the average of student learning outcomes with low numerical ability is 78.20. Abed's (2016) study states that numerical ability tests for students in education can be used to categorize students in the dimensions tested. Research conducted by Olatoye and Aderogba (2011), states that numerical ability affects student achievement in general ability test this is indicated by the percentage value of numerical ability of 35.6%. In line with this, research conducted by Cahyono et al. (2016) which states that there is a significant relationship between numerical ability with learning achievement on hydrolysis material, from the test t-two parties obtained the value of significance 0.014 and Pearson correlation coefficient 0.304. While Badru's (2016) study found a high numerical ability to have a higher adjusted average value than those with

low numerical ability. It is also said that students with high numerical ability perform better than students with low numerical skills.

Hypothesis 3

$F\text{-Count (AB)} > F(0.05) (1:66)$ i.e. $11.142 > 3.99$ then H_03 is rejected means there is interaction between learning model using laboratory media with numerical ability to student learning result on thermochemical material. In this study, it was found that if the factor of learning model by using laboratory media (factor A) and numerical ability (factor B) is combined, the interaction between the two factors significantly influences student learning outcomes. The form of factor model interaction using medial collaborator (factor A) and numerical ability (factor B) on student learning outcomes can be described as shown in Figure 1.

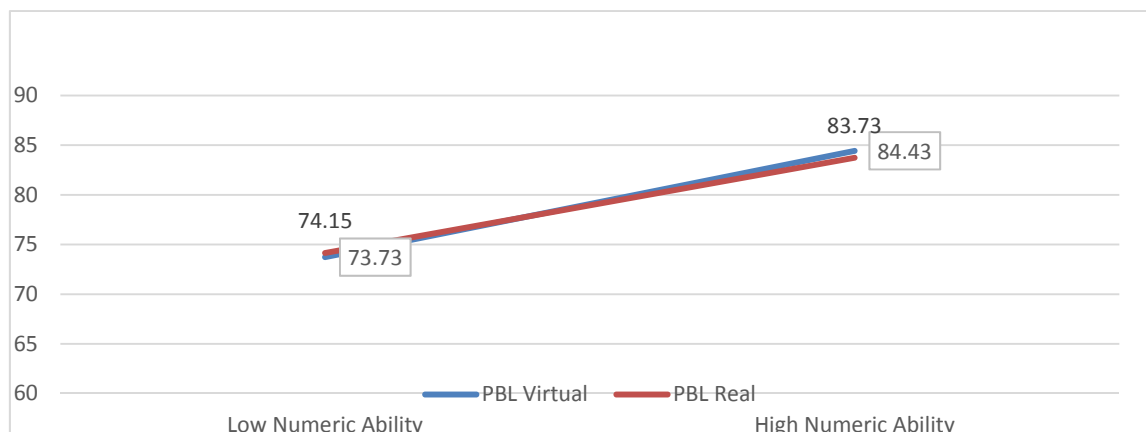


Figure 1. Interaction form factor model learning and numerical ability to student chemistry learning results

Based on the form of interaction between the learning model using laboratory media (factor A) and numerical ability (factor B) on thermochemical learning result as presented in Figure 1. It can be concluded that the student learning outcomes are taught by PBL learning model using virtual lab media with high numerical ability has a higher average learning outcome of 84.43, while the learning outcomes of students who are studied with PBL learning models using real laboratory media with high numerical ability have a lower average learning outcome of 83.73. Furthermore, the learning outcomes of students who are taught by PBL learning models using virtual lab media with low numerical ability have average learning outcomes of 74.15, whereas student learning outcomes that are taught by PBL learning models using real laboratory media with low numerical ability have average learning outcome of 73.73. So it can be concluded that there is interaction between learning model using medial collaborator and numerical ability where obtained F_{count} for interaction between learning model and numerical ability = 11.142 so $F_{\text{count}} > F_{\text{table}}$. Interaction graphs can also be said in fact the effect of high and low numerical skills is almost no different in terms of improving student learning outcomes.

The interaction between the PBL model and the numerical capability obtained is not as expected, with the intersection of graphic almost coincidental. This occurs because the mean difference between the two treatments is not much different.

5. Conclusion

The influence of the learning model using the laboratory on the students' learning outcomes on thermochemical materials with $F_{\text{count}} > F_{\text{table}}$ is $4.015 > 3.99$, there is the effect of high numerical ability and low numerical ability to the chemistry learning result on thermochemical material with $F_{\text{count}} > F_{\text{table}}$ value is $23.717 > 3.99$ and there is interaction between learning model using laboratory with numerical ability to result of thermochemical learning with value $F_{\text{count}} > F_{\text{table}}$ that is $11.142 > 3.99$.

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