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EXPLORING THE EFFICACY OF VIRTUAL LABORATORY SIMULATIONS IN ENHANCING STUDENT LEARNING OUTCOMES

Abstract. Virtual laboratory has become an essential tool to provide Physics subject.VL can be a great accelerator for delivering complicated and abstract topics in Physics.The study was performed to understand if a virtual laboratory-based teaching method is effective on student's academic achievement in Physics lesson.This study concentrated on academic performance of grade 8 students of Al Farabi lyceum, school year 2023-2024.The method used in the article is quasi-experimental.The sample divided to experimental group and control group.In the EG lessons provided by using VL and in the CG provided as traditional lesson.To measure students academical achievement participants passed pre-post tests. The study's findings suggested that students learning outcomes might be enhanced by simulation-based activities. Furthermore, it was shown that the majority of students thought highly of the virtual laboratory activities.

Keywords: Digital literacy, virtual laboratory, computer-based learning, student achievement

Introduction

Virtual laboratories have emerged as a valuable tool in the field of physics education, providing students with the opportunity to conduct experiments in a simulated environment. These virtual laboratories offer several advantages over traditional laboratories, such as cost-effectiveness, accessibility, and flexibility (Hunt, 2005).One study conducted by researchers found that virtual laboratories are widely implemented in universities, particularly in disciplines such as engineering, computer science, and information assurance.The use of virtual laboratories in physics education has been particularly beneficial in distance education courses, where logistical challenges and high costs often limit the ability to perform real experiments. Furthermore, virtual laboratories provide an alternative solution to address the lack of equipment or space constraints faced by physics students. These virtual laboratories are designed to parallel the theoretical and computational framework introduced in traditional lectures, providing students with hands-on experience and reinforcing their understanding of physics concepts. In the area of chemistry, the implementation of Connected Chemistry through virtual simulations has shown promising results in terms of student achievement.Similarly, a study conducted in the field of biology found that computer simulations for sustainable education led to quantitative improvements in student achievement.Additionally, research has shown that virtual laboratories can facilitate the understanding of complex concepts and improve representational skills in science subjects such as chemistry.There is also a strong demand from students for real-life applications and connections to be included in the virtual laboratory directions.Overall, the literature suggests that virtual laboratories have shown effectiveness and potential in physics education (García-Martínez et al., 2023).These virtual laboratories provide a cost-effective and accessible alternative to traditional laboratories, especially in distance education courses or situations where equipment is lacking or prohibitively expensive. Furthermore, they have been shown to improve student achievement and understanding of complex concepts. Virtual laboratories have shown effectiveness and potential in physics education, offering

several advantages over traditional laboratories such as cost-effectiveness, accessibility, and flexibility. Furthermore, the use of virtual laboratories can provide students with the opportunity to explore and experiment with physics concepts in a safe and controlled environment. The general purpose of the article is to check the impact of the virtual laboratory on the quality of students' education. The specific steps to be taken to implement this research:

1. Division of research participants into two groups: experimental and control group.
2. Taking pre-test from participants before starting the research work.
3. The main part of the study is to explain the lesson to the experimental group through a virtual laboratory, and to the control group using the traditional method.
4. Taking post-test from both groups.
5. Deriving results from the obtained results.

Methods

The participants of the study were 52 grade 8 students of Al Farabi lyceum, which 29 were females, 23 were males. The sample divided to experimental group and control group. From among the school's classes, two were chosen, one to act as an experimental group and the other as a control group. 26 pupils in the experimental group studied science with the use of virtual lab learning that the researchers had created especially for this study. 26 students studying science in a typical Physics classroom—the traditional manner of instruction—made up the control group. In this study used the convenient sampling method and participants chosen to determine the effectiveness of virtual-based learning on their academical achievement.

The following instruments were used in this study:

1. A virtual laboratory experiment focusing on the concept of Electricity;
2. Achievement pre-test and post-test;

The quasy-experimental research method of the study used the correlational model. It aimed to find out if there is a relationship between virtual laboratory-based learning and their academic performance. The teaching approach (virtual lab versus interactive demonstrations using real lab equipment) was the independent variable in this study. The conceptual knowledge and attitudes of the students toward physics were the dependent variables. This was followed by the construction of pre-test and post-tests, which were administered to selected students. After that, respondents were given a pre-test, after which virtual laboratory-based learning was carried out. After two weeks, conducted a post-test to check how well the students understood the published competencies. The results of the tests performed at the end of the study and were analyzed by Jamovi software by using paired t-test analyzes to analyze participant outcomes. The correlation between pre-test and post-test two test will be gotten to certain the effectiveness virtual laboratory -based learning.

