

**ADAPTING TO VIRTUAL LABORATORY TEACHING STRATEGY DURING
COVID-19: ITS EFFECTS ON PHYSICS STUDENTS' ATTITUDE IN KOGI STATE,
NIGERIA**

By

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Abstract

The study investigated adapting virtual laboratory teaching strategy during Covid-19: its effects on physics students' attitude. Two research questions and two hypotheses were raised and formulated respectively to guide the study. Physics Practical Attitude Scale (PPAS) was the instrument used for data collection with a reliability coefficient of 0.85 established using the cronbach alpha method. Two secondary schools were selected using the purposive sampling technique. The research questions were answered using mean and standard deviation while the hypotheses were tested using Analysis of Covariance at 0.05 level of significance. Findings of the study revealed a significant difference in the mean attitude score of students exposed to physics virtual laboratory practicals and those exposed to Physics conventional laboratory practicals in favour of virtual laboratory that had higher mean score. Also there is no significant differences on the students' attitudes scores based on gender. It was recommended that physics teachers should adopt the use of virtual laboratory so as to help improve and enhance their attitude toward physics practical as well as help them from contacting COVID 19 virus.

Keywords: attitude, COVID-19, Physics practical, Virtual laboratory

Introduction

The World Health Organization (WHO), on 31 December, 2019, was informed of pneumonia cases of unknown causes in Wuhan city of China. A novel corona virus was identified as the causes by Chinese authority on 7th January, 2020 and was named COVID-19. The COVID-19 was a potentially severe and primarily respiratory illness caused by a corona virus and characterized by fever, coughing and shortness of breath. The COVID-19 is a highly contagious respiratory disease caused by the SARS-COV-2 virus and the virus was thought to spread from person to person through close contact, sneezing, coughing among so many others ways. The spread of this disease led to COVID-19 pandemic which claimed millions of life all

over the world. Furthermore, the spread of the pandemic affected students, teachers, educators, parents and everybody worldwide as the outbreak of this pandemic led to closure of schools, shops, hospitals, market places and total lockdown all over the world,

In Nigeria before the pandemic outbreak, the use of digital and virtual learning was not common. The fear of spread of the virus led to use of digital computers for teaching and learning, online meetings and conferences. The continuation of the virus, changed education from total physical classroom interaction to both physical and virtual laboratory learning (Shahzad, et al 2020). This led to the reason why Lawal et al (2020) Opined that COVID – 19 has offered as opportunity to upgrade the mode of delivery of education and upgraded of modern technologies both in teaching Physics and other subjects (Sypasas et. Al, 2019).

Physics is a subject related to laboratory activities. It is a knowledge of natural phenomena involving inquiry and discovery through hands-on and mind-on experiments under the supervision of the teachers. In physics learning, laboratory activity is very important in providing opportunities for students to perform various kinds of hands-on and mind-on activities. Laboratory work is an essential component of the study of physics as well as other natural science disciplines. It helps students to learn concepts and hands-on skills and to illustrate theory. Furthermore, practical laboratory increases students' curiosity and positive attitude toward science (Bretz et al., 2013). Despite its importance, laboratory work is still facing many challenges such as the high cost of laboratory equipment and materials and dangers encountered when working with dangerous experiments. At the same time, evidence in literature shows that the integration of Information and Communication Technologies (ICTs), such as simulation, animation, videos, and visualizations is very promising (Hofstein & Kind, 2012). One form of using ICT in a learning physics lab is to combine a virtual lab with a real practical lab (Darrah et al., 2014).

Virtual education has exploded within the past few years and has become even more centric to the school life worldwide especially during the outbreak of COVID-19 pandemic. Together with the expansion of virtual courses is the increasing concerns about the quality of education it provides and the challenges faced by the teacher and the learner (Doan, 2020). Virtual learning is a learning experience that is enhanced through utilizing computers and/or the internet both within and outside and inside the classroom components. The instruction most commonly takes place in an online environment. The teaching activities are carried out online whereby the teacher and learners are physically separated in terms of place, time, or both (Ramesh, 2019). The course contents are conveyed through IT applications, multimedia resources, the Internet, videoconferencing among others. Virtual learning can also be defined as distance learning conducted in a virtual learning environment with electronic study content designed for self-paced (asynchronous) or live web-conferencing (synchronous) online teaching and tutoring (Ramesh, 2019). Virtual laboratory experiment have potential benefit to the students as it can be carried out anytime anywhere using smart phone and laptops. Onuh and Okigbo(2019) further pointed out that using virtual laboratory makes students become active in learning, enables students to understand difficult concept, easily make students overcome the possible danger in the real laboratory condition and improve students' confidence in carrying out real laboratory practical. Furthermore, Famuwagun and Mohammed (2020), argued that virtual laboratory provides opportunity for students to repeat any incorrect experiment thereby deepening the intended experience of the students.

