

# Learning Outcomes of Students in Traditional and Virtual Laboratory Instruction in Science

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**Abstract:** *The academic performance of the Filipino students as of now is at stake especially in the major subjects such as mathematics and science. Since Grade 9 is one among the low performer in high school in the said subject matter based on the results in the National Achievement Test last few years, they are used as respondents to be focused in the study as a ground in searching a solution for the problem in education. The researcher used two groups: control group and experimental group. Comparison of the performance of the groups were measured based on the scores obtained from the pretest and posttest. The methods, principles and objectives of lessons are parallel except the instructional materials used. The 10 weeks study involved the gathering of data using the pretest, posttest, observations, and interviews. The result shows that there is a significant difference  $= < 0.001$  in pretest – posttest. Consequently, the experimental group who used the Virtual Laboratory Instructions has higher performance across the topics tested. Thus, the influence of virtual laboratory remarkably stresses its positive contribution to science education. The results and recommendations of the study are intended to improve the skills of students and uplift the achievements in the field of science.*

**Keywords:** virtual lab, and traditional instruction

## 1. Introduction

Life with science and technology is absolutely change. As a matter of fact, it simplifies everything which resorts in the opening of new ideas, knowledge, inventions, and so forth. So as to make things easier. It has indeed, invaded human's conveniences and comforts which no one can actually reject. As well as, enable lengthening of life (Srivastav, 2015).

Quirino High School is a pilot school in the Congressional District III of the Division of Quezon City. It is also one of the largest schools in terms of population and lot area. However, in the lack of science education facilities, QHS is one among the 20 percent of public high schools in the division that has laboratories with non-traditional "modern" equipment that has a computer and LCD projector only (The Mania Times, 2014). As a result, many Filipino students had a few access to science laboratories. Hence, the absence of science laboratories could be a factor to poor quality of basic science education (The Mania Times, 2014) and low achievement scores in the National Achievement Test (NAT). As reported last SY 2009 – 2010, only 46.36 percent got the passing rate in the NAT, which is lower compared with SY 2008 – 2009, that got 47.40 percent passing rate (The Mania Times, 2014).

Another contributing factor is the teaching preparation of public school teachers in science. There is only a small fraction of teachers in high school that are capable to teach Physics, Chemistry, Biology and Earth Science because of different reasons like mismatch (The Mania Times, 2014). Therefore, they may avoid using laboratories because of some possible reasons such as insufficiencies strategically method in teaching science, doubts on their safety especially on risky experiments, low of self-esteem due to unknowledgeable, inadequate effort, time requirement in performing experiments (Walton, 2002), too many topics to discuss in every quarter, and insufficient budget for teachers buying materials for the activities. Consequently, the mastery of lessons among the students are at stake and the

interest in science attributed to the lack of laboratory and better delivery of lessons (Yang and Heh, 2007).

In addition, traditional way of teaching in the Philippines is still the most used strategies by Filipino teacher where teachers is constantly giving instruction to students and almost do everything, while students are sitting facing in front with an aligned position. Moreover, Philippine educational system is indeed following the steps of other countries just to adapt with the international standards and test

On the other hand, the term Virtual laboratory (VL) is unknown to almost Filipinos. It is not fully explored by educators and not used as a tool in the teaching-learning process. Most of the teachers considered PowerPoint presentation as a technological advancement in teaching. Thus, the introduction of the use of educational platforms/tools, more specifically the use of computer in supporting the laboratory methods can be a logical one (Kiyici and Yumusak, 2005). Using technology in science instruction offers wide opportunities for education development. Students can collaborate on meaningful activities with their classmates. Effective technology also can reinforce and enrich students' learning in interactive environment, which encourages the creativity through e-learning applications in different modes like visualization, simulation and modeling (Manner, 2003, Repnik and Grubelnik, 2010).

The problem is much different from what we already think. Because what we need is to redirect the old system and mold this to fit in, especially to the nature of students we have now. However, if there is an adaptation of new techniques, we should check first before we implement and guide all concerned stakeholders. Because the success of this strategy will depend on how the teachers learning activities and experiences will proceed (Chang, 2013; Fogleman, McNeill, and Krajcik, 2011).

