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The Effect of Virtual Labs Toward Students' Understanding of Physics Based on Gender

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Abstract. The concept of physics consists of concrete and abstract concepts. Students should be able to master the concept of physics as well as to be able to solve problems in physics. Students' concept mastery can be improved by technology-based learning. The study was conducted at three different high schools. We investigated the students' mastery improvement in physics learning assisted by virtual lab media. The sample was chosen using purposive sampling resulting 34 male students and 36 female students. The results showed that there was an increase in entire students' concept mastery. In general, male students' mastery of the concept was higher than the female students. In particular, male students demonstrated higher mastery of higher concepts on higher cognitive aspects (analyzing, synthesizing, creating), while female students had a higher ability in the lower cognitive aspects (remembering, understanding, and applying).

Keywords: Virtual Labs; understanding, gender

I. INTRODUCTION

One of primary goals of science education is to help students to comprehend the nature of scientific knowledge in school. Students are necessarily involved in science process and in communication explicitly. A successful science education allows students to engage them in a complicated conceptual alteration [2].

Physics is one of subjects requiring pertinent and acceptable reasoning and concept mastery. This subject consists of various concepts. Universally, concepts in physics consist of concrete and abstract concepts. It should be understood and comprehended in order to enable someone to solve problems in physics learning. According to Lindstrøm and Sharma (2009), mastering basic concepts are very essential in learning physics to know when, how, and why physics can be applied.

To comprehend the conceptual of certain learning material is the primary instructional objective in order to develop education. Two important knowledge should be acquired by students are conceptual mastery and procedural skill [19]. Gobert and Clement (1999) argue that concept mastery requires student to be able to develop their own thinking in the form of diagram by reading and comprehending a concept in a text

Mastering a concept is a reciprocal relationship of basic elements in a big structure functioning simultaneously in its use. Those components are facts (or knowledge) which should be known by student in order to enable them in accomplishing certain problem. After revising Bloom's Taxonomy, Krathwhol (2002) defines concept mastery as past of knowledge, in which it becomes the first dimension of education, while cognitive is dimension of knowledge. The working cognitive dimensions used in measuring level of mastery are as follows: remember, understand, apply, analyze, evaluate, and create. Physics is one of subject in science that is less preferred by students. They tend to consider physics as difficult subject since it deals with calculation. Moreover, many abstract concepts in physics are considered difficult for students to process into its logical notation [13]. This opinion is in line with Kustusch (2016) who highlighting students' difficulties in operating algebra and calculation.

Furthermore, some lessons requring experiment should confront with the fact of adequate facility. Some experiments conducted in a real laboratory can be an obstacle for its less effective in cost and equipment preparation by lab staff, and uncertain time management. Therefore, it is very essential for teacher to create innovation thus students can master the concept even with limited resources and space [30]. Teacher is expected to be capable intellectually in carrying knowledge to be applied in his instruction and to have ability and experience in implementing new learning strategy in his classroom [6].

Therefore, adequate learning media is required to support effective learning and complying with the current development of technology. In short, innovation is very crucial to enable students grasping abstract concepts in physics. Integration of information and communication technology in virtual laboratory becomes one of examples of innovation. Virtual learning environment has been widely known to transfer course

subject matters and facilitate communication in classroom. Computer-based learning program has been adopted in school to enhance or replace traditional instructional method. A comprehensive virtual lab can simulate the real environment for students. Besides enabling teacher to adjust conventional curriculum, virtual lab enables students to develop their own programs and identify problems in the implementation (Shyr, 2010). Some studies conducted in some high schools prove that the use of virtual lab is helpful to improve students' mastery of concept in physics (Nisrina et al., 2016; Suranti et al., 2016; Kusdiastuti et al., 2016; Sari et al ., 2016).

The current study utilizes virtual lab as learning media, which is expected to elevate students' comprehension of some concepts, for both male and female. According to Honigsfeld and Dunn (2003), male and female demonstrate significant difference in terms of learning style. It explains why classroom with both male and female is less able in analyzing various concepts. For this reason, teacher should be able to develop effective learning process. Moreover, the use of computer in learning influences male and female learning habit [28]. Different ability between male and female students can determine students' learning achievement.

II. METHOD

This quasi-experiment involved three classes of three different schools, which took samples by using purposive sampling technique. The samples were taken based on students' results on physics test conducted preceding this study. Proportionally, 34 males and 36 female students were taken as subjects of the study. Each class was given treatment using virtual lab in learning. Increase of concept mastery in each school was determined by the average N-gain measured using equation [4]:

$$N - gain = \frac{S_{post} - S_{pre}}{S_{max} - S_{pre}} \times 100\%$$

Data about concept mastery was collected using test conducted prior to and after learning, in which the instrument has passed validity and reliability tests, also difficulty and discrimination test. The test was designed as a multiple-choice test measuring the entire cognitive aspect, i.e. memorizing (C1), comprehending (C2), applying (C3), analyzing (C4), evaluating (C5), and creating (C6).