The quality of online education depends on the proper use of digital technologies in accordance with modern educational theories such as cognitivism theory. Cognitivism focuses on the role of the mind and cognitive processes in learning. It explains how the brain is

functioning and the levels of cognitive development that form the foundation of learning. Studies of cognitivism help educators understand how people learn and how to teach more effectively. In virtual learning, cognitivism can be applied through customizable learning environments, adaptive and personalized learning applications, and learning analytics.

Students' attitude toward Physics is a vital factor in teaching and learning. It affects their academic achievement in Physics. Okobia and Ogumogu (2012) viewed attitude as predisposition to respond in a favourable or unfavourable manner with respect to a given subject. Also Aku et al in Achimugu and Muftawu(2019), defined attitude as an outward and visible posture of human believes that determines what each individual will see, hear, think and do. Positive attitude indicate willingness to do well in one's academic pursuit and negative attitude indicate unwillingness to do well in one's academic pursuit. Ojo and Owolabi (2020) argued that positive or favorable attitude could enhance performance in physics while negative attitude of students toward physics may be responsible for poor academic performance in physics. They further argued that it is necessary for teachers to help students develop the right attitude toward physics practical. To this end, it is expected that virtual laboratory method will aid in enhancing students attitude toward physics.

Several related literature reviews address the relative effect of virtual and physical laboratories on students' attitude in science subjects has indicated below; Tuysuz (2010) carried out a study on the effects of virtual laboratory on students' achievement and attitude in chemistry using separation of matter unit for 9th grade students and found that virtual laboratory application, made positive effect on students' achievement and attitude when compared to traditional methods. Ojo and Owolabi (2020) investigated the effects of virtual laboratory instructional strategy on secondary school students' learning outcomes in physics practical and found that virtual laboratory had positive effect on students' performance and attitude towards physics practical. Gabari et al (2018) carried out a research on efficacy of virtual laboratory on the achievement and attitude of secondary school students in physics practical and found that the application of virtual laboratory had positive effect on students' achievement and attitude when compared to physical laboratory method. Onuh and Okigbo (2019) conducted a research on enhancing students' attitude in physics through the use of combined physical and virtual laboratory in secondary schools in Enugu state and found that combined virtual and physical laboratory had positive effect on students' attitude when compared to the use of only physical laboratory.

Furthermore, Grandalli (2015) carried out a research titled "comparison of degree of student satisfaction using simulation or a traditional laboratory to teach physical properties of ice" and found no difference in learning outcome of the two methods. Ambusaidi *et al* (2018) investigated the impact of virtual laboratory learning experience on 9th grade students' achievement and their attitude towards science. The results indicated no significant impact between virtual and physical laboratory on students' achievement and attitude towards science. These contradictions from literature showed the need to carry out more investigation on this area of research. Apart from filling the gap created by mixed result on studies on virtual laboratory, the research is important as it will contribute to the ongoing debate or role of virtual laboratory as an alternative solution under the times of COVID 19 and other types of restrictions due to the pandemic period. Therefore, this study aimed to investigate adapting to virtual laboratory teaching strategy during covid-19: its effects on physics students' attitude.

Literature reveals that there is no agreement among science educators on the influence of gender on attitude and academic achievement in science subjects when students are exposed to innovative teaching methods. For instance, Onuh and Okigbo (2019) found that the use of combined physical and inquiry virtual laboratory enhanced the attitudes of male physics students more than their female counterparts. Gambari et al (2018) showed that female students

had better attitude toward physics practical than their male counterparts when exposed to virtual laboratory instruction. Achimugu (2018) found that there is no significant difference between the male and female students exposed to innovative teaching methods. As a result of the contradicting reports on influence of gender in literature, it has become imperative to include gender as a moderating variable in the study aimed at finding out whether gender has any influence on students' attitude in physics practical when exposed to virtual and physical laboratory teaching method.

