



Students' Learning Experiences and Preference in Performing Science Experiments Using Hands-on and Virtual Laboratory

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ABSTRACT

This study investigated the hands-on and virtual laboratory learning experiences and laboratory preference of 91 students in performing science experiments. This study utilized a descriptive-correlation research design. The study revealed that students had positive learning experiences towards hands-on laboratory in terms of thinking, understanding, performing, and reasoning than in the virtual laboratory. Moreover, most of them highly preferred hands-on laboratories in terms of learning environment, motivation and enjoyment, stimulation of active learning, comfort, and convenience. The students' preferences in the different laboratory settings were significantly different. Hence, there was a moderate correlation between students' learning experiences and their laboratory preference in the hands-on laboratory. Meanwhile, there was a strong correlation between these two variables in a virtual laboratory. It is recommended to the educational institutions to enhance and strengthen their supports through providing complete laboratory facilities to the schools. Additionally, the teachers should continuously integrate laboratories to support the theoretical understanding of students in various science lessons. Importantly, the teachers and students should be innovative in performing experiments especially due to the limited instructional resources in this time of new normal.

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1. INTRODUCTION

Laboratory experiments have been part of science education for more than a century, and are considered as an essential component of science teaching (Isozaki, 2017). In the present time, laboratory experiments continue to play a substantial role in supporting scientific learning to students by obtaining practical skills through experiments (Aljuhani et al., 2018). It offers conceptual and theoretical knowledge to learn scientific concepts and methods in the nature of science (Ottander & Grelsson, 2006). On the other hand, laboratory experiences provide opportunities for students to express themselves explicitly with the material world utilizing instruments, data processing methods, models, and science theories.

Over the years, laboratory experiences are constantly changing and this affects the students' perceptions towards performing laboratory experiments. The traditional laboratory is the first known type of laboratory setting that has been widely used particularly in science education until it was equipped with technological tools resulting in the development of an accessible virtual laboratory. In a traditional laboratory setting, it involves experiments dealing with hands-on experiments that incorporate physical laboratory equipment in integrating scientific phenomena.

However, with the recent advancement in information technology, science education in the 21st century was also integrated with various technological innovations. Science instructors have a positive impression of technologies as teaching tools. Moreover, in another context, it was suggested among other things, that primary school teachers adopt the habit of utilizing a mobile application to teach their students to improve teaching and learning in Nigerian primary schools (Omolafe, 2021). These innovations lead us to the creation of virtual laboratories which provide simulated versions of traditional laboratories with objects that are virtual representations of real objects (Abou & Ayoubi, 2017). Pupils viewed and took direct measurements through virtual laboratory media, allowing the material offered to be easily grasped by students. Based on the findings, distance learning via virtual laboratory media could be one approach for implementing learning such that the spirit of learning is maintained even when learning is done remotely (Azizah et al., 2021). Thus, some educational institutions are now equipping their learners with this type of laboratory setting which fulfills the lacking in the traditional laboratory. Concerning this, teachers are now using virtual laboratories to support the students' theoretical understanding of science concepts. After they were exposed to this new type of laboratory, students perceived that it is "stimulating" and "satisfying" compared to traditional labs (Chan & Fok, 2009). In the Philippines, the common problem of many schools is that they do not have the essential equipment in their science laboratories. This result is to limit the student to perform a simple laboratory activity. In addition, due to lack of laboratory or insufficient instruments hands-on is rarely performed, instead, virtual labs are explored (Tüysüz, 2010).

Concerning the aforementioned studies, the researchers formulated a study that aimed to determine the learning experiences and laboratory preference of BSEd major in Science students in performing science experiments using hands-on and virtual laboratories. Also, to determine if there is a significant difference in their preference in both laboratory settings. Lastly, to determine the relationships of the variables. The results of this study provide a supplemental discovery to the basic and higher education teaching, particularly in science education.

