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PROMOTING CONCEPTUAL CHANGE THROUGH CONSTRUCTIVIST APPROACH USING VIRTUAL LAB IN PHYSICS TEACHING

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Abstract:

The focus of this paper is to examine constructivist approach using virtual lab for concepts and cognitive development. This paper moves toward describing the nature of students' alternative conceptions, the ways of changing cognitive structure, and cognitive aspects of learning and teaching science and provides guidelines for teachers, at all levels. Physics is one of the most fundamental natural subject which involve the study of universal law and the behaviors and relationship among a wide range of physical concepts and phenomena. The present study was conducted to see two common dimensions of change in learning style that emerged in physics teaching: describing the nature of students' alternative conceptions, the ways of changing cognitive structure, and cognitive aspects of learning and teaching physics and provides guidelines for teachers, at all levels. Both dimensions relate to shifts in pedagogical paradigms that appear to be prerequisites to effectively using virtual lab to promoting conceptual change. Our findings indicate that these shifts must not just occur at the teacher level, but must take hold throughout the educational system. The paper reports upon constructivism approach that promotes conceptual change when studying lissajous figure, using virtual lab. The study involved a total of 102 prospective physics students.

Keywords: Virtual Lab, constructivism, Science pedagogy, Conceptual change.

Introduction

In present era the role of a teacher has been changed to act more as an instruction designer and manager, tutor, and motivator serving the students to achieve their learning objectives. Constructivist approach is not just the bloom of the new paradigms in teaching and learning, but also to improve the effective and meaningful educational process. Learning induces a persistent, measurable, and specified behavioral change in the learner to formulate a new mental construct. It is well known that ICT which has various learning facilities and services can give contribution towards effective learning in science pedagogy. The utilization of science pedagogy for effective learning is based on different learning theory.

Physics is one of the most fundamental natural sciences which involve the study of universal law and the behaviors and relationship among a wide range of physical concepts

and phenomena. Experiments are the hallmark of Physics. Scientific attitude and vision can be developed by allowing young minds to perform experiments in physics lab and observe and understand the scientific phenomena to happen. Learning through experiments encourages students to bring scientific thinking to the processes of strong, innovative and logical path between concept and phenomena. For physics learning, labs also plays very active and significant role as it is essential to develop concepts because students are continuously required to identify the hidden concepts, define and explain underlying laws and theories using high level reasoning skills. So we can define concepts are classes of objects, symbols and events that are grouped together in some fashion by shared characteristics. Thus concept means much more than knowing the facts and imitating the operation. Conventional approach in real laboratory has some limitation and problems in developing these concepts etc. Today's traditional labs and the experiences acquired there, because of certain limitations of their own , are not meaningful adequately for students and are not able to make a significant contribution to conceptual changing of students (Yager , Engen and Snider ,1969). According to Hofstein (1988), students are performing experiments in the laboratory in a "cookbook" approach which focused on development of low level science skills. In order to overcome these problems of conventional approach through real lab, search of a new philosophy in which learner are actively constructing their own knowledge is needed (Jonget 1998). This is known as constructivist approach using virtual lab. Virtual lab is a computer program that allows student to run simulated experiments via the web or as a stand-alone application". A virtual laboratory could be a set of simulations put together (Examples are applets, flash base demons, animations). This allows the students to perform the experiments virtually at any time. In the present study Phet and java applets virtual laboratory software was used. In the present study, the researcher used the term conceptual change as defined by Tennyson in term of cognitive development.

Constructivism and virtual lab

"For more able students the pedestrian pace enforced by preprogrammed practical work in order to deduce what is blindingly obvious can be very frustrating**"** Woolnough & Allsop (1985, p. 8)**.** A major change in the goals and purposes of the lab work took place when an alternative approach to science learning, constructivism, began to gain acceptance. Constructivists hold that learning is an interpretive development, as new information is given sense in terms of the student's prior knowledge. From a constructivist point of view, each learner actively constructs and reconstructs his or her understanding rather than receiving it passively from a more authoritative source.

