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Implementation of higher order thinking laboratory (HOTLAB) on magnetic field with real blended virtual laboratory to improve students critical thinking skills

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Implementation of higher order thinking laboratory (HOTLAB) on magnetic field with real blended virtual laboratory to improve students critical thinking skills

W Setya[1*], R D Agustina[1], R P Putra[1], S Prihatini[1], R Hidayatulloh[1], P S Isnaeni[1], and A Malik[1]

[1]Program Studi Pendidikan Fisika, UIN Sunan Gunung Djati Bandung, Jl. Cimencrang, Bandung 40292, Indonesia

[*]suratwindasetya@uinsgd.ac.id

Abstract. The 21st century demands critical thinking skills, problem solving, and communication skills, so physics education students must be prepared to have these skills in the current industrial 4.0 era. These skills can be trained and developed through Higher Order Thinking Laboratory (HOT-LAB) activities. The purpose of this study was to analyze the effect of the HOT-LAB laboratory type on the improvement of critical thinking skills on the concept of magnetic fields. This research uses One Group Pretest-Posttest Design. The instrument uses questions of practical understanding and understanding of 10 questions. The results of data analysis showed that the average N-Gain score for the experimental class was 45.3 and the control class was 35.7. The use of HOTLAB in a real blended virtual laboratory has moderate effectiveness to improve Critical Thinking Skills on the subject of magnetic field.

1. Introduction

Education has an important role in the process of developing a country, the quality of education in that country must be one of the important things that must be considered [1,2], one of the important concerns is that science lessons, especially physics, are still lacking in place. in the hearts of students. Physics is considered a difficult subject and less fun. Teachers also do various ways to overcome so that physics subjects are more fun and enjoyable, so they are motivated to study physics [3,4].

The teaching and learning process is essentially a communication process, delivering messages from the introduction to the recipient, messages in the form of content or teachings that are poured into communication symbols, both verbal and nonverbal, this process is called encoding. in that interpretation sometimes it works, and sometimes it doesn't work or fails. in other words, it can be said that the failure or inability to understand what is heard, read, seen, or observed is caused by disturbances that hinder communication [5]. The effectiveness of the learning process is reflected in the students' efforts in achieving learning objectives in accordance with the learning objectives that have been applied. The effectiveness of the learning process is related to the paths, efforts, techniques, and strategies used in achieving learning objectives optimally, precisely and quickly [6].

The use of the laboratory can be used as a supporting medium [7]. The learning process can be carried out by conducting direct experiments in real laboratories [8]. As reported in previous research, practicum becomes the spirit of physics learning which can also improve students' process skills [9]. The types of laboratory activities in schools are generally divided into two, namely: real and virtual laboratories. A real laboratory is a real laboratory where all tools and materials used for practical purposes are real (can be held and seen) [10]. The learning applied to the real laboratory is learning through direct observation.

Real laboratory learning is equipped with real tools and materials to conduct experiments, in this real laboratory students are faced with real objects. Real laboratory learning is needed to encourage students to be enthusiastic about learning and have certain experiences [11].

This real experiment is a way in which students work together on an exercise or experiment to find out the effect or effect of an action. Through real experiments students learn facts, symptoms, concepts, principles, laws and so on. So that in addition to acquiring cognitive knowledge, you can also acquire skills/performance and can apply these knowledge and skills to new situations and acquire a scientific attitude [2,12]. As for the implementation of a good laboratory, it is required to have good management, the management in question includes: 1) experts and skilled technicians, 2) efficient management, 3) administrative, 4) adequate equipment, 5) adequate facilities, and 6) building facilities according to the provisions and complete [13].

One of the determining factors for the success of laboratory activities in training and equipping higher order thinking skills is the practicum model used. The practicum model represents the stages and work activities carried out. Thus, each practicum model has specific learning objectives that students want to provide through practical activities using the model [14]. The HOT-V Lab model is a virtual practicum model oriented to practice critical thinking skills and creative problem solving through practicums that involve physics materials with a high level of abstraction. Based on the research results [14], there is strong evidence that the HOT-V Lab model is able to produce high effectiveness in improving students' critical thinking skills (KBK) and creative problem solving (KPMK). HOTRVL is analyzed for its effects before being implemented in a meaningful physics learning curriculum and lifelong learning in accordance with the industrial revolution 4.0 [15].