2. METHOD

Descriptive-correlation design and purposive sampling were used in this study. The sampling focuses on one particular subgroup in which all the sample members are similar, such as students who should have experience utilizing both hands-on and virtual laboratories during their Science (biology, chemistry, and physics) experiments. It involved the purposively selected 91 Bachelor of Secondary Education major in Science students. Specifically, there were 19 first-year students, 34 second-year students, and 38 third-year students of the College of Teacher Education in Sultan Kudarat State University for Academic Year 2020-2021.

The researchers designed two (2) sets of 5-point Likert's scale survey questionnaires composed of 88 questions. The first set of the survey questionnaire consists of 40 items referring to the learning experiences of the student in performing hands-on laboratory and virtual laboratory experiments. On the second set, the 48 items refer to the students' laboratory preference in conducting the laboratory experiments. In this setting, the researchers administered an online survey through Google Form to its respondents to gather the data needed.

Frequency counts, percentages, means, overall mean and standard deviation were the statistical tools used in analyzing the students' learning experiences of Science students in hands-on and virtual laboratories. The Pearson's r correlation was used in analyzing the correlations between the variables of the study. Then, Analysis of Variance (ANOVA) for regression and t-test for significant differences of correlated samples were used.

3. RESULTS AND DISCUSSION

3.1. Presentation of the Significant Difference in Students' Laboratory Preference

The Significant difference in students' laboratory preference is shown in **Table 1**.

Table 1. Significant difference in students' laboratory preferences.

Group	N	Mean	Sd	df	t	p	Interpretation
Hands-on	91	4.01	0.43	180	10.75	0.00001	Significant*
Virtual	91	3.20	0.57				

Note: n – number of respondents, sd – standard deviation, t – t-value, p – significance value

Independent samples t-test was conducted to determine the significant difference in students' laboratory preference on two different laboratory settings; hands-on and virtual laboratory. It is evident in table 1 that based on the perceived learning experiences of BSEd Science major students the result shows that there is a significant difference between the two laboratory settings in terms of their laboratory preference. This interpretation was taken from the computed value of p (0.00001) which is lesser than 0.05 probability value from $t = 10.75$ and the degree of freedom of 180 in scores for Hands-on laboratory ($M=4.01$, $SD=0.43$) and Virtual Laboratory ($M=3.20$, $SD=0.57$). Consequently, these values and interpretations rejected the first hypothesis; there is no significant difference between a hands-on and virtual laboratory in terms of students' laboratory preference in performing science experiments. Hence, it cannot be assumed that the two variables are equal.

3.2 Correlation of Students' Learning Experiences and their Laboratory Preference in the Hands-on Laboratory.

The result of the test of correlation between the learning experiences of the students and their laboratory preference towards performing hands-on and virtual laboratory experiments is shown in **Table 2**.

Table 2. Correlation of students' learning experiences and their laboratory preference in the hands-on laboratory.

Group	F	Df	p	R	Interpretation
Learning experience x preference (Hands-on)	20.57	90	0.00002	0.43	Moderate or substantial correlation/positive relationship/ significant*

*at .05 level of significance

Note: F – F-test value, df – degrees of freedom, p – probability value, R – Pearson's R-value

3.3. Correlation of Students' Learning Experiences and their Laboratory Preference in a Virtual Laboratory.

The result in **Table 3** reveals that the correlation is moderate or substantial since the computed r-value is +0.43. According to [Ratner \(2009\)](#), this r value belongs to the range between ± 0.41 to ± 0.70 which is interpreted as a "Moderate or substantial correlation".

Results of ANOVA showed a significant difference between the learning experience and preference in the hands-on laboratory of the students; $F(1, 89) = 20.57$, $p < 0.001$. Thus, the learning experience and preference in hands-on laboratories are significantly different from each other. The null hypothesis that there is no significant difference between the two variables mentioned attained would be rejected ([Chan & Fok, 2009](#)).

Table 3. Correlation of students' learning experiences and their laboratory preference on virtual laboratory.