Statement of the Problem

At the time when the whole world is faced with a global pandemic, every aspect of life was put to a lockdown, observing social distancing if one must be in the public. Nigeria was not left out, it was a complete lockdown in the country. Education is a thing of continuity and can't afford to suffer a shutdown as a result of pandemic. Hence, the need for an alternative means of teaching and learning. Specifically, the ineffective methodology employed by physics teachers as well as non-use of model techniques during instruction generally leads to students' low enrollment and negative attitude toward Physics as noted by many researchers in the background of this study. These and the lockdown in Nigeria as a result of global pandemics is responsible for this study. Thus, the big question to answer in this study is; what could be the effect of the virtual laboratory teaching strategy on physics students' attitude during COVID 19 era?

Purpose of the Study

The purpose of this study was to determine the effect of virtual laboratory teaching strategy on Physics students' attitude during COVID 19 era.

Specifically, the study sought to determine the:

- 1 Difference in mean attitude rating scores of secondary school students taught physics practical using virtual laboratory method and those taught with conventional laboratory method.
- 2 Difference in mean attitude scores of male and female students taught practical physics using virtual laboratory

Research Questions

The following research questions guided the study;

- 1 What is the difference in the mean attitude scores of students exposed to physics practical through virtual laboratory method and those exposed to conventional laboratory method before and after treatment?
- 2 What is the difference in the mean attitude scores of male and female physics students exposed to virtual laboratory before and after treatment?

Research Hypotheses

The following null hypotheses were formulated and tested at 0.05 level of significant.

- 1 There is no significance difference in mean attitude scores of students exposed to virtual laboratory method and those exposed to the conventional laboratory method.
- 2 There is no significance difference in mean attitude scores of male and female physics students exposed to virtual laboratory method

Methodology

The study adopted the quasi experimental design. The specific design used for this study was a pre-test, post-test, non-equivalent control group design. The population for this study consisted of all senior secondary year one (SS1) physics students in all the 257 public senior secondary schools in Kogi State. There are 5,271 students offering physics in SS1 in Kogi State. Senior secondary one considered appropriate for the study because, they would have been exposed to theoretical knowledge of Physics and have not be exposed to physics practical and thus have no prior knowledge of the practical exercises under consideration. The sample for this study is made up of 88 Physics students of senior secondary one (SS1) in two co-educational schools in Kogi State. Multi-stage sampling technique was used to select the sample. Firstly, purposive sampling was used to select secondary schools that was co-educational and have computer laboratory under the school net programme. Secondly, simple random sampling technique by balloting was used to assign intact classes to experimental and control groups.

The instrument used for this study was Physics Practical Attitude Scale (PPAS). The PPAS is a 20-Items designed to assess student's attitude towards practical physics. The instrument was scored on four point modified Likert scale of strongly agree (SA), Agree (A), Disagree (D) and Strongly Disagree (SD). Positive statements were scored as follows; SA= 4, A= 3, D=2, SD=1, while negative statements were scored as follows; SA=1, A=2, D=3, SD=4. The PPAS was subjected to face and content validity. The face validity was carried out by three experts (two from science education and one from measurement and evaluation) in Kogi State University Anyigba. The experts validated the items in terms of clarity of language appropriateness and adequacy of items in measuring what they are supposed to measure. The content validity was determined using table of specification to cover the attitude dimensions. Pilot study was conducted to establish the reliability of the instrument. The instrument was administered to secondary schools students who were not part of the sample through test-retest method. The data collected for PPAS through pilot study were analyzed using Cronbach alpha method. A reliability coefficient of 0.85 was obtained. The regular physics teachers of the two sampled school representing the experimental and control groups were trained as research assistants. The experimental group teacher was coached using the virtual laboratory instructional package adopted from PHET (2006) made up of three components namely practical procedures, video and virtual laboratory. The control group teacher was trained using conventional practical lesson plan prepared by the researchers. After the training that lasted one week and before the commencement of the treatment, the PPAS was administered as Pre-test for both groups. During the teaching, the researchers kept monitoring the regular physics teachers to ensure that they did not deviate from the procedure of instruction given to them by the researchers. The teaching lasted for four (4) weeks, after which PPAS was administered to the experimental and control groups as post-test. The pre-test was reshuffled to give a different look before being used as post- test in such a manner that the same content of PPAS served as both pre-test and post-test.