To understand abstract concepts, in general, high reasoning skills are needed. To achieve high-level reasoning abilities, students need to be familiarized with learning methods that require the use of reasoning. By being trained in using their reasoning abilities, in the process of understanding physics concepts, students do not only use empirical experience, but are also accustomed to understanding concepts through reasoning. So that students are accustomed to using their reasoning abilities, it takes a model, method, strategy and learning media that can be used to make it easier to understand and master physics concepts through the reasoning process [16]. Critical thinking ability is one of the higher-order thinking skills needed to make it easier to understand abstract concepts [17]. Critical thinking is reflective thinking, a complex metacognitive process and involves several skills (such as analyzing, evaluating and inferring) which aims to make logical decisions about what to do in solving a problem.

One of the subjects that raises abstract things that are difficult to understand is the magnetic field. Based on the results of Pateda's research [18] regarding the understanding of the concept of magnetism, it shows that the understanding of the magnetic concept of physics students is still relatively low, students still have errors in the concept of magnetism, including (1) in determining the direction of the magnetic force, magnetic field, and electric current using the right hand rule, (2) determining the distribution of the magnetic field on a bar magnet, (3) determining the magnetic poles of a bar magnet that has been cut into small pieces.

Based on the background and several research results as described above, this study was conducted to determine the effect of applying the HOT-Lab model to magnetic field materials based on real and virtual lab experiments to improve students' critical thinking skills.

2. Method

This study used the One Group Pretest-Posttest Design with a total of 20 subjects (10 women and 10 men). The research design used can be seen in Figure 1. This study used a One Group Pretest-Posttest Design consisting of a control class and an experimental class with 20 subjects each. The research design used can be shown in Figure 1.

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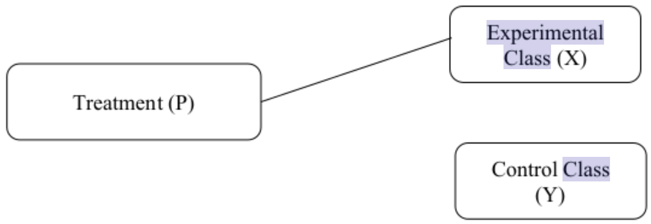

Figure 1. Research Design One Group Pretest-Posttest Design

The experimental class will get treatment in the learning process using a virtual laboratory PhET while the control class will use the lecture method. Class division and sampling can be seen in Table 1.

Table 1. Pretest-Posttest Control Group Design

Sample	Class	Pretest	Treatment	Posttest
Random	Experiment	X_1	P	X_2
	Control	Y_1		Y_2

Remarks: X1 = Pretest before treatment for the experimental class; X2 = Posttest after treatment for the experimental class; Y1 = Pretest before treatment for the control class; Y2 = Posttest after treatment for the control class; P = Treatment for the experimental class

The indicator measured on the achievement of Critical Thinking Skills is by Pretest-Posttest. The instrument used in this study was carried out by filling in questions of practical understanding and conceptual understanding of approximately 10 questions.

3. Result and Discussion

The pretest and posttest analysis of critical thinking skills are presented in figure 1, on the graph the average pretest-posttest and N-Gain values for the experimental class and control class are presented. The average value of the experimental class on the pretest was 56.5. While the average value of the control class on the pretest was 53. In addition, the average N-Gain in the experimental class is 45.3 and the average N-Gain in the control class is 36.7.

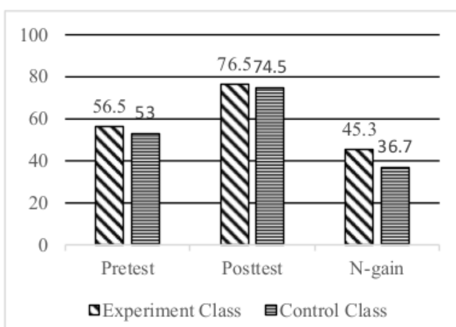

Figure 2. Average scores of pretest, posttest, and N-Gain for Critical Thinking Skills

Figure 2 shows that the posttest and N-Gain scores of the experimental class are higher than the values of the control class. This is evidenced by the increase in pre to post in both classes by 20% for the experimental class and 21.5% for the control class. The increase in the posttest average value in the experimental class was 76.5 with a difference of 2 values from the control class. It can be seen that the use of HOTLAB in real blended virtual laboratory activities can increase the average score of students in the experimental class compared to students in the control class. This result is in line with previous research which showed that the use of HOTLAB can improve critical thinking skills [19]. In addition, the results obtained by Sahidah [20] on the use of HOTLAB which are oriented towards problem solving are also in line with the results of the pretest and posttest increasing in two classes, and also the highest N-Gain value is in the Experiment class. The results of the data shown from the increase in the Pretest-Posttest carried out, and also the results of the N-Gain obtained were also calculated based on statistical data [21,22]. The data calculated by statistics can be seen in Table 2.