The study aimed to determine the influence of traditional instruction and virtual laboratory instruction on the student achievement in Science in the Schools Division of Quezon City during the school year 2017 – 2018. Specifically it intended to answer the following questions (1.) What is the achievement of the students in the pretest using Virtual Laboratory Instruction and traditional instruction in selected 5 topics in science? (2.) How may the Virtual Laboratory and traditional instruction in teaching 5 topics be described? (3.) What is the achievement of the students in the post test using Virtual Laboratory Instruction and traditional instruction in selected 5 topics in science? (4.) Is there a significant difference between the pretest and posttest on the achievement of the students? (5.) What issues and concerns are encountered by the students and teachers in Virtual Laboratory Instruction?

The objectives of this research is to unleash the common knowledge and lay outgrowing passion in seeking development to science education. The context of this study is to analyze if the traditional instruction and virtual laboratory instruction are useful in elevating the achievement of students in science through results from pretest to posttest. The purpose of this is to engage students in science; acquire scientific inquiry skills; and experience the culture of doing science, under motivating circumstances, by undertaking active, guided, experimentation, carried out on more basic and top-level scientific facilities (Rocard et al., 2007) and to determine which of the traditional or new approach such as virtual laboratory instruction is highly applicable to Quirino High School students. This evidently explains, why we should undertake studies pertaining to virtual lab as a tool in teaching strategies. Since virtual reality simulations and animations are important applications that develop and fitly place in the learning process to engage students and enhance their conceptions, they could be also helpful to generate interactions at the same situation (Ong and Mannan, 2004).

This study was limited to the influence of traditional and virtual laboratory instruction on the student's achievement in science, specifically, on Physics which was taught in the

second quarter of Grade 9 level. Its duration was the whole second quarter incorporating the two instructions in teaching the two groups to find out the acquired competencies with which the students gain knowledge.

## 2. Methodology

### Research Design

The researcher used pretest – posttest descriptive comparative method design to measure the influence that occurred on the traditional group and experimental group. And draw conclusions by means of statistics, which cannot affect their own presence and behavior or attitude in collecting and converting data.

### Population and Sampling

The respondents of the study were selected students of Grade 9 of Quirino High School located in Molave St., Project 3, Quezon City. The needs in improving academic performance for further development in producing productive learner was identified in Grade 9 based on the results of National Achievement Test these few years in the Division of Quezon City. To establish a zero variability in selecting respondents, the researcher made an independent sample test from the scores of pretest.

Simple random sampling was used in selecting the student respondents of the study. These procedures were used when the subsets of individual were chosen from a larger group of population. Each student has the same probability to be chosen randomly. A prior calculated sample size = 88 were selected based on the power = 0.95 effect size = 0.80, at alpha = 0.05. Samples were randomly selected from different sections.

With 95 percent confidence level, the total population of 174 grade 9 students and the confident interval per section, a sample size was computed 50 percent or 88 grade 9 students to be the respondents from 4 different sections. The distribution of student participants are shown on table 1.

**Table 1:** Distribution of Student Participants Per Group

Sections	Group	Population per Section	Confidence Interval/Margin of Error	Percent (%)	Total Sample Size	Sample size per group
Amethyst	Experimental	46	14%	50	24	12
	Traditional					12
Aquamarine	Experimental	44	15%	50	22	11
	Traditional					11
Sapphire	Experimental	42	16%	50	21	11
	Traditional					10
Zircon	Experimental	42	16%	50	21	10
	Traditional					11
total		174	8%	50	88	44

### Sources of Data

The sources of data refer to the test, validity, interview, observation, administration and retrieval, and data gathering procedure used by the researcher to facilitate the gathering of pertinent information and data needed to answer the specific questions.

### Pretest and Posttest

The main instrument be used in this study for the collection of data was the test from the division office but reconstructed, deleted and some items were added by the researcher to fit in. Pretest and Posttest were based on the table of specification aligned in DepEd K12 Curriculum Guide in Science for Grade 9 learning competencies, which

consists of 55 items covering all competency. It was administered to all student respondents before and after the exposure to traditional and virtual laboratory instruction. Several authors testified this method in their researches because test can provide an evidence from the teachers to a valid judgment to students' progress in every learning. (El-Sabagh, 2011; Maldarelli et al., 2009; Metrailler et al., 2008; Chen et al., 2008; Yang and Heh, 2007; Noguez et al., 2007)