Pre -test	Group	Method	Post-test
Achievement Test	Experimental	Virtual laboratory (Phet Colorado)	Achievement Test

Achievement Test	Control	(Conventional method)	Achievement Test

Table 1. Research design

Results and discussion

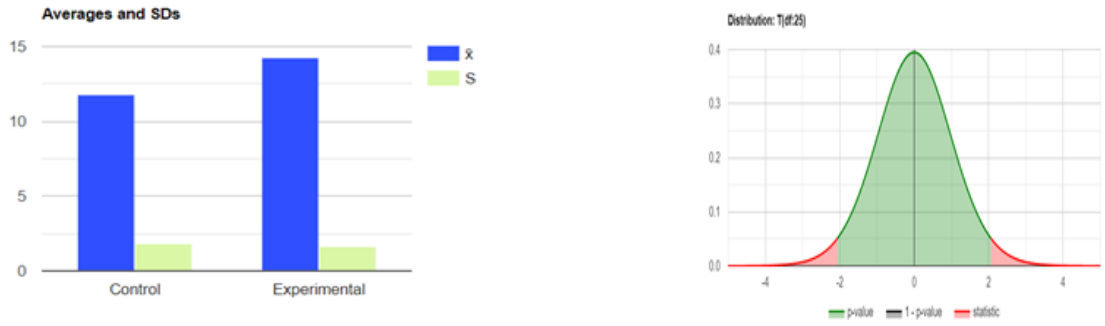

Table 3- Distribution T (df:25)

Results of the paired-t test indicated that there is a significant large difference between Control (M = 11.8, SD = 1.8) and Experimental (M = 14.3, SD = 1.7), $t(25) = 9.1$, $p < .001$. The sample difference between the averages of Experimental and Control is big enough to be statistically significant. Research has shown that students who engage with virtual laboratories demonstrate improved understanding of scientific concepts and increased retention of knowledge compared to those who only engage in traditional laboratory settings.

Research findings consistently demonstrate that students who actively engage with virtual laboratories exhibit a deeper understanding of scientific concepts compared to their counterparts in traditional laboratory settings. These virtual environments enable students to manipulate variables, observe outcomes, and conduct experiments in a controlled yet interactive manner, fostering an immersive learning experience.

Conclusion

In conclusion, we found that using Virtual laboratory is effective in teaching Physics. Based on the results of this study, it seems clear that the use of VL increased student achievement levels and had a positive effect on students' Physics.The study showed that there is significant correlation between students academical performances after using virtual laboratory-based learning.

We may infer that virtual laboratories are a useful tool for improving students' understanding of science subject and that they are suitable for conducting real-world experiments using topics connected to electricity. Virtual laboratories must therefore be included in the science curriculum. Additionally, educators ought to be urged to utilize the virtual labs that are accessible, as they aid in pupils' comprehension and provide several opportunities for experience with inquiry.

If the findings of this study can be applied to other research populations, more research with students at various educational levels should be conducted. The quantitative results of this study, which

examined the efficacy of virtual labs, were constrained, and additional research utilizing qualitative techniques might be required.

References

1. Abou Faour, M., & Ayoubi, Z. (2017). The effect of using virtual laboratory on grade 10 students'conceptual understanding and their attitudes towards physics. *Journal Of Education In Science Environment And Health, 4 (1),* 54-68. https://dergipark.org.tr/en/download/article-file/415803
2. Ambusaidi, A., Al Musawi, A., Al-Balushi, S., & Al-Balushi, K. (2018). The impact of virtual lab learning experiences on 9th-grade students' achievement and their attitudes towards science and learning by virtual lab. *Journal of Turkish Science Education, 15 (2),* 13-29.
3. https://www.tused.org/index.php/tused/article/download/207/163/
4. Hamed, G., & Aljanazrah, A. (2020). The Effectiveness of using virtual experiments on students' learning in the general Physics lab. J*ournal of Information Technology Education: Research, 19* , 977-996.
5. Tsihouridis, C., Vavougios, D., & Ioannidis, G. S. (2013, September 25-27). *The effectiveness of virtual laboratories as a contemporary teaching tool in the teaching of electric circuits in Upper High School as compared to that of real labs* [Paper presentation]. International Conference on Interactive Collaborative Learning (ICL), Kazan National Research Technological University, Kazan, Russia.
6. Wästberg, B. S., Eriksson, T., Karlsson, G., Sunnerstam, M., Axelsson, M., & Billger, M. (2019). Design considerations for virtual laboratories: A comparative study of two virtual laboratories for learning about gas solubility and colour appearance. *Education Information Technologies, 24(3),* 2059- 2080.

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HARDWARE AND SOFTWARE TOOLS IN CHEMISTRY EDUCATION

Abstract. This review explores the impact of technology on chemistry education. Augmented reality (AR) offers interactive learning experiences, while smartphones provide hands-on experimentation tools. Virtual reality (VR) platforms simulate field trips for environmental chemistry. Educational software, like CocoSoft, automates analytical chemistry processes. The integration of computational chemistry tools and virtual simulations bridges theory with practice. This review highlights the benefits and challenges of technology in chemistry education, emphasizing its potential to improve learning and readiness for a technology-driven world.

Keywords: Technology, hardware, software, integrative chemistry, chemistry teaching

Introduction