Table 2. Differences in Average Pretest scores for Critical Thinking Skills

Score	Class	Average	Normality	Homogenity	Significance
Pretest	Experiment	56.5	$X^2_{Count} > X^2_{Table}$ (0.91) > (0.05) (Normal)	$F_{Count} > F_{Table}$ (0.74) > (0.05) (Normal)	$t_{Count} > t_{Table}$ (0.87) > (0.05) (No influence)
	Control	53	$X^2_{Count} > X^2_{Table}$ (0.23) > (0.05) (Normal)		
N-Gain	Experiment	45.3	$X^2_{Count} > X^2_{Table}$ (0.20) > (0.05) (Normal)	$F_{Count} > F_{Table}$ (0.34) > (0,05) (Normal)	$t_{Count} < t_{Table}$ (0.01) < (0.05) (There is influence)
	Control	35.7	$X^2_{Count} > X^2_{Table}$ (0.12) > (0.05) (Normal)		

The differences in student pretests on students' Critical Thinking Skills when using HOTLAB in a real blended virtual laboratory contained in Table 2 were analyzed using a t-test. The results of the analysis show that the experimental class scores 56.5 and the control class scores 53. This indicates that the average scores obtained in the pretest are not significantly different or have no effect, this means that the pretest scores in the experimental and control classes are the same. Furthermore, the average N-Gain score obtained in the experimental class was 45.3 and the control class obtained an average score of 35.7. The increase in the N-Gain Critical Thinking Skills score of students who were given treatment showed a significant difference or had an effect when given treatment. This means that HOTLAB in a real blended virtual laboratory can improve students' Critical Thinking Skills.

4. Conclusion
Based on the results of the study, it was found that the control class had a difference of 9.6 points between the experiment class, and the means N-Gain increased by 9.6%. The use of HOTLAB in a real blended virtual laboratory has moderate effectiveness to improve Critical Thinking Skills on the subject of magnetic field.

5. References

[1] Maulina R N and Kustijono R 2017 *Prosiding Seminar Nasional Fisika (SNF)* **1** 65
[2] Putra R P and Anjani R A 2020 *J. Profesi Kegur* **6** 167
[3] Quddus A, Hamid T, and Kasli E 2017 *J. Ilm. Mhs. Pendidik. Fis* **2** 122
[4] Putra R P, Silvianti N, Idris S F and Nabilla N 2021 *Radiasi J. Berk. Pendidik. Fis* **14** 23
[5] Aulia P R 2017 *Skripsi. UNIMED (Medan: State University of Medan)*
[6] Koriaty S 2016 *Edukasi J. Pendidik* **14** 132
[7] Rizki A E and Syuhada F A *J. Inov. Pembelajaran Kim* **2** 1
[8] Putri S B, Sarwi S and Akhlis I 2018 *UPEJ Unnes Phys. Educ. J* **7** 14
[9] Widodo A, Maria R A and Fitriani A 2016 *J. Pengajaran MIPA* **21** 92
[10] Putri E P K, Hamzah H B and Tiwow V M A 2017 *Mitra Sains* **5** 26
[11] Hizbi T 2019 *Kappa Journal, Pendidik. Fis. FMIPA Univ. Hamzanwadi* **3** 1

[12] Simbolon D H and Sahyar S 2015 *J. Pendidik. dan Kebud* **21** 299
[13] Khoiriroh F and Shofiyah N 2019 *Proc. ICECRS* **2** 299
[14] Sutarno S, Setiawan A, Suhandi A, Kaniawati I and Hamdani D 2018 *J. Pendidik. Eksakta* **3** 5
[15] Makiyah Y S, Malik A, Susanti E and Mahmudah I R 2019 *Diffraction* **1** 1
[16] Sutarno M 2011 *Progr. Stud. Pendidik. Fis. Jur. PMIPA FKIP Univ. Bengkulu* **1** 1
[17] Rahmawati K M, Prastowo S H B and Bektiarso S 2019 *J. Pembelajaran Fis* **8** 80
[18] Setyaningsih E, Harijanto A and Prastowo S H B 2018 *Jember FKIP e-PROCEEDING* **3** 167
[19] S Sapriadil S, Setiawan A, Suhandi A, Malik A, Safitri D A, Lisdiani S A S and Hermita N 2019 *J. Phys.: Conf. Ser.* **1204** 012025
[20] Sahidah, Lisdiani S A, Setiawan A, Suhandi A, Malik A, Sapriadi and Safitri D 2019 *J. Phys.: Conf. Ser.* **1204** 012033
[21] Serungke M, Muhibbuddin and Suhrawardi 2020 *J. Phys.: Conf. Ser.* **1460** 012134
[22] Putra AP, Rochman, C and Setya W 2020 *Jurnal Belajar Mengajar Fisika* **5** 80

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