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Submission date: 06-Sep-2018 04:20PM (UTC+0700)

Submission ID: 997652263

File name: Enhancing_Communication_Skills_of_Pre-service_Phys.pdf (262.19K)

Word count: 4032

Character count: 22888

PAPER • OPEN ACCESS**Enhancing Communication Skills of Pre-service Physics Teacher through HOT Lab Related to Electric Circuit**

To cite this article: A Malik *et al* 2018 *J. Phys.: Conf. Ser.* **953** 012017

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Enhancing Communication Skills of Pre-service Physics Teacher through HOT Lab Related to Electric Circuit

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Abstract. This study aimed to investigate the improvement to pre-service teacher's communication skills through Higher Order Thinking Laboratory (HOT Lab) on electric circuit topic. This research used the quasi-experiment method with pretest-posttest control group design. Research subjects were 60 students of Physics Education in UIN Sunan Gunung Djati Bandung. The sample was chosen by random sampling technique. Students' communication skill data collected using a communication skills test instruments-essays form and observations sheets. The results showed that pre-service teacher communication skills using HOT Lab were higher than verification lab. Student's communication skills in groups using HOT Lab were not influenced by gender. Communication skills could increase due to HOT Lab based on problems solving that can develop communication through hands-on activities. Therefore, the conclusion of this research shows the application of HOT Lab is more effective than the verification lab to improve communication skills of pre-service teachers in electric circuit topic and gender is not related to a person's communication skills.

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1. Introduction

The challenge for 21st-century education is to educate student living and working in an information-rich technology environment. Someone must be mastering communication skills as part of a competency context that can be used in the face of 21st-century challenges and opportunities [1-3]. Many universities prepare students to meet the competencies in accordance with workplace demands. Communication skills that include listening, writing, speaking and interpersonal are to be existent in teachers to facilitate the understanding of teaching materials, as well as to have the ability to take their responsibilities effectively [4]. Students tasks are not only restricted to grasp the academic content but also the extent to the need to know how to keep learning, making effective and innovative use of what they know throughout their lives [5]. Communication allows one to learn and apply adaptive strategies to overcome the problematic situation [6].



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But unfortunately, students' communication skills are still low. This is reflected by observations in one of the universities in West Java province shows students difficulties in describing the scheme, explaining the relationship between physics variables, transforming data onto tables and graphs, formulating data mathematically and presenting the results. Student communication skills can be provided for school through face-to-face learning in the classroom and lab activities in the laboratory. Communication skills belong to transferable skills which are the skills people need can be provided with the context of classroom learning. Various empirical studies aimed at improving students' communication skills through learning have been largely undertaken using various strategies and learning models such as scientific communication program [7], blended learning [8], open inquiry [9], virtual interactions [10], role-play [11], interprofessional approach [12], and science communication competence [13]. Research to investigate communication skills related to other aspects such as content knowledge and life skills has been done [14-16].

Laboratory activities are a part of university learning that is very potential to be used to provide communication skills to students. The laboratory offers opportunities for productive, cooperative interactions among students and with the teacher that have the potential to promote positive learning environment [17]. The demands of laboratory application in school in the face of the 21st century have been widely recommended by science educators because of the many benefits derived from such laboratory activities [18-20]. However, not all lab designs can supply skills of communication, such as the lab verification design. One of the lab designs constructed to supply higher order thinking skills includes communication skills are HOT Lab. The steps in the HOT Lab are the result of a combination of creative problem solving and problem-solving labs. From merging the two models, the HOT Lab steps were then compiled which consisted of five general processes: 1) understanding the challenges, 2) producing ideas, 3) preparing for laboratory activities, 4) practicing the activities, and 5) communicates and evaluates the results of activities [21].

Electric circuit topic is an important topic because of it is widely applied to everyday life. In addition, the electrical circuit is an empirical science that is suitable to be studied through investigation activities. This study aims to explore the use of HOT Lab in supplying students' scientific communication skills be associated with gender influences. Communication skills reviewed to include scientific writing, information representation, and knowledge presentation. This paper describes the results of research related to the debriefing of students' communication skills through the application of HOT Lab.

2. Experimental Method

The method applied in this research was a quasi-experiment method with control group pretest-posttest design. The experimental group, in the laboratory on the electric circuit topic used HOT Lab design, consisting of 11 stages of activities including real-world problems, determining and evaluating ideas, asking experiment questions, providing materials and equipment, predicting, applying question method; exploring, measuring, analyzing, concluding, and presenting [22]. While the control group used a verification lab design consisting of 9 stages of activities including conveying the purposes, delivering basic theory, providing tools and materials, giving a preliminary assignment, giving trial procedures measuring, analyzing, concluding, and answering end task.