The research instrument PPAS was given to the students as pre-test by their regular Physics teacher before commencement of lesson and after the lesson, the pre-test was

reshuffled and given to the students as post-test. Both the pre-test and post-test were collected back from the students by their class teachers. The data was organized accordingly for data analysis. Data obtained from the study were analyzed using mean and standard deviation to answer the research questions while analysis of covariance (ANCOVA) was used in testing the hypotheses at 0.05 significant levels.

Results

Research Question One: What is the difference in the mean attitude scores of students exposed to physics practical through virtual laboratory and those exposed to conventional laboratory method?

Table 1

Mean and Standard Deviation of Mean Attitude Scores of Students Exposed to Physics Practical through Virtual Laboratory and Those Exposed to Conventional Laboratory Method.

Variable strategies	N	Pre-test		Post-test		Mean attitude Gains
		X	SD	X	SD	
Virtual Laboratory	44	33.09	7.02	52.22	12.19	19.13
Conventional Laboratory	44	32.63	7.48	43.34	9.50	10.71

Where; N= Number of respondents, X= mean, SD = Standard Deviation

Table 1 showed that students exposed to physics practical through virtual laboratory and those exposed to conventional laboratory method. The students exposed to physics practical through virtual laboratory had mean attitude pre – test score of 33.09 with standard deviation of 7.02 and post-test mean attitude score of 52.22 and standard deviation of 12.19. The students exposed to conventional laboratory had a pre-test and post – test mean attitude score of 32.63 and 43.34 respectively with standard deviation of 7.48 and 9.50 respectively and mean attitude gain of 10.71. However, for each of the groups, the post attitude mean was virtual laboratory having the highest mean attitude gain. This is an indication that virtual laboratory improved student’s attitude in physics practical than conventional laboratory.

Hypothesis one: There is no significant differences in the mean attitude scores of students exposed to physics practical through virtual laboratory and those exposed to conventional laboratory.

Table 2

Analysis of Covariance of Students Mean Attitude Scores of Students Exposed to Conventional Laboratory.

Source	Type III sum of squares	Df	Mean square	F	Sig.
Corrected model	9235.866 ^a	2	4617.933	44.168	.000
Intercept	2422.285	1	2422.285	23.168	.000
Pre-Test	1388.582	1	1388.582	13.281	.000
Strategies	7631.935	1	7631.935	72.996	.000
Error	8887.032	85	104.553		
TOTAL	179205.000	88			
Corrected Total	18122.898	87			

The result in Table 2 shows that with respect to the mean attitude scores of students exposed to physics practical through virtual laboratory and those exposed conventional practical laboratory method, an f-ratio of 13.281 was obtained with associated exact probability value of .000. Since the associated probability (.000) was less than 0.05 set as level of significance, the null hypothesis which stated that there is no significant difference in the mean attitude scores of students exposed to physics practical through virtual laboratory and those exposed to conventional laboratory method is rejected. Thus, inference drawn is that there is a significant difference in the mean attitude scores of students exposed to physics practical through virtual laboratory and those exposed to conventional laboratory method with those exposed to virtual laboratory having a higher mean gain. This is an indication that virtual laboratory improved students' attitude in physics than conventional laboratory method.

Research Question Two: What is the difference in the mean attitude scores of male and female physics students exposed to practical through virtual laboratory?

Table 3

Mean and Standard Deviation of Attitude Scores of Male and Female Physics Students Exposed to Physics Practical through Virtual Laboratory

Variable	Pre-test			Post-test		Mean attitude Gain
	N	X	SD	X	SD	
Male	21	32.90	7.54	57.85	11.74	24.95
Female	23	33.26	6.67	47.08	10.36	13.82

Where: N = Number of respondents, X = mean SD = Standard deviation

Table 3 showed that mean attitude score of male students exposed to physics practical through virtual laboratory had pre-test mean score of 32.90 with standard deviation of 7.54 and post -test mean score of 57.85 with standard deviation of 11.74 and mean attitude gain of 24.95, for female students exposed to physics practical using virtual laboratory had pre – test and posttest mean score of 33.26 and 47.08 respectively with standard deviation of 6.67 and 10.36 respectively and mean attitude gain of 13.82. Thus the result showed that, the male students exposed to physic practical using virtual laboratory method, mean attitude gain was greater than the female students exposed to physics practical using virtual laboratory. This result shows that virtual laboratory lead to male student’s higher attitude in physics practical than female students.