III. RESULTS AND DISCUSSION

This study is aimed at finding an increase of concept mastery of physics in three different schools after learning using virtual lab. Test results were further analyzed and grouped based on gender category. Figure 1 shows the avarage comparison of pre-test and post-test, in which the male students demonstrate positive attitude towards the use of computer technology. Later, it also demonstrated positive impact.

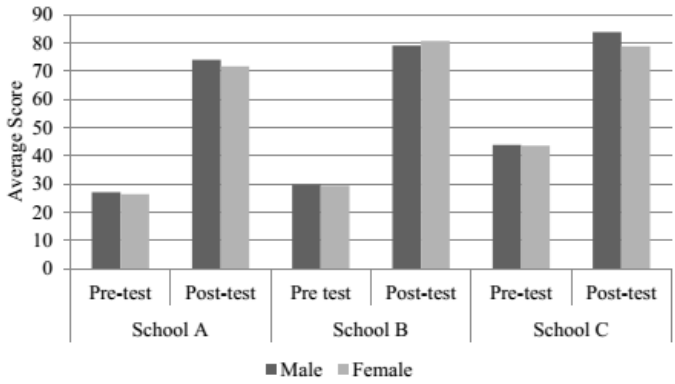

Fig. 1. Comparision if test results of male and female students of cencept mastery, on school-basis

Based on Fig 1., male and female students tend to show similar initial ability in each school. After giving treatment, using virtual lab, results show difference of concept mastery between male and female. In school A and C, male students have better average score than the female. The higher initial score of male students cause higher achievement after the treatment. The difference was also influenced by students' ability in operating virtual lab equipments. In line with this finding, Volman & van Eck [27] state that the difference ability is related to different experiences in operating computer, in which students who have worked often with computers show better ability, while male students have better experience than female students. Shashaani [22] also reveals that computer experience is related attitude towards computer. His study proves that male students have better experience than female students, in which the male students demonstrate positive attitude towards the use of computer. The use of the technology has benefited learning.

Herga et al. [10] prove that the use of virtual lab in learning can grow better comprehension on students. Suranti et al. [25] claim that instructional model using virtual lab to experimental groups can increase concept mastery compared to control group (using conventional teaching aid). Gunawan et al. [8] reveal that virtual media aid can increase students' creativity, both verbal and figural.

In school B, female students in the pre-test showed lower achievements than male students, but turned higher in the post-test. In the post-test, both male and female students increased, which was influenced by the use of virtual lab. This proves that the use of virtual lab can improve students' concept mastery. The higher score of female students in the post-test, which is not significant, indicates that female students in general were better in performance than the male, which supports Voyer et al. (2014) study claiming female students give more efforts than the male, especially in mathematic calculation. On the other hand [29], Loori (2005) reveals different result, in which male students are identified to show more preferences on logical and mathematical intelligences, while the female students prefer intrapersonal intelligence (take an action based on her understanding) [17]. Moreover, S. Skaalvik and E. Skaalvik,

(2004) also reveal that male students grow self-conception, potential performance, intrinsic motivation, and ego orientation in mathematic better than the female, while the female students have more intrinsic motivation to learn about language [24].

Increase of the three schools are identified as medium to high. It shows that the use of virtual lab has increased the level of concept mastery of both male and female students. This finding supports a study by Zacharia and Anderson [31] which assert that the use of simulation can increase students' ability to make acceptable prediction and explanation about phenomenon within an experiment. It also encourages significant physic conceptual alteration being learned. Besides, Tsovaltzi et al. (2010) reveal that there is significant positive relationship between the use of virtual lab and the results of post-test [26].

Combination of real and virtual experiments can enhance students' conceptual comprehension than real-only-experiment [32]. A study by Çelik, et al.(2015) expose that virtual environment using simulation has given positive impact in improving students' comprehension [3]. Thus, it can be stated that the use of virtual lab in learning can increase the concept mastery of male and female students in the entire indicators.

However, in general, the male students demonstrate more significant increase than the female, in which the different between male and female are not significant. This study supports studies by Altintas & Ozdemir (2012); Coşkun et al. (2014); and Güven (2010) which claim that problem solving skill is not significantly influenced by gender.

