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BLENDED LEARNING: THE EFFECT ON HIGHER ORDER THINKING SKILLS (HOTS) IN THERMODYNAMICS

Asep Saefullah[1*], Amalia Fitriyani[2], Yayat Ruhiat[3], Diana Ayu Rostikawati[4]
[1,3]Department of Physics Education, Universitas Sultan Ageng Tirtayasa, Indonesia
[2]MTs Al Wathoniyah 43 Jakarta, Indonesia
[4]Departmnet of Mathematics Education, Universitas Bina Bangsa, Indonesia

**Corresponding author:* asaefullah@untirta.ac.id

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ABSRACT

This study aims to determine the effect of the application of the blended learning model to improving higher order thinking skills (HOTS) on thermodynamic material. The research method used in this study is quasi-experimental, while the research design used is Non Equivalent Design. Samples were taken using purposive sampling technique, with class XI MIA 1 as an experimental class and XI MIA 2 as a control class. The instrument used in this study was an HOTS test item in the form of multiple choice questions. Data analysis techniques using SPSS software to test hypotheses, and Microsoft Excel to determine the magnitude of the increase in HOTS. The results of the independent sample t-test showed a significance value (2-tailed) of 0.03. Large increase in the experimental class by 0.50 (50%), and by 0.40 (40%) in the control class. This shows that learning using the blended learning model has a better effect in HOTS than learning without blended learning.

BLENDED LEARNING: PENGARUHNYA TERHADAP *HIGHER ORDER THINKING SKILLS* (HOTS) PADA MATERI TERMODINAMIKA

Kata Kunci:

Blended learning
Kemampuan berpikir tingkat tinggi
Termodinamika

ABSTRAK

Penelitian ini bertujuan untuk mengetahui pengaruh penerapan model *blended learning* terhadap peningkatan kemampuan berpikir tingkat tinggi (HOTS) pada materi termodinamika. Metode penelitian yang digunakan dalam penelitian ini adalah kuasi eksperimen, sementara desain penelitian yang digunakan adalah *Non Equivalent Design*. Sampel diambil dengan menggunakan teknik *purposive sampling*, menggunakan kelas XI MIA 1 sebagai kelas eksperimen dan XI MIA 2 sebagai kelas kontrol. Instrument yang digunakan dalam penelitian ini adalah instrumen test soal HOTS berbentuk pilihan ganda. Teknik analisis data menggunakan *software* SPSS untuk uji hipotesis, dan *microsoft excel* untuk mengetahui besar peningkatan HOTS. Hasil uji *independent sample t-test* menunjukan nilai signifikansi (2-*tailed*) sebesar 0,03. Besar peningkatan pada kelas eksperimen sebesar 0,50 (50%), dan sebesar 0,40 (40%) pada kelas kontrol. Ini menunjukan pembelajaran menggunakan model *blended learning* memberikan pengaruh peningkatan HOTS yang lebih baik dibanding pembelajaran tanpa *blended learning*

1. INTRODUCTION

Learning continues to evolve as information and communication technology (ICT) advances. The influence of ICT advances in the learning process includes the shift of limited time of learning in the classroom to be easy learning that can be accessed anywhere and anytime, the shift from paper to online learning, and the shift of physical facilities to network facilities [1]. The availability of good facilities and infrastructure are including internet facilities in most schools should be optimized to do e-learning based. E-learning can improve the learning experience because students can be able to learn anywhere and under any circumstances as long as they can access the internet [2]. The atmosphere of e-learning forces students to be able to present a more active role in the learning process because e-learning requires students to look for the material with their effort and initiative.

The appearance of e-learning arouses some new learning models, namely Blended Learning, Mobile Learning, Web-Based Learning, Virtual Learning, Internet Learning, Networked Learning, and Distance Learning. Blended Learning is a learning model that combines face-to-face learning with online learning [3]. In face-to-face learning, there is direct attention by teachers, interactive and responsive, while online learning makes students easy to access the material anytime and anywhere. ICT based learning cannot be separated from the learning demands of the 21st century, which is technology integration as a learning media to develop learning ability.

