
IDENTIFICATION AND DESIGN VIRTUAL LAB SITUATION FOR DEVELOPING PRINCIPLES OF CATHODE RAY OSCILLOSCOPE IN PHYSICS”

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Abstract

Selection of virtual lab for physics is a highly complex process, incorporating diverse need, such as design and features. This paper focuses on the identification and selection of virtual labs that were found effective for developing basic principles of physics. Thus, this research assesses the effectiveness of virtual lab in terms of developing principles of Cathode Ray Oscilloscope CRO. In this study 207 under graduate students from Indian Universities were divided into two groups to participate in experimental study. Pre-Test, Post- Test scores were used for finding out the achievement gain of the students. Statistical tools such as, t-test, were used for analyzing the data related to gain scores of both control as well as experimental groups. These findings indicate that virtual lab experiments have significant effective on achievement of physics with respect to conventional lab experiment.

BACKGROUND

Virtual labs are considered as collaborative, technological virtual activities that basically simulation of physical lab situations. Virtual labs enable students to repeatedly carry out experiments in a safe environment during lessons. Virtual Laboratory also, is used in the system aiming to replace physical machine with virtual machines on one host server. They eliminate the limitation of physical appearance so that users are able to complete security exercises on the local operating system utilizing the client/server architecture.

The present study seeks to investigate the effectiveness of virtual laboratory with respect to conventional physics lab of developing principles in physics. As the present study was quasi experimental research, to study the effectiveness of developing principles in physics through virtual laboratory a need was felt to selection of virtual laboratory experiment and software on the enigmatic topics from physics curriculum. In physics “Principles” are defined as relationship between two or more than concepts, facts and rules that are grouped together in some fashion by shared characteristics. In the present study, the researcher used the term principle as defined by Tennyson (2009) in term of relationship of concepts in term of cognitive development. In the present study, effectiveness refers to superiority or otherwise of virtual laboratory software used for purpose of developing concepts and principles in terms of student’s achievement which is measured through researcher made achievement test after proper pilot tryout.

Before actually selecting the experiments for virtual laboratory it was necessary to review the consideration and research based related software of virtual laboratory.

OBJECTIVES OF THE STUDY

To have objectives and scientific study of a topic, it is necessary to dissect the topic into some small measurable terms. The topic of the present study is divided into following specific objectives. The objectives of the present study are ---

1. To identify and design virtual laboratory situations from the available resources (Java Applets, Phet, Amrita Olabs) with the help of which the identified concepts and principles can be developed.
2. To Study the effectiveness of achievement of identify principles through virtual laboratory vis-a-vis conventional laboratory.

To achieve this objective, the researcher examined some of the virtual laboratories on the basis of their software and architecture. Companies that develop simulation software and books dealing with human-computer interaction were studied. Present researcher of the study found that there is no general "best" architecture, each virtual lab is better in different situations. It was more a consequence of the particular implementation than of the paradigm on which it stands. In order to judge which architecture is better, it needs to refer to a particular context. Their performance cannot be generally measured, but only relatively to specific tasks. After studying the available literature on virtual lab, researcher has identified few criteria which can be considered important to identify a virtual lab situation for the purpose of the present study. These criteria along with their applications are given below.

Easiness in Learning: Easiness for users to accomplish basic tasks the first time they encounter the design of the interface, language used, as well as its similarities in application of certain tasks (like opening-closing of the program) to other programs; are some of the factors on which virtual lab situation can be judged.

Efficiency: Quickness in performing tasks, carry out the procedures in very short notice; are such of the issues which can be through of factors for appropriate selection of virtual lab.

Memorability: When users return to the design after a period of not using it, degree of easiness with which they can re-establish proficiency, the nature of the program being easily remembered by the users, are some of the factors which one can think of while deciding about appropriate lab.

Errors: Number of errors users make its servesity ,degree of easiness with which they can recover from these errors and its usability in such nature as avoiding the users making mistakes, are considered as some of the factors for good and appropriate virtual lab situations.

Satisfaction: The usage of the program should be pleasant and easy, with an esthetic, functional interface design, capable of meeting requirements of the users. The users should be able to carry out any applications they so desire, in an active manner without contradicting in their applications. On the basis of these criteria researcher has examined some virtual lab situations from the available resources to achieve the objective of the present study.

