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## Research Article

### Mobile Virtual Laboratory as Innovative Strategy to Improve Learners' Achievement, Attitudes, and Learning Environment in Teaching Chemistry

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#### ABSTRACT

As our world becomes more technologically advanced, research suggests that technology-rich learning environments support students as well. Mobile Virtual Laboratories can be used to replicate physical laboratories and augment the incorporation of technology inside science classrooms in an attempt to provide students with laboratory experiences that would not otherwise be available in high school settings. This study measured the effectiveness of mobile virtual laboratory as innovative strategy to improve learners' achievement, attitudes, and learning environment in teaching chemistry. The study utilized one-group pretest-posttest design. The innovative strategy is calculated using this design by measuring the difference between the pretest and posttest scores, attitudes and learning environment in teaching chemistry. The study revealed that the utilization of the innovative strategy mobile virtual laboratory in teaching chemistry showed that learners have a strong positive attitude. More so, the learners have a strong positive learning environment when exposed to the innovative strategy mobile virtual laboratory based on the six domain of learning environment in teaching chemistry. As shown by the significantly higher mean in the posttest than in the pretest, the innovative strategy mobile virtual laboratory had a positive impact on the learners' achievement. Consequently, the learners exposed to the mobile virtual laboratory in teaching chemistry are significantly differ in pretest and posttest results. The findings of this study have the potential to reassure educational professionals, contribute to the body of research within the field of chemistry achievement, attitudes, and learning environment, and encourage further research into the efficacy of mobile virtual laboratories as a teaching tool.

**Keywords:** attitudes, innovative strategy, learners' achievement, learning environment mobile virtual laboratory, teaching chemistry

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## **Introduction**

Chemistry is seen as a daunting topic by learners because it is difficult to create the abstract concepts that are commonly encountered in the subject area. Students in high school chemistry classes often memorize problem-solving techniques rather than comprehending the chemical concepts involved. These chemistry classes are often defined as having a broad scope but limited depth. Many students, according to research, do not grasp basic chemistry concepts (Kamisah & Nur, 2013). And many of the students' scientifically misconceived notions persist from grade school through university, and even beyond (Sozbiler & Pynarbapy, 2010). Many students struggle to grasp more advanced concepts that expand on basic concepts because they do not completely and sufficiently understand them. Many high school and university students struggle with basic chemistry concepts. Despite the importance of a thorough understanding of chemistry, most students leave introductory courses with only a rudimentary grasp of the topic. Many scholars, instructors, and science educators have regarded chemistry as a challenging topic for students due to the abstract nature of many chemical principles, classroom teaching styles, a lack of teaching aids, and the complexity of the chemistry language. All of this leads to a lack of understanding and confusion among students, from elementary school to university. For the last three decades, there has been a lot of discussion about chemistry terms being misunderstood.

On the other hand, public school classrooms are scarce in the Philippines, and the situation for science laboratories is even worse. Science laboratories are said to be in short supply in both elementary and secondary schools across the country. According to DepEd results, only 1 out of every 10 public schools in regions III, IV-A, X, XI, and XII has a science laboratory. This ratio is three laboratories for every 10 schools in the National Capital area (The Manila Times, 2014). The public schools in the other regions do not have any science laboratory to facilitate science learning.

Several reform attempts exist to enhance chemistry education in the K-12 curriculum in

public schools in response to demands from this situation, and in accordance with national funds committed to enhancing science education. Many of these improvement efforts revolve around the addition of inquiry to the chemistry laboratory. Laboratory experiments are often compared to cookbooks, in which students directly follow instructions without questioning them. In order to make the laboratory more engaging for students, inquiry elements have been added. However, various teachers view the word inquiry in different ways. Many chemistry courses are not inquiry-based, despite demands for further inquiry in the classroom. This is partially due to misunderstandings about what inquiry is and how inquiry activities are implemented (Demir & Abell, 2010). Inadequate funding and a shortage of opportunities for professional growth have also led to a reluctance to follow inquiry activities.

In order to compete globally, learners require a strong foundation in science. To this end, the development and evaluation of educational innovations in chemistry classes have become increasingly significant. One such educational innovation – virtual laboratories – was evaluated in this study. Intended to simulate real experiments, virtual laboratories, available through the mobile phones, can utilize less instructional time, reduce reliance on complex, hazardous, and costly equipment, and allow students to experience high-level investigations that might not otherwise be possible in a high school classroom setting. In response to urging to adopt more educational technology in science classrooms, the use of virtual laboratories also can offer an engaging instructional medium, one to which many students of the digital age are well-accustomed. However, evidence is required about whether this instructional tool is indeed effective and whether virtual laboratories should continue to be developed and utilized in classrooms.