The population of this study was students of Physics Education of UIN Sunan Gunung Djati Bandung semester V academic year 2015/2016. The samples used in this study were 60 students consisting of 30 students (12 male and 18 female) of the experimental group and 30 students (9 male and 21 female) of group control. The sampling technique used was simple random sampling.

The instruments used in this research were observation sheet and communication skill test in the form of the essay. Indicator communication skills refer to the Levy et al framework [7]. The observation sheet was used to assess aspects of communication skills: scientific writing (8 indicators), information representation (5 indicators) and knowledge presentation (7 indicators). Assessment of all three aspects used rubric with scale 1-3. In addition to using observation sheet for communication skill of information representation aspect using the test in form essay (11 questions) with indicator representing knowledge into the scheme (3 questions), graph (3 questions), verbal (3 questions) and mathematics (2 questions).

¹ The improvement of communication skills of students uses calculation normalized gain average $\langle g \rangle$ and criteria from Hake [23]. The difference enhancement of communication skills between the experimental and control group uses the calculation of t-test score; previously calculate the normality using One-Sample Kolmogorov Smirnov Test and the homogeneity used Test of Homogeneity of Variances. Besides to determine the impact of the implementation of the HOT Lab design on improving students' communication skills relative to the application of verification lab, the effect size calculation was performed. The effect size of this study was determined by computing the standardized difference (d) with calculation and criteria of Cohen et al. [24].

3. Result and Discussion

Based on observation of laboratory activities using observation sheet to assess the communication skills of students on the scientific writing aspect, information representation and knowledge presentation obtained data as shown in Figure 1.

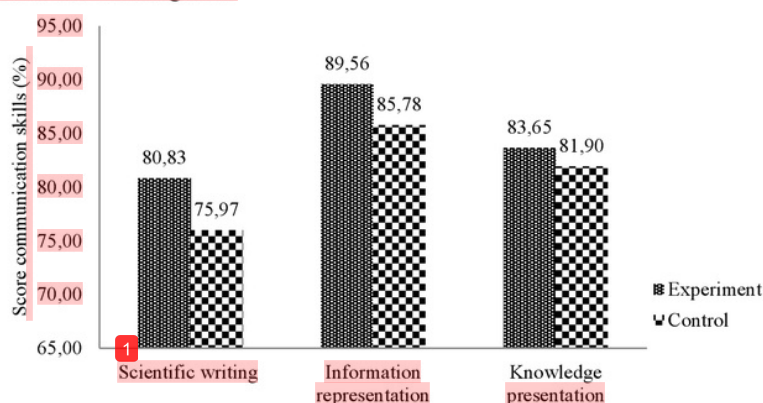


Figure 1. Average scores of each aspect of communication skills of students

The three aspects of communication skills consist of scientific writing, information representation, and knowledge presentation in the group using HOT Lab are higher than that using verification lab. The information representation aspect shows the highest average score in the two groups. The average score of the lowest communication skills is in the knowledge presentation aspects either in the groups using the HOT Lab or the verification lab.

Communication skills of students on information representative aspect used HOT Lab better than verification lab. Aspects of information representative can be developed when students undertake activity of asking experimental questions, predicting, applying question method; exploring, measuring, analyzing, and concluding on the HOT Lab. Students using laboratory verification are not trained in terms of thinking ability and science skills, only developing practical skills [25].

The scientific writing aspect of students using HOT Lab is better than using verification lab. The HOT Lab provides an opportunity for students to apply concepts to solve problems encountered in everyday life. Students seek and select various sources of reference, discuss information obtained, determine and evaluate information relevant to the problem, create reports and present the results.

Student communication skills on the aspect of representation of information for both groups were using HOT Lab and verification lab can be seen in Figure 2.