The learning process in the 21st century has characteristic purposes arranged in 4C, namely: Communication, Collaboration, Critical Thinking, and Problem Solving, Creativity, and Innovation [5]. In general, several aspects indicate the High Order Thinking Skill (HOTS) or high-level thinking ability that a person has, namely critical thinking, creative thinking, then solving the problem [6]. One of the International studies on student's cognitive skills that is Trends in Mathematics and Science Study (TIMSS) in 2011 in the science field (including Physics) showed that students' ability on the cognitive level of analysis and application is lower than the cognitive level of understanding or memorizing. It indicated that the high-level thinking ability of Indonesian students is quite low [7], [8]. The low HOTS on students' ability can be made by the learning process that has not been oriented on the empowerment of high-level thinking ability and only emphasized understanding the concepts. Based on the school observations, most teachers still use the direct learning method and have not been utilized the ICT facilities available in the school.

The availability of computer laboratory facilities and the internet in the school makes the use of the Blended Learning model perceive as appropriate to be implemented. Blended Learning can combine with Cooperative Learning which focuses on learning as a group [9]. One of the learning approaches of Cooperative Learning is Student Teams Achievement Divisions (STAD), which emphasized the students to interact as a group to achieve a better achievement [10] [11]. Thermodynamic material was chosen because there were still limited studies related to Physics Education in this material. Thermodynamic is a part of Physics that learned about the heat. The point discussion is including the 1st and 2nd laws of Thermodynamic, Isobaric experience, Isochoric, Isothermic, then adiabatic, and other topics [12] [13].

In the previous studies, there were some efforts done to improve students' high-level thinking ability, such as: developing a HOTS-based of students' worksheet [14], creating HOTS-based on physics' practicum tools [6], and use some kinds of Cooperative Learning model [15], and Problem Based Learning [16]. Previous studies have also implemented the Blended Learning model, but only to increase students' learning outcomes in the concept of straight motion [17]. Therefore, in this study, the Blended Learning model was

chosen to improve the high-level thinking ability (HOTS) in the Thermodynamics material.

2. METHOD

This study is quasi-experimental research using a Non-Equivalent Design. This design divided the research objects into two groups, namely one as a control class and one as an experimental class [18]. The research procedure consisted of 3 stages, namely: First stage, the implementation stage, and the last stage.