The current research is focused on the field of learning environments, according to the researcher. The interactions that take place inside a classroom, between students, and between teachers and students are the subject of classroom learning environment study (Fraser,

2012). Instrument for assessing student expectations of what is happening in the classroom may be used to guide potential directions for improving the learning environment. Since there are links between the learning environment and student attitudes toward science and achievement in science (Fraser, 2012), improving the learning environment through educational innovation such as virtual laboratories can improve students' attitudes and achievement levels.

Chemistry attitudes among middle and early high school students have been shown to be declining in comparison to their previous schooling experiences (Oliver & Venville, 2011). Students who lose interest in science are less likely to study the subject in higher education and are less likely to pursue careers in science (Tytler & Osborne, 2012). If educational researchers can find proof of the efficacy of instructional media that engages students in chemistry at this crucial developmental stage, it could help to educate current and future practices for enhancing attitudes toward science and science-related professions. As a result, in addition to assessing students' perceptions of the learning environment, this study also looked at students' attitudes toward science, particularly since there are robust and cost-effective instruments for assessing such attitudes.

Although achievement has historically been used to assess the efficacy of educational innovations, the emphasis of this research was on how the psychosocial aspects of the classroom were affected. However, the result of virtual laboratories on accomplishment was conjointly thought-about so as to see students' understanding of the fabric and to substantiate previously-established links between accomplishment and such psychosocial aspects of education. If each students' perceptions of the school-room atmosphere associated their attitudes towards chemistry improved as a results of an intervention, however their abstract understanding was unchanged, then the intervention could not be thought-about to be really effective. From this, the study will evaluate the effectiveness of the mobile virtual laboratory as innovative strategy to improve learners' achievement,

attitudes, and learning environment in teaching Chemistry among

Specifically, it will seek answers to the following questions:

1. What is the attitude of the learners as exposed to the mobile virtual laboratory as innovative strategy in teaching chemistry as described in the following?
  - 1.1 Inquiry
  - 1.2 Enjoyment
2. What is the level of learners' learning environment during the mobile virtual laboratory as innovative strategy in teaching chemistry as described in the following?
  - 2.1 Integration
  - 2.2 Material Environment
  - 2.3 Teacher Support
  - 2.4 Task Orientation
  - 2.5 Investigation
  - 2.6 Differentiation
3. What is the learners' achievement based on the pretest and posttest results using the mobile virtual laboratory as innovative strategy in teaching chemistry?
4. Is there a significant difference that exists between the pretest and posttest results using the mobile virtual laboratory as innovative strategy in teaching chemistry?

## Methods

To assess the impact of a treatment or innovation on a given sample, the study uses a one-group pretest-posttest design. This design was described as using the same treatments, tests, and innovations on a single group of subjects with the same characteristics who were purposively selected based on the criterion that those learners have difficulty learning chemistry activities in the laboratory. It also has linear ordering, which necessitates the measurement of a dependent variable before and after a treatment. The impact of innovation is calculated using this design by measuring the difference between the pretest and posttest. If there is a substantial difference between the pretest and posttest scores, the difference can be attributed to the independent variable.

The study involves 30 Grade 11 Learners from Technical, Vocational and Livelihood Track- Home Economics of Senior High School

from Graceville National High School. The data gathering instrument that utilized was adapted from the research survey of Oser (2013) which measured the learners' attitudes and learning environment during the chemistry classes as exposed to the innovative strategy of mobile virtual laboratory. On the other hands, the researcher was utilized self-made- pretest -post-test which are validated by chemistry experts in the academe. Each item in the pretest -post-test was carefully checked and the whole content then, submitted to the chemistry experts to establish its reliability and validity, it will be piloted to 30 respondents and run in the computation program for test reliability and validity. Based on the test-retest reliability revealed it was acceptable with computed value of .813.

In analyzing the data, descriptive and inferential statistics will be employed, weighted mean used to determine the learners' achievement, attitudes, and learning environment in teaching Chemistry. The t-test will be employed to determine if there is a significant difference between the pretest-posttest before and after the implementation of innovative strategy innovative strategy of mobile virtual laboratory in teaching chemistry.

## Result and Discussion

To ensure transparency and accuracy, the data obtained in this analysis was thoroughly analyzed and interpreted.