Hypothesis two: There is no significant difference in mean attitude of male and female physics students exposed to physics practical through virtual laboratory.

Table 4

Analysis of Covariance of Mean Attitude Scores of Male and Female Physics Students Exposed to Physics Practical through Virtual Laboratory

Source	Type III sum of square	Df	Mean square	F	Sig.
Corrected Model	1701.854 ^a	2	850.927	7.439	.002
Intercept	2622.924	1	2622.924	22.930	.000
Pre-Test	428.524	1	428.524	3.746	.060
Gender	1310.606	1	1310.606	11.458	.002
Error	4689.873	41	114.387		
TOTAL	126410.000	44			
Corrected Total	6391.727	43			

Table 6 shows that there was significant difference between the mean attitude scores of male and female students exposed to physics practical through virtual laboratory. An F-ratio of 11.458 was obtained with associated exact probability value of .002, since the associated probability (.002) was less than 0.05 set as level of significance, the null hypothesis which stated that there is no significance difference mean attitude scores male and female physics students exposed to physics practical through virtual laboratory was rejected. Thus, inference drawn is that, there was significant difference in the mean attitude scores of male and female physics students exposed to physics practical through virtual laboratory in favor of the male with higher mean attitude score.

Discussion of Findings

The results from Tables 1 and 2, showed that there was a significant difference in the mean attitude scores of students exposed to physics virtual laboratory practical and those exposed to conventional physical laboratory practical in favor of virtual laboratory method that had higher mean scores. This implies that virtual laboratory improved students' attitude toward physics practical than the conventional laboratory. This finding agrees with the findings of Tuysuz (2010) and Ojo and Owolabi (2020), who stated that students' attitude toward science subjects was enhanced by using virtual laboratory than conventional laboratory. The findings however disagreed with the findings of Tatli and Ayas (2013) and Guisti (2018) who found that conventional laboratory method enhances students' attitude toward physics than virtual laboratory. It also disagreed with the finding of Ambusaidi *et al.* (2018) who found no significant impact between physical and virtual laboratory on student attitude toward science subjects. The superiority of virtual laboratory in the present study may be due to students' active participation in repeatedly carrying out many practical exercises at their homes using virtual laboratory method.. Thus virtual laboratory method should be adopted as it will help to curb the menaces of the spread of COVID-19 through physical contact. That to say the use of virtual laboratory will help to reduce death and loss millions of lives by the school children.

It is also found that there were significant difference in the man attitude scores of male and female physics students exposed to virtual physics practicals in favour of the male with highest mean attitude scores. This implies that mean attitude gain of male students exposed to virtual physics laboratory method practical was significantly greater than the mean attitude gain of the female students exposed to the physical laboratory method. The finding of this study agrees with the findings of Onuh and Okigbo (2019) who found that the use of inquiry virtual laboratory enhanced the attitude of male physics students more their female counterparts. The findings disagree with the findings of Adigun and Ekwukoma (2014), Achimugu (2018) and Kulthau et al (2019) who stated that inquiry method like virtual laboratory method of students in physics are enhanced irrespective of gender. The reason why the present study differ with the above findings, may be as result of the fact that, the female students are over burdened with domestics works and hence have no time for frequent virtual laboratory exercises at their home when compared to their male counterparts that have much more time.

Recommendations

1. Stakeholders in physics education should adopt the use of virtual laboratory method so as to reduce the incidence of deaths and loss of lives of physics student occasioned by spread of COVID 19 through physical contact and closeness to each other.
2. Physics students should adopt the use of virtual laboratory so as to help them improve and enhance their attitude in physics concepts
3. Parent should not over labor their girl- child at homes with domestic works so as give them more time to carry out more virtual laboratory exercises.
4. Seminars, workshops and conferences should be organized by bodies like Science Teacher Association of Nigeria (STAN), and Nigeria Institute of Physics (NIP) on the use of virtual laboratory.

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