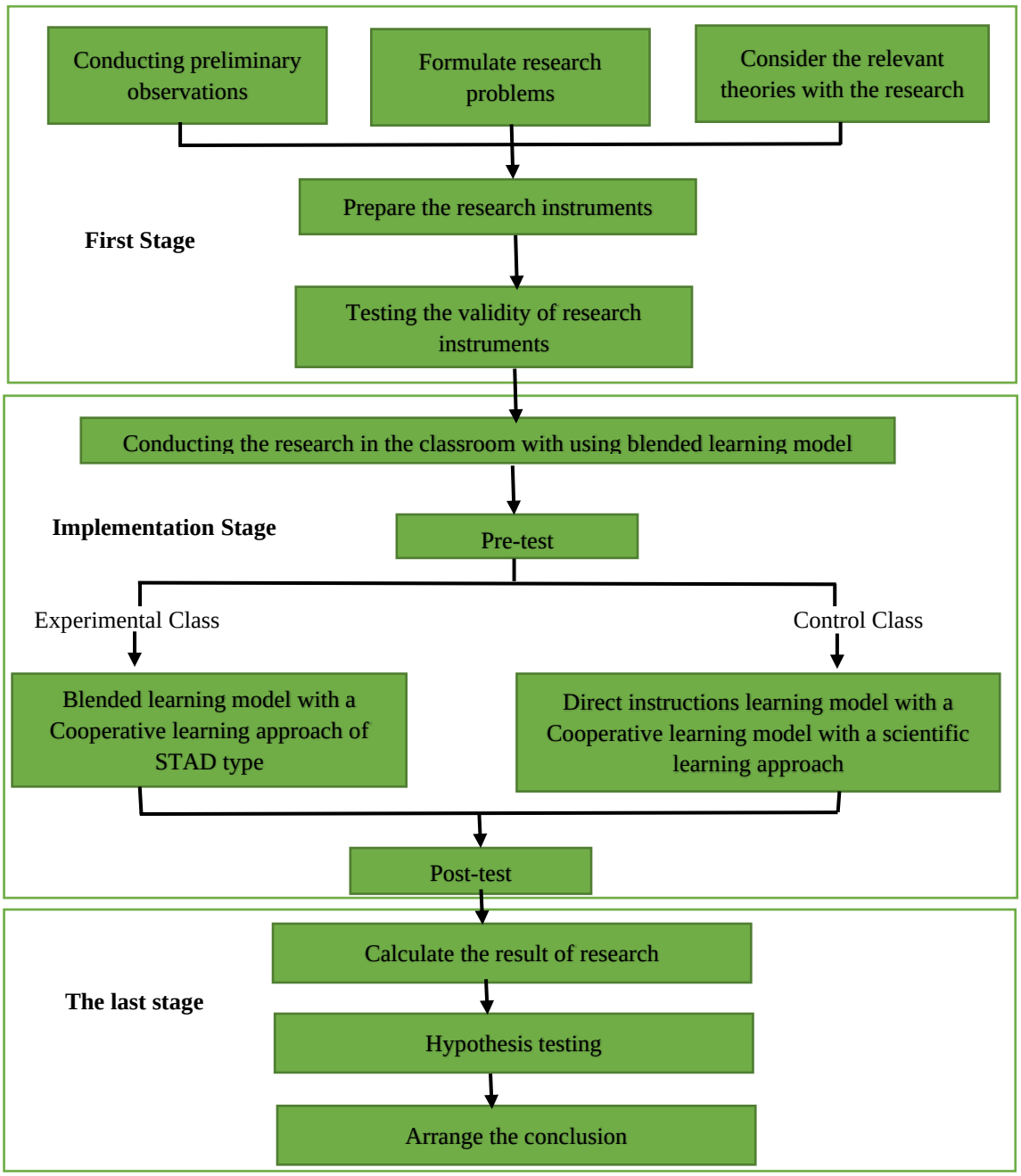


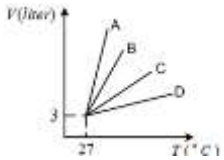
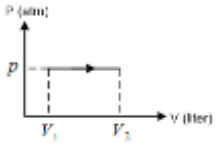
Figure 1. Flowchart of Research Procedures.

This research was conducted from February to April 2019 at MAN 21 Jakarta. The research sample in this research were students of XI MIA 1 and XI MIA 2, the sampling technique established by using a purposive sampling technique, that is a sampling

technique with specific considerations or special selection [18]. The criteria used in choosing the research sample have a relatively similar level of ability between the two groups.

The research instruments were High Order Thinking Skills (HOTS) test instruments in the form of multiple-choice questions. The research instruments consisted of a cognitive level of analysing (C4), evaluating (C5), and creating (C6). Then, instruments were testing the validity and reliability test using Quest software [19]. The results of the validity test showed the question instruments has been created as valid and reliable criteria in a high category [20]. Examples of question test instruments in this study can be seen in Table 1.

Table 1. Example of HOTS Question Test Instruments in the Thermodynamic Material.