*Table 1. Attitude of the Learners as exposed to the Mobile Virtual Laboratory as Innovative Strategy in Teaching Chemistry.*

Attitude Domains	Weight Mean	Verbal Interpretation
Inquiry	4.35	Positive Attitude
Enjoyment	4.78	High Positive Attitude
OVERALL	4.57	High Positive Attitude

The Table 1 entails the Attitude of the Learners as exposed to the mobile virtual laboratory as innovative strategy in teaching chemistry. The data revealed that inquiry domain has 4.35 as positive attitude and enjoyment domains have 4.78 which expressed as high positive attitude. The findings implies that the learners have a strong positive attitude with the utilization of the innovative strategy

mobile virtual laboratory in teaching chemistry as reflected on the weighted mean of 4.57. The discoveries of this exploration confirm the ones of past investigations done by Bozkurt and Ilik (2010), and Tüysüz (2010), where attitudes of learners towards science have improved and decidedly affected when exposed to the mobile virtual laboratory as innovative strategy in teaching chemistry.

*Table 2. Level of Learners' Learning Environment during the Mobile Virtual Laboratory as Innovative Strategy in Teaching Chemistry*

Learning Environment Domains	Weight Mean	Verbal Interpretation
Integration	4.67	High Positive
Material Environment	4.63	High Positive
Teacher Support	4.50	High Positive
Task Orientation	4.78	High Positive
Investigation	4.89	High Positive
Differentiation	4.59	High Positive
OVERALL	4.68	High Positive

As can be gleaned from the analysis of Table 2, shows the level of learners' learning environment during the mobile virtual laboratory as innovative strategy in teaching chemistry. Looking on the learning environment domains such as Integration (4.67), Material Environment (4.63), Teacher Support (4.50), Task Orientation (4.78), Investigation (4.89), and Differentiation (4.59) was described as high positive learning environment when the learners' exposed to the innovative strategy mobile virtual laboratory. Thereby, that the learners

have a strong positive learning environment when exposed to the innovative strategy mobile virtual laboratory as based on the weighted mean of 4.57. it also portrayed the studies of Husnaini & Chen (2019). And Ghergulescu et al. (2019) that virtual laboratory was more efficient in developing challenging concepts and scientific inquiry self-efficacy and creating an interactive learning that provides learners with customized features in learning science concepts.

*Table 3. Learners' Achievement based on the Pretest and Posttest results using the Mobile Virtual Laboratory as Innovative Strategy in Teaching Chemistry*

	Pretest Score	Posttest Score	Gain Scores
Mean	79.2	87.53	40.05

Based on the Table 3 were the learners' achievement based on the pretest and posttest results using the mobile virtual laboratory as innovative strategy in teaching chemistry. Looking on the data provided on the table, it indicates that before the utilization of innovative strategy learners' achievement in pretest were 79.2, then in posttest were 87.53. Thus, the learners' gain the score of 40.05%. relatively, it can be culled that innovative strategy

mobile virtual laboratory had a positive effect on the learners' achievement of the learners, as evidenced by the significantly greater mean in the posttest than in the pretest. From this finding confirmed studies of achievement Alneyadi (2019); Penn & Umesh, (2019; Pyatt & Sims, (2012); Tatli & Ayas, (2013); Tsovaltzi et al. (2010) and Tüysüz (2010) , that mobile virtual laboratory applications made positive effects on students' achievements in chemistry.

*Table 4. Test of Significant Difference that exists between the Pretest and Posttest results using the Mobile Virtual Laboratory as Innovative Strategy in Teaching Chemistry*

df	t- test	t-test critical value	Probability Level	Decision	Interpretation
29	17.62	2.04	$P > 0.05$	$H_0$ is rejected	Highly Significant

In the course of investigation in Table 4, the study hypothesized that there is Significant difference that exists between the pretest and posttest results using the mobile virtual laboratory as innovative strategy in teaching chemistry, the data collected were subjected to analysis of t-test to determine the extent difference between the means of two data on the variables under study.

Since the computed t-test of 17.62 is greater than t-test critical value of 2.04 at the .05 level of probability with the degree of freedom of 29, the null hypothesis is rejected, and the alterna-

tive hypothesis is accepted. Specifically, the researcher concludes that pretest and posttest results are significantly differ as the learners exposed to the mobile virtual laboratory in teaching chemistry.

This is line with the observations of Sypsas et al. (2019), who discovered that combining virtual labs with interactive labs helps students gain a deeper understanding of science.

## Conclusion

On the basis of the findings presented, the following conclusions are drawn.

1. The utilization of the innovative strategy mobile virtual laboratory in teaching chemistry showed that learners have a strong positive attitude.
2. The learners have a strong positive learning environment when exposed to the innovative strategy mobile virtual laboratory based on the six domain of learning environment in teaching chemistry.
3. As shown by the significantly higher mean in the posttest than in the pretest, the innovative strategy mobile virtual laboratory had a positive impact on the learners' achievement.
4. The learners exposed to the mobile virtual laboratory in teaching chemistry are significantly differ in pretest and posttest results.

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