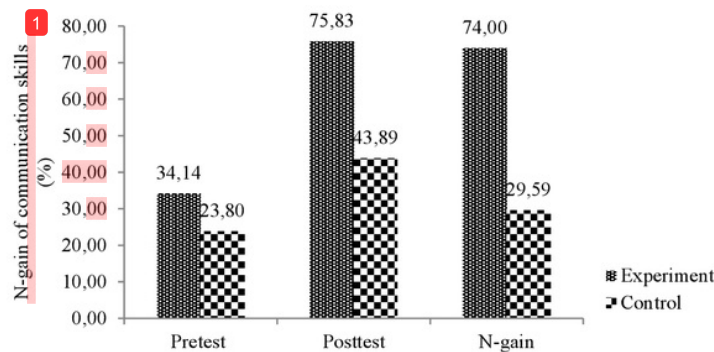


Figure 2. Normalized gain average of communication skills on aspect of information representation

Normalized gain average student's communication skills on the aspect of information representation to the group using HOT Lab (74.00%, high category) is much greater than that group of using verification lab (29.59%, low category). The result of statistical calculation of communication skills of students on the aspect of information representation to experiment group using HOT Lab and control group using verification lab is shown in Table 1

Table 1. Statistic calculation of students' communication skills on aspect of information representation

Data type	Normality ($\alpha = 0.05$)				Homogeneity ($\alpha = 0.05$)	Uji t ($\alpha = 0.05$)	
	Level		Information			Level	Information
	Significance (2-tailed)						
	Experimental	Control	Experimental	Control			
Communication skills	0.936	0.768	Normal	Normal	0.878	0.000	Significant

Based on Table 1 show there is a significant difference in the communication skills on the aspect of information representation of students that were applying HOT Lab compared with the verification lab. In addition, the normalized gain average for each aspect of communication skills of students on the aspect of information representation to both groups was also calculation as shown in Figure 3.

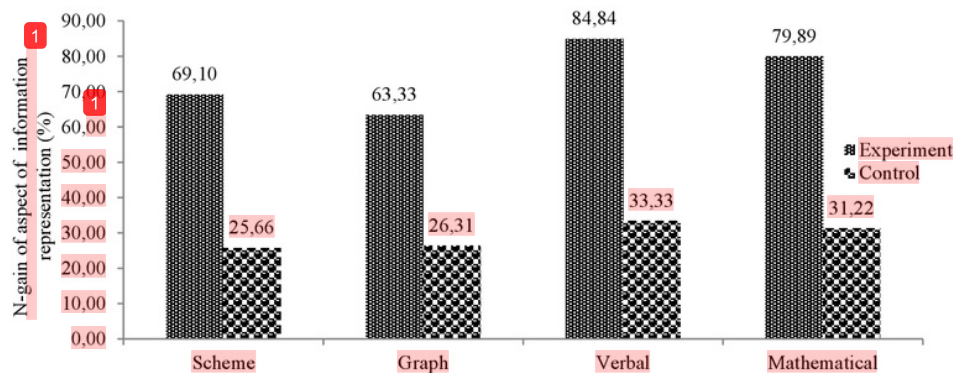


Figure 3. Normalized gain average of each aspect of information representation

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Figure 3 shows that student' communication skills on the aspect of information representation to each indicator (scheme, graph, verbal and mathematical) for both groups are also increasing. The improvement on two indicators (verbal and mathematical) of communication skills on the aspect of information representation to the group using HOT Lab (include high category) is higher than verification lab (include medium category). The enhancing communication skills on the aspect of information representation to indicators of scheme and graph including the middle category in the group using the HOT Lab is higher than the verification lab (low category).

Communication skills on the aspect of information representation to verbal indicators experienced the highest increase compared to other indicators in both the HOT Lab and lab verification groups. HOT Lab provides opportunities for students to develop communication skills on the aspect of information representation to verbal indicators by discussing collaboratively on determining and evaluating ideas, predicting, exploring, analyzing, concluding, and presenting activities. Verbal indicators on students that use lab verification are poorly developed because their activities do not provide students with opportunities to communicate verbally. They only focus to prove the concept has been studied before. It is following the developed focus on competencies on the verification lab design explaining and supporting what students learn, teaching experimental techniques, and less training of reasoning skills [26].

Communication skills on the aspect of information representation to the graph indicator experienced the lowest increase compared to other indicators either in the group using the HOT Lab as well as the verification lab. Students are using HOT Lab on activities of predicting, answering question method, exploring, measuring, and analyzing can develop the graph indicator. Students who use laboratory verification only perform practicum in accordance with predefined procedures. The results of this study prove that students are still difficult to communicate the graph to be understood by others. Students' interpreting skills should be developed, since analyzing and interpreting data are necessary for the practice of physics and science in general [27].

The average difference normalized gain of students' communication skills on the aspect of information representation by gender is shown in Figure 4.