Cognitive Level	Indicator of Questions	Example of Question
Analysing (C4)	Analyse the graphic of V and T in the Isobaric process to determine the largest effort	There are four canisters consist of gas A, gas B, gas C, and gas D. Each gas has the same initial temperature volume. The four tubes heated in the relatively same time on the constant pressure, as shown in the following picture.  Which Gas has the largest effort …. a. Gas A d. Gas D b. Gas B e.cannot be determined c. Gas C
Evaluating (C5)	Evaluate statements below based on the provided data in the table.	Pay attention to the table. **Experiment** | **T_1 (K)** | **T_2 (K)** | **Q_1 (J)** 1. | 400 | 100 | 200 2. | 400 | 120 | 200 3. | 500 | 150 | 400 4. | 500 | 200 | 400 Based on the table above, so 1. The largest efficiency of the engine existed in experiment 1. 2. The largest effort was produced by experiment 4. 3. The engine efficiency of experiment 2 was similar to experiment 4. 4. The smallest effort existed in experiment 2. The correct statement is indicated on the number... a. 1, 2 and 3 b. 1 and 3 d. 4 only c. 2 and 4 e. 1, 2, 3 and 4
Creating (C6)	Create an equal change of under energy based on graphics and data.	The ideal amount of gas is m mass, doing the process in p constant pressure.  If the volume changes from V1 into V2 and the temperature changes from T1 to T2, so Cp is the type of heat of P constant, and Cv is the type of V constant, so the energy change in it is… a. $mc_p(T_2-T_1)$ d. $mc_v(V_2-V_1)$ b. $p(V_2-V_1)$ e. $mc_p(V_2T_2-V_1T_1)$ c. $mc_v(T_2-T_1)$

The data from test results was analysed using statistical analysis, such as the normality test and hypothesis test (independent t-test and one-tailed test). Statistical analysis was using software named SPSS volume 16. The pre-test and post-test data were processed and analysed by using Microsoft excel to found out students' improvement of high-level thinking after being given treatments through the calculation of n-gain [21] as can be seen in Table 2 below

Table 2. Categorization of n-gain Value

n-gain	Interpretasi
$g > 0{,}7$	High
$0.3 > g \leq 0.7$	Medium
$g < 0.3$	Low

3. RESULTS AND DISCUSSION

Before move into the discussion and result analysis, here is an overview of the operational procedures of the research that has been carried out.

Table 3. *Storyboard* of Research Procedure

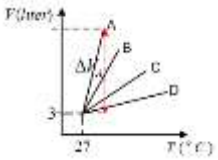
Syntax	Research Procedure
1. Determining the learning purpose 2. Preparing the material and learning media.	Determining the learning purpose aims to improve students' High Order Thinking Skills (HOTS) in the Thermodynamic material.  • Preparing HOTS-based of students' worksheet (LKPD) in the Thermodynamic material. • Preparing google classroom flatform that uses in online learning. • Preparing material of presentation for face-to-face learning.
3. Determining the strategy and learning methods.	Choosing Blended Learning combines face-to-face learning and online learning. Online learning can facilitate students to access the material to learn easily. While, the Cooperative learning approach of the STAD chose to facilitate students to be cooperative in the learning process to achieve the greatest achievement specifically in the improvement of HOTS.
4. Doing Online learning.	• Upload the learning material including HOTS-based of students' worksheet by application: *Google Classroom*.  amalia fitriyani 28 Feb 2019 Assalamualaikum wr wb. selamat sore, berikut saya lampirkan link lembar kerja peserta didik (LKPD) bagian 1. silah unduh dan dikerjakan bagian yang harus dikerjakan di buku catatan. kerjakan sebisa kalian, dan jangan mencontek sebelum mulai pembelajaran akan ada pengecekan tugas :) jika ada hal yang kurang dimengerti silahkan ditanyakan melalui gclass. terima kasih :) selamat mengerjakan :) https://drive.google.com/file/d/1H4bEjoWZ3R_ykMydN3fZXv0d2cnp_Zoo/view?usp=sharing • Doing the online interaction with students about material and tasks that has been provided. • The teacher assigns the students to learn the material that will discuss in face-to-face learning, so the students already have the initial knowledge. • The initial knowledge can be useful in sharpening analytical and evaluating skills during face-to-face learning.

5. Doing face-to-face learning.	Doing face-to-face learning or implementing the STAD approch.	
6. Evaluating the learning process.	Evaluate the learning process in Thermodynamic material using HOTS-based questions.	