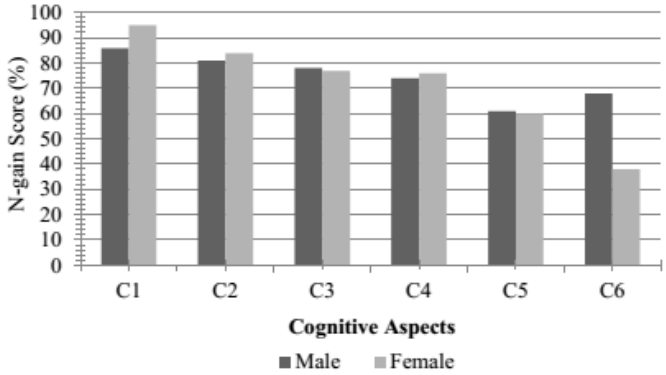

Fig. 2. Gender-based comparision of concept mastery on each cognitive aspect

Increases in three schools are also analyzed based on cognitive aspect (as shown in Figure 2). Finding shows that female students demonstrate higher concept mastery on low and mid cognitive aspect, including C1 (memorizing), C2 (comprehending), and C4 (analyzing). On the other hand, the male students are better in higher-cognitive aspect, including C5 (evaluating) and C6 (creating). This finding is in line with a study by Severiens & Ten Dam (1994), which reveals that male students have higher capacity in learning abstract concept.

Furthermore, the male students tend to use spatial intelligence in solving problem, while the female tend to use their logical reasoning. It denotes that the male students tend to have better ability in creating perception, storing, memorizing, creating, and modifying information taken during learning interaction to become problem resolution

IV. CONCLUSION

Learning physics using virtual lab as learning media has improved students' concept mastery. Both male and female students show significant increase of their score (N-gain), in which all schools demonstrated medium to high increase. In general, male students indicate better concept mastery than female, which is not significantly different. Female students demonstrate higher concept mastery on low and mid cognitive aspect, including C1 (memorizing), C2 (comprehending), and C4 (analyzing). On the other hand, the male students are better in higher-cognitive aspect, including C5 (evaluating) and C6 (creating).

Based on findings, some recommendations can be given are, as follows: (1) students' initial ability to operate computer should be taken into consideration to facilitate learning, and (2) it is suggested for teacher to be more aware of the character of male and female students in receiving and comprehending lesson..

REFERENCES

[1] Altintas, E., & Ozdemir, A. S. 2012. The Effect of Teaching with the Mathematics Activity Based on Purdue Model on Critical Thinking Skills and Mathematics Problem Solving Attitudes of Gifted and Non-Gifted Students. *Procedia - Social and Behavioral Sciences*, *46*, 853–857.

[2] Carey, S., & Smith, C. 1993. On Understanding the Nature of Scientific Knowledg. *Jurnal Educational Psychologiest*, *28*(3), 235–251.

[3] Çelik, H., Sari, U., & Harwanto, U. N. 2015. Evaluating and developing physics teaching material with Algodoo in virtual environment: Archimedes' principle. *International Journal of Innovation in Science and Mathematics Education*, *23*(4), 40–50.

[4] Cheng, K. K., Thacker, B. A., Cardenas, R. L., Crouch, C., Cheng, K. K., Thacker, A., & Cardenas, R. L. 2004. Using an online homework system enhances students' learning of physics concepts in an introductory physics course. *American Journal of Physics*, *72*(11), 1447.

[5] Coşkun, Y. D., Garipağaoğlu, Ç., & Tosun, Ü. 2014. Analysis of the Relationship between the Resiliency Level and Problem Solving Skills of University Students. *Procedia - Social and Behavioral Sciences.*

[6] Etkina, E. 2010. Pedagogical content knowledge and preparation of high school physics teachers. *Physical Review Special Topics - Physics Education Research*, *6*(2), 1–26.

[7] Gobert, J. D., & Clement, J. J. 1999. Effects of student-generated diagrams versus student-generated summaries on conceptual understanding of causal and dynamic knowledge in plate tectonics. *Journal of Research in Science Teaching*, *36*(1), 39–53.

[8] Gunawan, G., Sahidu, Hairunnisyah., Harjono, Ahmad., Suranti, N.M.Y. 2017. The Effect of Project Based Learning With Virtual Media Assistance on Student's Creativity in Physics. *Jurnal Cakrawala Pendidikan*, *36*(2), 167–179.

[9] Güven, M. 2010. An analysis of the vocational education undergraduate

students' levels of assertiveness and problem-solving skills. *Procedia - Social and Behavioral Sciences*, *2*(2), 2064–2070.

[10] Herga, N. R., Cagran, B., & Dinevski, D. 2016. Virtual laboratory in the role of dynamic visualisation for better understanding of chemistry in primary school. *Eurasia Journal of Mathematics, Science and Technology Education*, *12*(3), 593–608.

[11] Honigsfeld, A., & Dunn, R. 2003. High School Male and Female Learning-Style Similarities and Differences in Diverse Nations. *The Journal of Educational Research*, *96*(4), 195–206.