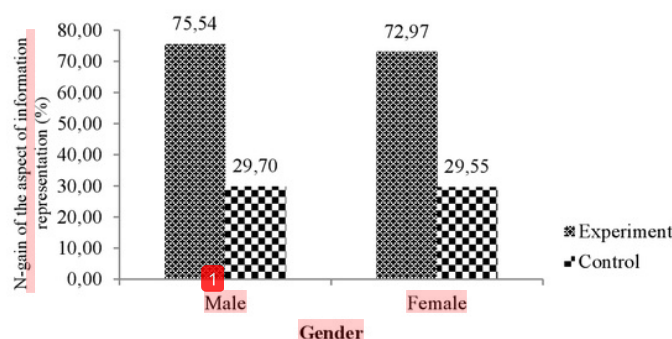


Figure 4. Normalized gain average of student on the aspect of information representation by gender

Male student's communication skills on the aspect of information representation are higher than female. A difference in communication skills on the aspect of information representation occurs to both of the groups using HOT Lab and verification lab. The improvements communication skills of students on the aspect of information representation of male and female in the group using HOT Lab were high category while student male and female in the group using verification lab were a low category.

The result of statistical calculation of students' communication skills on the aspect of information representation by gender on the group using HOT Lab is shown in Table 2.

Table 2. Statistic calculation of the aspect of information representation by gender

Data type of communication skills		Normality ($\alpha = 0.05$)				Homogeneity ($\alpha = 0.05$)	Mann-Whitney ($\alpha = 0.05$)	
		Level		Information			Level	Information
		Significance (2-tailed)					Significance (2-tailed)	
Aspect of information representation		Male	Female	Male	Female	-	1	No
		0.980	0.714	Normal	Normal	Homogeneous	0.308	significant

Based on Table 2 it can be concluded that there is no significant difference in the communication skills of male students on the aspect of information representation compared to female students after being applied HOT Lab. Calculation $\langle g \rangle$ for each indicator of communication skills on the aspect of information representation based on gender for the class using HOT Lab was done. The calculation results are shown in Figure 5.

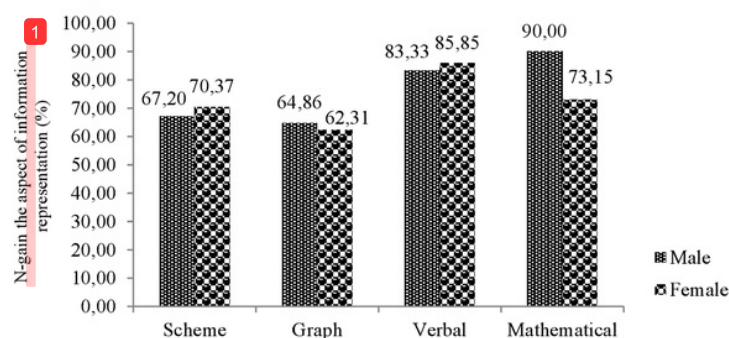


Figure 5. Normalized gain average on each the aspect of information representation by gender

Communication skills of students on the aspect of information representation to indicators of scheme and verbal for both genders similarly increase. The improvements to two indicators of scheme and verbal of the female student are higher than the male students. The enhancing of two indicators (scheme and verbal) in the female student is in the high category and male student are in the medium and high category.

The male student is higher than female on indicators of the graph and mathematical of the aspect of information representation. The improvements in the graph indicator are in the medium category in the male and female student. The aspect of information representative of the indicators of mathematics is included in the high category in both male and female student. The highest increase in the aspect of information representation is the mathematical indicator including high category occurred in the male student. Graph indicator is the lowest increase in the aspect of information representation to both male and female student, but the male student is higher than the female student.

The result of calculation effect size of communication skills of students is 7.22 based on the Cohen criterion [24]; this means that implementation HOT Lab gives a great effect. Thus, it can be concluded that the application of HOT Lab gave the high effect of improving communication skill of students compared with verification lab. The results of this study are in accordance with previous research, which shows that HOT Lab can also enhance other transferable skills required by students to face change and competition in the 21st century one of critical thinking skills [28].

4. Conclusion

We have successfully studied the enhancing communication skills of pre-service physics teacher through the HOT Lab. The category of communication skills on the aspect of representation information students applying HOT Lab was included high while those applying the verification lab was included low level. In sum, the applying HOT Lab on electric circuit topic provides significant enhancing

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communication skills of students. A person's communication skills were not influenced by gender. The female student has better in communication skills in the aspect of information representation to indicators of the scheme and verbal than the male student. While the two indicators from of the aspect information representation (graph and mathematical) male student had better than female student did.

5. Acknowledgments

The researcher would like to thank the students who participated in this research. Special thanks were also to the chairperson, lab operator and laboratory assistant of the Program Studi Pendidikan Fisika UIN Sunan Gunung Djati Bandung who gave permission and helped conduct the research.

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