The efforts of improving students' HOTS in the Thermodynamic material made by created HOTS-based of students' worksheet that can be download into *google classroom* in online learning [14] [15], and implementing Cooperative learning with the STAD approach during face-to-face learning [16].

Here is an example of a solution on HOTS-based questions listed in Table 2 on the analysing level, accompanied by students' analysis answers of the control class and experimental class at each cognitive level.

Table 4. Example of HOTS Discussion

Cognitive Level	Answer Discussion	Students' Analysis Answers
Analysing (C4)	The effort of the process of constant pressure of Isobaric is, so to determine the largest effort seen by the volume change.  The results of the graphic showed that gas A involved the largest volume change, so gas A gained the largest effort.	• In the control class, 12 students answered correctly when did the pre-test, and 17 students who answered correctly while doing the post-test. N-gain of the question in control class was 0,29 in the low category. • In the experimental class, 8 students answered correctly while answered the pre-test, and 34 students who answered correctly when answered the post-test. N-gain for this question in the experimental class was 0,80 in the high category.

The result findings obtained the value of independent sample t-test gained significant value in 0,03 (smaller than 0,05) indicated that the Physics learning with Blended Learning model can be influenced through the improvement of students' High Order Thinking Skill (HOTS) in the Thermodynamic material. The result of hypothesis testing using a one-tailed test obtained the value as t_{count} = 2,1976 higher than t_{table} = 1,6921 indicated the improvement of HOTS on students' ability given by the Blended Learning model was better than students who did not get the Blended Learning model. As for, the largest improvement of students' HOTS in control class and experimental class can be seen in Table 4.

Table 5. Students' High Order Thinking Skill (HOTS) Ability

Class	Pre-test Score	Post-test Score	N-gain Value
Control	23,68	54,26	0,40 (40%)
Experimental	26,18	62,79	0,50 (50%)

Based on Table 5, it can be seen that both of control class and experimental class had a low pre-test score, the score of the control class was 23,68 and the score of the experimental class was 26,18. It seen from both pre-test scores, students had the low ability of High Order Thinking Skills (HOTS). Several things caused students to have a low ability

of High Order Thinking Skill (HOTS), such as the implementation of direct instruction frequently has not been able to accommodate the personal differences even more with a large number of students in a classroom, less of learning time because other activities often confiscate the learning process then teacher give them a limited time of learning material, students have limited attention and the content of theories require a deep understanding.

As for, if the data in Table 5 presented in a diagram form, then it will obtain a diagram as Figure 2 below.