[12] Krathwohl, D. R. 2002. *A Revision of Bloom's Taxonomy: An Overview*. *American Journal of Psychology* (Vol. 122). https://doi.org/10.1207/s15430421tip4104

[13] Kurniawati, I. D., & Diantoro, M. 2014. Pengaruh Pembelajaran Inkuiri Terbimbing Integrasi Peer Instruction Terhadap Penguasaan the Effect of Peer Instruction Integrated Guided Inquiry Learning on Concepts Acquisition and Critical Thinking of Students. *Jurnal Pendidikan Fisika Indonesia (Indonesian Journal of Physics Education)*, *10*(1), 36–46.

[14] Kusdiastuti, M., Harjono, A., & Sahidu, H. 2016. Pengaruh Model Pembelajaran Inkuiri Berbantuan Laboratorium Virtual Terhadap Penguasaan Konsep Fisika Peserta Didik, 2 (3), 116–122.

[15] Kustusch, M. B. 2016. Assessing the impact of representational and contextual problem features on student use of right-hand rules. *Physical Review Physics Education Research*, *12*(1), 10102.

[16] Lindstrøm, C., & Sharma, M. D. 2009. Link maps and map meetings: Scaffolding student learning. *Physical Review Special Topics - Physics Education Research*, *5*(1), 1–11.

[17] Loori, A. A. 2005. Multiple intellligences: A comparative study between the preferences of males and females. *Social Behavior & Personality: An International Journal*, *33*(1), 77–87.

[18] Nisrina, N., Gunawan, G., Harjono, A. 2016. Pembelajaran Kooperatif dengan Media Virtual untuk Peningkatan Penguasaan Konsep Fluida Statis Siswa, 2 (2), 66–72.

[19] Rittle-Johnson, B., Siegler, R. ., & Alibali, M. . 2001. Developing_conceptual_understanding_and_procedural.pdf. *Journal of Educational Psychology*, *93*(2), 346–362.

[20] Sari, P.I., Gunawan, G., Harjono, A. 2016. Penggunaan Discovery Learning Berbantuan Laboratorium Virtual pada Penguasaan Konsep Fisika Siswa, 2 (4), 176–182.

[21] Severiens, S. E., & Ten Dam, G. T. M. 1994. Gender differences in learning styles: A narrative review and quantitative meta-analysis. *Higher Education*, *27*(4), 487–501.

[22] Shashaani, L. 1994. Gender-Differences in Computer Experience and Its Influence on Computer Attitudes. *Journal of Educational Computing Research*, *11*(4), 347–367.

[23] Shyr, W. J. 2010. Enhancement of PLC programming learning based on a virtual laboratory. *World Transactions on Engineering and Technology Education*, *8*(2), 196–202.

[24] Skaalvik, S., & Skaalvik, E. M. 2004. Gender Differences in Math and Verbal Self-Concept, Performance Expectations, and Motivation. *Sex Roles*, *50*(3/4), 241–252. https://doi.org/10.1023/B:SERS.0000015555.40976.e6

[25] Suranti, N.MY., Gunawan, G., & Sahidu, H. 2016. Pengaruh Model Project Based Learning Berbantuan Media Virtual Terhadap Penguasaan Konsep Peserta didik pada Materi Alat-alat Optik. *Jurnal Pendidikan Fisika Dan Teknologi*, *2*(2), 73–79.

[26] Tsovaltzi, D., Rummel, N., McLaren, B., Pinkwart, N., Scheuer, O., Harrer, A., & Braun, I. 2010. Extending a virtual chemistry laboratory with a collaboration script to promote conceptual learning. *International Journal of Technology Enhanced Learning*, *2*(1/2), 91–110.

[27] Volman, M. 1997. Gender-related effects of computer and information literacy education. *Journal of Curriculum Studies*, *29*(3), 315–328.

[28] Volman, M., & van Eck, E. 2001. Gender equity and information technology in education: The second decade. *Review of educational research*, 71(4), 613-634.

[29] Voyer, D., & Voyer, S. D. 2014. Gender Differences in Scholastic Achievement: A Meta-Analysis. *Psychological Bulletin*, *140*(4), 1174–1204.

[30] Ye, L., Wong, N. S., & Ho, J. . W. Y. 2016. Design,Development and Evaluation of Biochemistry Virtual Laboratory for Blended Learning. *GSTF International Journal on Education*, *3*(2), 40–45.

[31] Zacharia, Z., & Anderson, O. R. 2003. The effects of an interactive computer-based simulation prior to performing a laboratory inquiry-based experiment on students' conceptual understanding of physics. *American Journal of Physics*, *71*(6), 618.

[32] Zacharia, Z. C. 2007. Comparing and combining real and virtual experimentation: An effort to enhance students' conceptual understanding of electric circuits. *Journal of Computer Assisted Learning*, *23*(2), 120–132.