The following virtual lab programmes were obtained by contacting the companies that develop them.. The virtual lab also provides animations about how to create the experiments, and allows the use of sample experiment and problem sets. Detail analysis of comparison of different virtual labs are giving in below in **Table-1.1**

S. No.	ITEMS	Crocodile physics401	Amrita OLABS	Java applets	PhET
1.	It is capable of covering the curriculum of the target group.	X	√	√	√
2.	The sample models match with the curriculum of the identified target group.	×	√	√	√
3.	It is capable of covering the identified concepts and principles.	√	√	√	√
4.	Has help menu and provides interface to other software.	√	√	√	√
5.	Provides information to users about the experiment tools and experiment.	√	√	√	√
6.	Provides information and evaluations about the user groups (age, school, grade, etc.).	√	√	√	√
7.	Wide range of physics experiment	×	√	√	√
8.	Provides auxiliary tools (calculator, etc.).	×	√	√	×
9.	open source, free online download	×	√	√	X
10.	There are difficulty levels for experiments.	×	√	√	√
11.	Supports different teaching methods (project method, problem solving, etc.).	X	√	√	√
12.	Convenient for use in group works.	x	x	x	x
13.	Experiment tools and sample experiments match with the learning and teaching	×	√	√	√
14.	Range of change parameters while doing experiment.	×	√	√	√
15.	Working procedures of experiment is parallel to conventional lab experiment	×	√	√	√

TABLE-1.1 Comparison of Different Virtual Labs Situations

On the basis of analysis, researcher has selected two virtual lab programs for the study. The Online set-up used by students in this study was **Java applets** and **PhET** virtual lab programs.

ANALYSIS OF PHYSICS CURRICULUM

For selecting any instructional tool, it is necessary to analyze the whole subject under consideration. Under this process subject is divided into topic, sub-topic, subsub-topics, procedures, process, principles, rules, law, concepts, facts and information. Such analysis helps to identify the instructional need of the topic from learning point of view. The subject of physics in under graduate contains five units.

The whole subject was analysed and detailed unit wise objectives were formulated. table -1.2 indicates the title of unit, number of topics in each unit and number of objectives formulated for each topic. The formulated objectives were discussed and feedback was taken from the faculty members of Physics of BU, Bhopal.

S.NO.	TITLE OF UNIT	NUMBER OF TOPIC	NUMBER OF OBJECTIVES
1	Oscillation and Rigid Body Motion	12	32
2	Superposition of a Harmonic Motion	09	20
3	Properties of Matter	17	40
4	Motion of Charge Particles in Electric and Magnetic Fields	15	36
5	Wave Motion	15	25

TABLE-1.2 Unit wise and topic wise number of objectives of physics of first year under graduate of Indian University

RESEARCH QUESTIONS

In this sequence to examine the effectiveness of virtual laboratory the study was done through a few steps in the preliminary analysis in order to determine the difficult topic thus will be included in the study. Based on the analysis of the curriculum and discussions with physics faculty, questionnaire was designed for faculty members. With respect to each topic under each unit, faculty members were asked to answer about the “nature of content” on following three aspects.

1. Is the topic important from the point of view of Exam or understanding other topic?
2. Does topic focuses on facts, concepts and principles?
3. Does topic require any laboratory experience?
4. Does topic require learner’s active participation?

The students as well as faculty members were conducted and the data was collected in the form of responses on the designed questionnaire.

Analysis of responses and finalization of topic for virtual laboratory experiment

Based on the interaction with the faculty of physics from degree college of India. The response was collected among 100 physics faculty members in order to conclude whether there is a need to support the current instructional tools used in teaching for difficult topics in physics.

Identifying the difficult concepts and principles for virtual laboratory experiment

Physics is a field that involves the study of physical phenomena and student are continuously required to identify the hidden concepts and principles. During studies, a student is supposed to learn number of concepts.

Researchers suggested that developing conceptual understanding is only accomplished through learning that promotes conceptual change. Use of laboratory inquiry-based experimentation and virtual experimentation provided through interactive computer-based simulations could be used as conceptual change learning environments.

According to the findings in present study researcher has considered one major topics (study of Lissajous Figure on CRO) and their related concepts and principles to investigate the effectiveness of virtual laboratory for developing principles because researcher has realized that above experiments involved crucial concepts which are required scientific skills for understanding and it can only be developed through lab experiment method. This experiment and their verification can only be defined in term of other concepts and principles, different parameters and different mathematical relationship. Virtual laboratory as well as conventional lab gives a specific platform to students to perform experiments in identified lab situations.