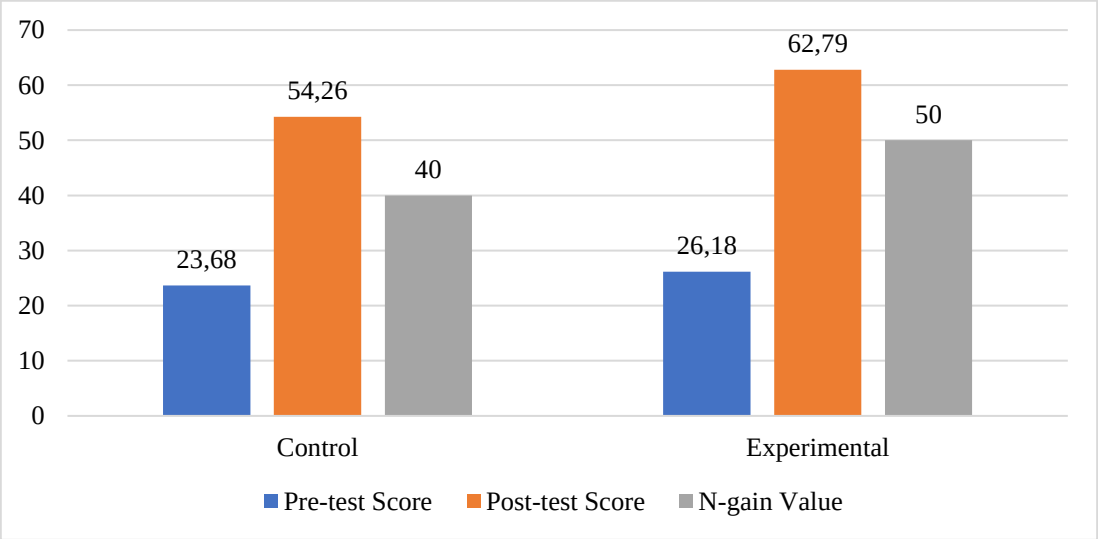


Figure 2. Pre-test Score, Post-test Score, and n-gain of High Order Thinking Skill (HOTS) of Control Class and Experimental Class.

According to Figure 2, it also seen the control class was improved High Order Thinking Skill (HOTS), from a pre-test score was 23,68 to a post-test score of 54,26 with a normalized gain value as 0,40 or 40% and categorized in a medium category. It related to the statements from previous studies that Cooperative learning can be able to increase the High Order Thinking Skill (HOTS) in a medium category [17]. In the experimental class, it seen that the students enhanced High Order Thinking Skills (HOTS), from a pre-test score of 26,18 to a post-test score of 67,29 with an improved level as 0,5 or 50% and it categorized into a medium category. It means that Blended Learning with the Cooperative model in STAD type can be improved students' High Order Thinking Skills (HOTS) in Thermodynamic material. It also related to the previous studies stated that Blended Learning can be able to enhance a high-level of thinking skill in the Mathematics field (HOTMC) [22].

High Order Thinking Skills (HOTS) ability consisted of 4 levels of cognitive abilities, namely: analysing (C4), evaluating (C5), and creating (C6). Table 6 showed the pre-test score, post-test score, and the value of n-gain in the control class and experimental class at each cognitive level of High Order Thinking Skills (HOTS).

Table 6. High Order Thinking Skill (HOTS) for Each Indicator

Indicators	Control Class			Experimental Class		
	Pre-test	Post-test	n-gain	Pre-test	Post-test	n-gain
Analysing	21,15	72,00	0,64	22,88	79,25	0,73
Evaluating	25,33	43,17	0,24	27,00	50,00	0,32
Creating	29,00	26,00	-0,04	24,00	15,00	-0,11

Analysing Level (C4)

At the cognitive level of analysing, the pre-test score of the control class was 21,15, meanwhile, the post-test score was 72,00. There was an improvement of students' High Order Thinking Skills (HOTS) in analysing level with large increases of 0,64 or increased by 64% in a medium category. In the experimental class, there was an improvement of students' High Order Thinking Skills (HOTS) from a pre-test score of 22,88 into a post-test score of 29,25. The improvement of analysing level to experimental class was 0,73 or improved in 73% and indicated in a high category.

Evaluating Level (C5)

At the cognitive level of evaluating, the pre-test score of the control class was 25,33, while the post-test score was 43,17. There was an improvement of students' High Order Thinking Skills (HOTS) in evaluating level as 0,24 or improved in 24%, then categorized in a low category. In the experimental class, the pre-test score on the evaluating level was 27,00, while the post-test score was 50,00. There was an improvement in evaluating level in students' High Order Thinking Skills (HOTS) in 0,32 or 32% and indicated into a medium category.

Creating Level (C6)

At the cognitive level of creating, the pre-test score of the control class was 29,00, although the post-test score was 26,00. There was an enlargement of cognitive level in students' High Order Thinking Skill (HOTS) in 0,04 or 4% and obtained a low category. In the experimental class, the pre-test score in evaluating level was 24,00, although the post-test score was 15,00. There was an enlargement of the cognitive level of evaluating in students' High Order Thinking Skills (HOTS) as -0,11 or 11% and obtained a medium category.

The results of the High Order Thinking Skill (HOTS) at each indicator can be seen in Figure 3 below.