**Table 2:** Distribution of Items per Lesson

Number	Items	Topics
1 – 10	10 items	Work, Power and Energy
11 – 20	10 items	Sound
21 – 30	10 items	Light
31 – 40	10 items	Heat
41 - 55	15 items	Electricity
Total	55 items	

**Validation**

The test questionnaires were checked by the Master Teachers and teachers of Science, as first level of validation. It was then presented to the researcher's adviser who made further improvements to avoid problems such as ambiguity of directions and vagueness of some items. The 20% population of Grade 9 students in the same school took the exam to observe the reliability. Results were item analyzed and tested its normality distribution, it is assumed to be normally distributed since it is not closed to zero. This process helped the researcher in preparing the final form of pretest and posttest.

**Interview**

In reconstruction of the experiences and what happened, interviews are concerned with the facts and sequence of an event (McNamara, 1999). A guide for an interview were followed to find out the possible issues and concerns of students in using Virtual Laboratory. This would help to examine or develop and suggest improvements from the evaluation dealing with incorrect behaviors.

**Observation**

To see clearly what happened in the actual usage of virtual rather than depending on the respondents. Thus, the researcher explored what meant on and enhanced the understanding of various kinds of interaction, as part of research.

**Administration and Retrieval**

The researcher had undergone any activity in the school, she secured first a permit from the Division Office of Quezon City signed by the Superintendent. The test constructed was reproduced according to the number of respondents and personally distributed and administered by the researcher. After the test, all answer sheets were gathered as soon as possible.

**Data Gathering Procedure**

A pretest was administered to both traditional and experimental group before the exposure of traditional approach and virtual laboratory approach. The results were tabulated and analyzed thereafter.

The teacher used the Phet Simulation Interactive portal for the laboratory activities of experimental group while the traditional group used classroom based activities. Activities were aligned on the learning competencies in science. Materials being used for the two groups were not identically the same. In the Traditional Group, they followed the Localization process in the public school settings. However, in Experimental Group, the computers were set up and internet connections. Time and place were all considered for the performance of the activities. Every class was allotted 60 minutes or 1 hour based on the schedule of the school hours.

After five lessons, the teacher made sure to give the posttest every after the lesson and check as soon as possible to measure the significance of the two groups.

**Data analysis**

The collected data of this study were analyzed with the SPSS (Statistical Package for Social Science) for windows on all statistical computation and with the help of statistician.

**Reliability**

The pretest and posttest had undergone a reliability statistics using split-half reliability. The result of the split-half is 0.744 which was good for a classroom test. In similar manner, Cronbach's Alpha was also applied to determine the internal consistency of the test delivered. A result of 0.832 is within an acceptable level.

**3. Results and Discussion**

**1. Achievement of the students in the pre-test using Virtual Laboratory Instruction and traditional in selected 5 topics in science**

**Table 3:** Level of Proficiency of Students in the Pretest

Pretest per Topic												
Group	Performance	Work		Sound		Light		Heat		Electricity		Mean
		f	%	f	%	f	%	f	%	f	%	
<b>Traditional Group</b>	Mastered	0	0	0	0	0	0	5	11.36	28	63.64	<b>20.79</b>
	Developing	8	18.18	10	22.73	8	18.18	16	36.36	7	15.91	
	Least Mastered	36	81.82	34	77.27	36	81.82	23	52.27	9	20.45	
	<b>Mean</b>	2.84		3.55		3.07		4.39		6.95		
<b>Experimental Group</b>	Mastered	0	0	7	15.91	0	0	5	11.36	28	63.64	<b>21.54</b>
	Developing	3	6.82	11	25.00	11	25.00	13	29.55	8	18.18	
	Least Mastered	41	93.18	26	59.09	33	75.00	26	59.09	8	18.18	
	<b>Mean</b>	2.25		4.00		3.70		4.11		7.48		

The researcher classified the achievement of respondents based on the scores as to mastered, developing, and least mastered per topic. These techniques of assessing the performance of students are in accordance with DepEd Order no. 73 s.2012. The table shows that, either traditional group students or experimental group students has a low skills on all five topics. Therefore, the equality of variances are equal. However, in the mean score results of students, the experimental group were higher than the traditional group except for the topic "Work and Heat". Although, the difference of both mean scores of the two groups are not quite far.