Selected Experiment	Identified Principles related experiment	Related Concepts
Study of Lissajous figure on CRO	1.relationship between frequency and lissajous figure 2. relationship between frequency and CRO	1.Super position of waves
		2.Lissajous Figure
		3.Working principle of CRT and e-gun
		1.Super position of waves
		2.Lissajous Figure

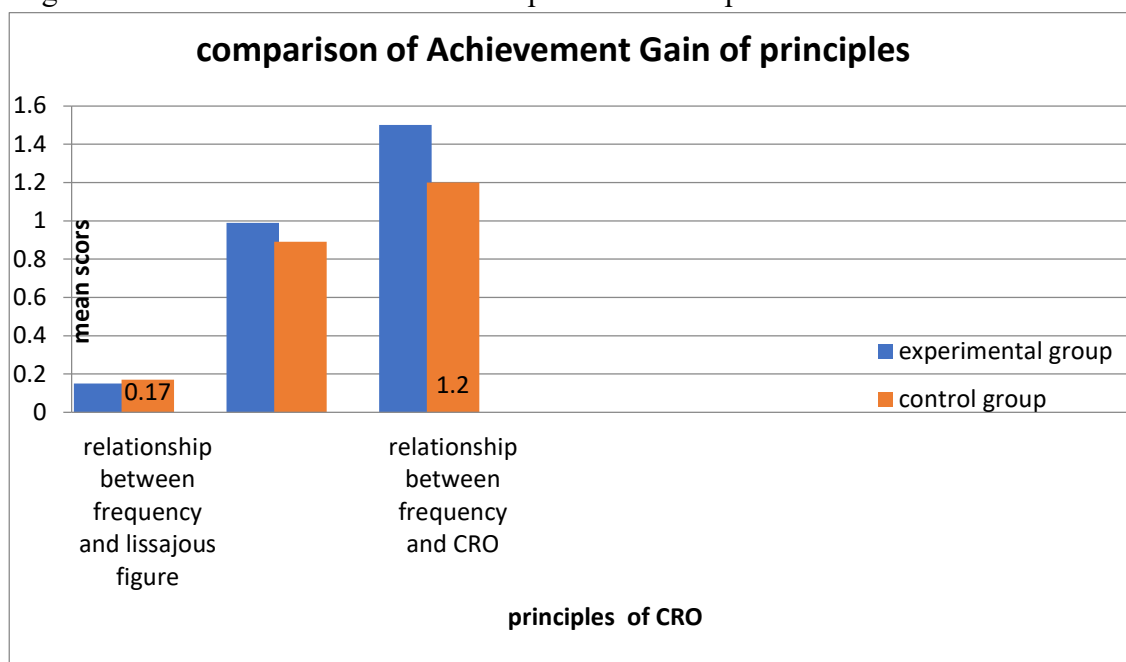
According to findings Cathode Ray Oscilloscope (CRO) was found very difficult to understand without any additional efforts of instructional tools. CRO are commonly used to observe the pattern of waves of an electrical signal but it also very useful in the field of applied sciences, medicine, engineering, and telecommunications industry. So study of working of CRO and Lissajous figure are very important concepts in physics. Oscilloscopes are usually calibrated so that voltage and time can be read as well as possible by the eye. This allows the measurement of peak-to-peak voltage of a waveform, the frequency of periodic signals, the time between pulses, the time taken for a signal to rise to full amplitude and relative timing of several related signals.

In virtual laboratory sound software allows the sound being listened to be displayed on the screen as by an oscilloscope and determine the unknown frequency with different lissajoues figures with the help of experiment “**Study of Lissajou Figure on CRO.**”

METHODOLOGY

Formulation of learning objectives and of principles for virtual laboratory experiment

Through this preliminary identification, it is hoped to gather some data in order to determine the concepts and principles for the study. Oscillation, Simple harmonic motion , working of electron gun and CRO , electron model, are the basic topics at graduation level in physics .In these topics some concepts and principles are common that was found to be difficult for college students to understand because it requires the understanding of property of matter, behavior of particle in microscopic level (Nurrenbern & pkkering,1987) and involves the use of direct and inverse ratio which requires proper reasoning, the ability to identify and control variables and probabilistic thinking. These skills are essential for development of concept involved.



Graph -1.3

The Achievement Gain of Two Groups in Term of Developing Principles of LISSAJOUS Figure in Physics through Virtual Lab and Conventional Lab

FINDINGS AND DISCUSSION

The analysis of data described in objectives and inferences of above shows that there is significant difference between mean achievement gain of learners develop identified principles of experiment. The mean achievement gain scores of each identified principles related to the experiments of two groups of student learning through virtual lab experiment and conventional lab experiment is further present in the following **graph-1.3** The above graph shows that achievement

gain of student in term of developing each identified principle of the experiments through virtual lab is higher compared to Conventional lab. The analysis shows that virtual lab experiment helps the student in develop isolated each two principles related to the experiment in better way than the conventional lab experiment. The study found that virtual lab experiment is more effective for development of principles in physics. The study show that virtual lab experiment is more effective for development of principles in physics then conventional lab experiment. These findings indicate that virtual lab experiments have significant effective on achievement of physics with respect to conventional lab experiment.

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