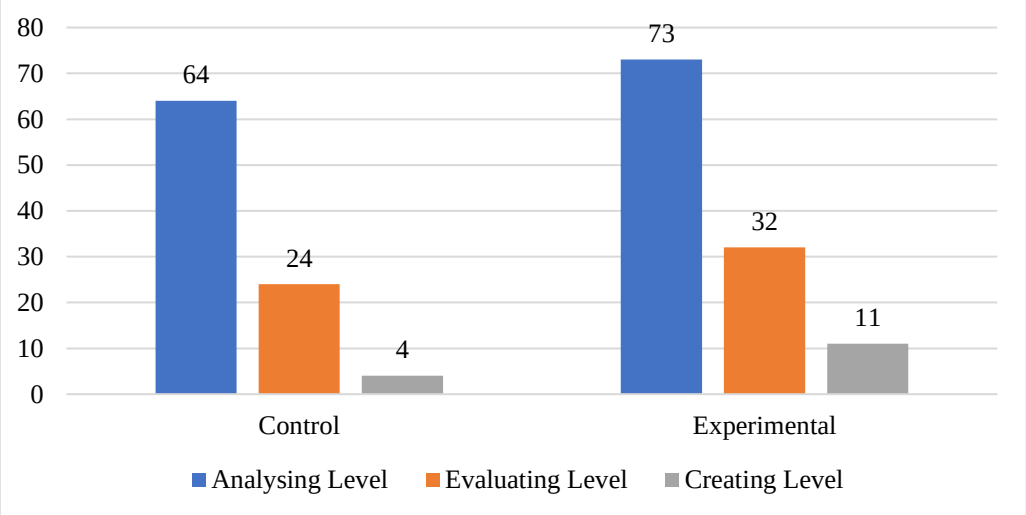


Figure 3. N-gain Diagram of High Order Thinking Skill (HOTS) at Each Cognitive Level

Based on Figure 3 seen in the cognitive level of analysing, students in the control class and experimental class have the largest improvement of High Order Thinking Skills (HOTS) instead of the cognitive level of evaluating and creating. It showed that students' analysing ability was quite good with an average score of 72. Whereas, in the creating level, students in the control class and experimental class got a decreasing of High Order

Thinking Skills (HOTS). The similar results were also obtained from research conducted by Yusmanto (2017), stated Cooperative learning with using students' worksheet can be able to improve students' High Order Thinking Skill (HOTS), started from analysing level, evaluating level, up to a creating level. The findings also showed the creating level got the lowest improvement than others' cognitive level because students still have some difficulties in finding the answers from a different perspective [17]. In this study, several factors showed the cause of the declining progress of students' High Order Thinking Skill (HOTS), among others: students' lack of understanding of the related problem in creating formulas from the problem given. Moreover, the number of questions in creating level is also limited (only one question) to measure students' High Order Thinking Skill (HOTS). It causes the students' ability in creating level was decreasing.

Previous studies also obtained findings that students' High Order Thinking Skills (HOTS) on creating levels had the lowest improvement. Students still got some difficulties obtaining the answers from other sides or different perspectives.

4. CONCLUSION

According to the results and discussion, it obtained the conclusion that Physics learning with using Blended Learning influenced students' High Order Thinking Skills (HOTS) in the Thermodynamic material. Besides that, students are given a learning model of Blended Learning got a better High Order Thinking Skill (HOTS) improvement than students were not given a similar treatment. The experimental class increased with 0,50 (50%) at a medium level, meanwhile in the control class was improved with 0,40 (40%) in a medium category. In the cognitive level of analysing (C4) of experimental class improved in 0,72 (73%) in a high category and control class enhanced in 0,64 (64%) in a medium category, in the cognitive level of evaluating (C5) of the experimental class was increased as 0,32 in a medium category and control class was 0,24 in a low category, then in the cognitive level of creating (C6) of experimental class improved in -0,11 and control class in 0,04. It indicated that the Blended learning model gives a better result on students' High Order Thinking Skills (HOTS) than learning without using the Blended learning model. The research findings also showed a balanced number of questions as instruments test at each cognitive level towards High Order Thinking Skills (HOTS).

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