**2. The Virtual Laboratory and Traditional Instruction in teaching 5 topics**

The researcher prepared the lesson plans and activities per topics. The topics being discussed are according to the Curriculum Guide and should be taught all throughout the 2<sup>nd</sup> quarter. Also, the venues and places where the classes were conducted, the materials used like computers and visual aids connected to the topics were also brought in preparations. The materials used for Traditional Instruction and Virtual Lab Instructions were different, to measure the influences of two different method. However, the concept of teaching, the delivery and skills/objectives that must be met by the students after a certain topic were the same. Before the conduct of different instructions, the researcher distributed the pretest to all respondents. The teacher who handled the classes of traditional group and virtual lab group was the same and also the researcher of this study.

**Traditional Instructions:** Classes were done in a regular classroom with a usual set up. They were divided into

several groups for the better performances in the lab activities. The researcher also used visual aids made of cartolinas and other laboratory materials were localized. The teacher followed the daily lesson plan like explaining every topic, and motivating students to recite by giving those chips as rewards. At the end of the discussion, performance of activities were always implemented as an assessment of students' understanding, mastery and making generalization. Before the researcher moved to the next topic, post tests were distributed as a quiz to be answered on a paper. The results of the posttest were checked and encoded/recorded for analysis.

**Virtual Laboratory Instructions:** Students in experimental group will occupy the computer laboratory room. The computer laboratory was already charged to be used in the study. All the programs needed were checked and installed. Same as the traditional class, the division of students into several groups were also done, and following of the daily lesson plan are observed. This time, the researcher used different materials in teaching compared to the traditional instruction such as PowerPoint presentation, videos, projector, PhET activities, internet connection and computer are being used by the students. The teacher discussed the topics and gave also chips as a motivation. After the discussion, the teacher would gave sets of activities using PhET simulation and other platforms from computers as a follow up. Thereafter, quizzes would be followed for an assessment and it is automatically and encoded the results.

**3. Achievement of the students in the post test using Virtual Laboratory Instruction and traditional in selected 5 topics in science**

**Table 4:** Level of Proficiency of Student in the Post test

Group	Performance	Posttest per Topic										Mean
		Work		Sound		Light		Heat		Electricity		
		f	%	f	%	f	%	f	%	f	%	
Traditional Group	Mastered	6	13.64	5	11.36	4	9.09	12	27.27	37	84.09	27.43
	Developing	21	47.73	18	40.91	6	13.64	15	34.09	6	13.64	
	Least Mastered	17	38.64	21	47.73	34	77.27	17	38.64	1	2.27	
	Mean	4.95		4.57		4.00		5.18		8.73		
Experimental Group	Mastered	15	34.09	19	43.18	5	11.36	32	72.73	42	95.45	36.02
	Developing	19	43.18	19	43.18	32	72.73	12	27.27	1	2.27	
	Least Mastered	10	22.73	6	13.64	7	15.91	0	0	1	2.27	
	Mean	5.73		6.30		5.25		7.18		11.57		

In overall posttest results, both group have increased in the number of students who have a mastered skills on all topic. Therefore, both instructions were efficient to students' learning. However, the experimental group shows a big difference in terms of the number of students who have a mastered skills and least mastered skills. Thus, virtual laboratory instruction could be a helpful strategy in learning science.

The development of student's performance and reliability of technology application in teaching science were more important. The result of this study can be a helpful and important findings in the development of new techniques in teaching to uplift the quality of education around the country.

**4. A significant difference between the pretest and posttest on the achievement of the students**

**Table 5:** Comparison of Pretest and Post test

Paired t test		N	Mean	SD	t	df	Sig. (2-tailed)
pair 1	Traditional Pretest & Posttest	44	-6.636	4.615	-9.537	43	<0.001
pair 2	Experimental Pretest & Posttest	44	-14.477	4.727	-20.314	43	<0.001