Group	F	Df	p	R	Interpretation
Learning experience x preference (virtual)	127.13	90	< 0.00001	0.77	Strong or high correlation/ positive relationship/ significant*

*at .05 level of significance

Note: F – F-test value, df – degrees of freedom, p – probability value, R – Pearson's R-value

Therefore, that the students' learning experiences in the hands-on laboratory are significantly correlated to their preference in terms of the learning environment, motivation, cognitive, skills processes they can acquire. The result was supported by the findings of [Tüysüz \(2010\)](#), where he found out that there is a significant relationship between the learning experiences of students in perceiving knowledge towards performing science experiment and their preference in performing hands-on laboratory experiments ([Azizah et al., 2021](#)). Also, his study suggested that there is a statistically significant relationship with the attitude of the students when performing experiments in hands-on laboratory settings. Additionally, the findings of [Pyatt and Sims \(2012\)](#), also support the results that there is a significant relationship on the learner's performance using expository/hands-on laboratory to their laboratory preference, which students indicated between the scales of often and sometimes. Moreover, they also

concluded that there is a significant relationship between students' attitudes as consequences of their learning experiences and preference towards performing in an expository/hands-on laboratory.

4. CONCLUSION

Hands-on and virtual laboratories are learning environments that are viewed by the students differently. Based on the results, the students were confident that they learned things in a hands-on laboratory. It includes the skills, process, concept, and knowledge of Science in doing an experiment. Moreover, students were agreed that they can also learn these in a virtual laboratory. Therefore, hands-on laboratory and virtual was viewed by the students as a good learning environment in which they acquire various knowledge, skills, understanding, and process. In terms of preference, a hands-on laboratory is highly preferred than a virtual laboratory since it gives the students the different satisfaction that stimulates their learning that this setting provides.

Thus, there is a significant difference in students' preference in both hands-on and virtual laboratories. It was also revealed that the learning experiences of the students are moderately correlated to their laboratory preference in the hands-on laboratory, while it is strongly correlated in the virtual laboratory. Therefore, there is a significant relationship between the learning experience and laboratory preference in both laboratory settings.

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6. AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. Authors confirmed that the paper was free of plagiarism.

7. REFERENCES

- Abou Faour, M., and 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 (JESEH)*, 4(1), 54-68.
- Aljuhani, K., Sonbul, M., Althabiti, M., and Meccawy, M. (2018). Creating a Virtual Science Lab (VSL): the adoption of virtual labs in Saudi schools. *Smart Learning Environments*, 5(1), 1-13.
- Azizah, E. V., Nandiyanto, A. B. D., Kurniawan, T., and Bilad, M. R. (2021) The effectiveness of using a virtual laboratory in distance learning on the measurement materials of the natural sciences of physics for junior high school students. *ASEAN Journal of Science and Engineering Education*, 1(3), 175-182.

- Chan, C., and Fok, W. (2009). Evaluating learning experiences in virtual laboratory training through student perceptions: a case study in Electrical and Electronic Engineering at the University of Hong Kong. *Engineering Education*, 4(2), 70-75.
- Isozaki, T. (2017). Laboratory work as a teaching method: A historical case study of the institutionalization of laboratory science in Japan. *Espacio, Tiempo y Educación*, 4(2), 101-120.
- Omolafe, E. V. (2021). Primary educators experts' validation of the developed mathematics mobile application to enhance the teaching of mathematics in Nigeria primary schools. *ASEAN Journal of Science and Engineering Education*, 1(3), 157-166.
- Ottander, C., and Grelsson, G. (2006). Laboratory work: the teachers' perspective. *Journal of Biological Education*, 40(3), 113-118.
- Pyatt, K., and Sims, R. (2012). Virtual and physical experimentation in inquiry-based science labs: Attitudes, performance and access. *Journal of Science Education and Technology*, 21(1), 133-147.
- Ratner, B. (2009). The correlation coefficient: Its values range between+ 1/– 1, or do they?. *Journal of Targeting, Measurement and Analysis for Marketing*, 17, (2), 139-142.
- Tüysüz, C. (2010). The effect of the virtual laboratory on students' achievement and attitude in chemistry. *International Online Journal of Educational Sciences*, 2(1), 37-53.