**Table 6:** Descriptive Comparison of Pretest and Post test

Topics	Group	Descriptive Statistics						Normality of Difference	Comparison of Means
		Min	Max	Mean	Median	Mode	Stdev		
Work	Pretest	0	6	2.55	2	2	1.37	0.0006**	<.0001**
	Post test	0	9	5.34	5	6	1.61		
Sound	Pretest	0	7	3.77	4	4	1.71	<0.0001**	<.0001**
	Post test	2	9	5.43	6	6	1.75		
Light	Pretest	0	6	3.39	4	4	1.40	0.0017**	<.0001**
	Post test	2	8	4.63	5	5	1.42		
Heat	Pretest	0	8	4.25	4	4	1.76	0.0017**	<.0001**
	Post test	2	9	6.18	6.5	7	1.80		
Electricity	Pretest	0	13	7.22	7.5	9	2.97	0.0567	<.0001**
	Post test	3	15	10.15	11	11	2.72		
Overall	Pretest	8	35	21.17	21	20	5.35	0.7402	<.0001**
	Post test	14	45	31.73	33	36	6.32		

Note: 5% level of significance was used in all test

ns – normal/equal/no significant difference

\* - not normal/not equal/ different

To compare the pretest and posttest scores of Traditional and Virtual Laboratory Instructions effect on two groups, paired sample t test was used. Based from the table, there was a highly significant difference between pretest scores and the post test scores. However, for the topic “Heat” on the traditional group there was a slight difference on the result of the pretest and posttest. Therefore, virtual laboratory instructions show a great influence on the learning of students on the subject matter.

#### 5. Issues and concerns encountered by the students and teachers in virtual laboratory instruction

Virtual laboratory instructions was an unknown strategy particularly in public schools. Using this as a substitute to a laboratory activities was a difficult strategy to use for a school like Quirino High School. So, when this was introduced to be used by the students for the whole second quarter, different reactions and ideas were perceived. Half of the class were excited because of different reasons such as the cool atmosphere inside the classroom, using of computers, and etc., but to be exact, they do not have any idea on what and how they would learn science in that kind of environment.

After the three months of studying science in a new approach, the researcher gathered several issues and concern from the students about virtual laboratory. They gave rational reviews about it, according to them, it gave an experience to take laboratory activities even if they were absent; they were not afraid on experimentation even without the supervision of the teacher; they can repeat the activities for several times without spending money especially on the topic of circuits where there is a need for trail and errors; they became interactive in class and learned from it. However, some students stated that learning did not happen to them due to fear of using computers or gadgets.

The teacher observed various effect of virtual laboratory to students. This could tend to be one of the issues and concerns in using virtual lab. Here are the positive observations: students could do laboratory activities even without the teacher, they could handle their own; students became active in class and had enthusiasm in learning science; they became confident in technology (but not all);

most of the students passed the subject matter and got higher grades. Moreover, students also recognized a negative effect in using virtual laboratory such as: increased number of plagiarizing; socialization decreases because there is no collaboration and interaction with other students; practicality was vanished because there is no physical encountering on the devices or use of skills.

On the part of the teacher, there were dilemmas encountered in the use of virtual laboratory to students such as: ability to use computers especially if there were failure and inconsistency of the software or equipment; slow handling computers due to lack of training; time consuming in setting up the devices and preparations. But, virtual lab also gave a relative effect on the teacher as it was used for three months such as: experimentation became safe; it was not difficult to provide activities for students who were absent; teacher did not spend lots of money for materials in the activity; easier and faster observation that made the activities finished on time; teacher became resistant in the changes relative to the science subject where information constantly change.

These issues and concerns of the students and teachers after the use of virtual laboratory were based on the observation after the study.

#### 4. Conclusions

From the findings of this study, the following conclusions are drawn.

- 1) Teachers are not knowledgeable in using computers as a mode of teaching strategies.
- 2) Students become enthusiastic in learning science; they can handle their own even if the teacher is out. They became confident and passed the subject matter after using virtual laboratory activities.
- 3) Some tend to plagiarize in doing reports/activities.
- 4) Some students are incapable of using computers and resulting to failure due to absence of materials.

#### 5. Recommendations

Based on the findings and conclusions, the following recommendations are made:

- 1) Attend seminars and lectures about virtual environment to make them more equipped in handling or using technological instruments and other platforms.
- 2) Apply more effective modes of approaches and strategies using virtual laboratories, platforms, and software.
- 3) Put up a science clinic per department for the enhancement of knowledge about virtual laboratory to both students and teachers
- 4) Provide materials needed by the teachers in teaching such as computer, laptop, projector, internet connections, or funding and assistance for teachers in producing gadgets as learning materials

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