The constructivism is not an accumulation or memorizing the information, but rather it is about thinking and analysis. The constructivism is about the comprehension and practice, rather than feedback (Cavide Demirci 2009). It is about the active learning and it is not a process of learning upon passive receipt of the ready-made information from someone else (Narrated by: Özdemir, 2002). At its core, constructivism-as adopted in Science Education (as opposed to wider interpretations of 'constructivism' in the social sciences, e.g., Beld, 1994; Potter, 1996; Gergen, 1999; Phillips, 2000b; Matthews, 2000)-is a perspective which views human learning as an active process, i.e., something done by, not on or to, the learner herself (Cavide Demirci 2009) . One of the most effective approaches of constructivist in physics teaching for promoting conceptual change is Virtual Laboratory. This approach goes beyond current science approach where students may manipulate variables but independent decision-making is constrained. This approach leads the occurrence of constructivist approach in teaching and learning science.In the virtual laboratory the learner can work at their own pace to understand the requirements of the learning

objectives and examine new material. Learners can be guided through the learning process in steps by prompts which elicit inputs followed by reinforcing feedback. Multiple opportunities for practice and assessment can be provided until learners become proficient. Learners are then directed to the next step in the sequence until the performance requirements of all objectives has been achieved.

The central idea of constructivists approach using Virtual Laboratory is the implementation of learning environment that offers students all the attendant manipulative features, ability to make mistakes and measurement errors where the conditions are very similar to those realized in conventional laboratories. The constructivist epistemology is argued as its structures its own information on the basis of the individual's interaction of his surroundings. The constructivism is connected with the construction of the information rather than acquiring it. To this theory, it is how the individuals learn that matter therefore in this lab students build the learned concepts into their cognitive structure and build up a consistent conceptual framework their own capacity and style. This conceptual framework is required by students to develop the higher order level abilities that enable them to use and apply their learning in a meaningful way (Javidi, 2005).

For promoting concepts in physics through constructivists approach using virtual laboratory the Kolb's experimental learning cycle model are used to shape the theoretical framework of this study. It is in the above context, the present study attempts to study the conceptual change through constructivists approach using virtual lab in physics teaching. While studying conceptual change of physics, six significant and basic concepts of lissajous figure and CRO were taken into consideration.

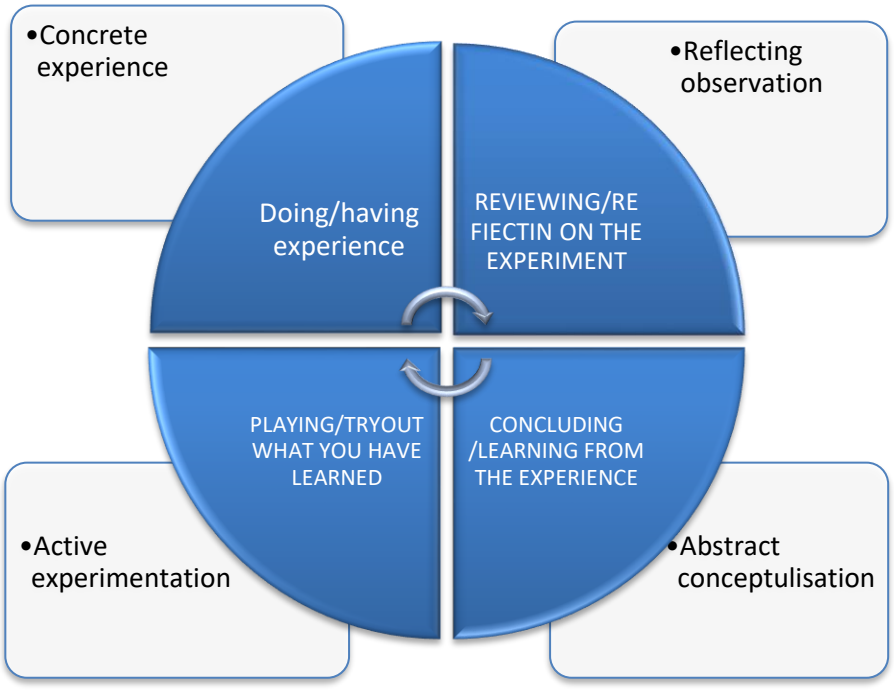

Figure -1.2

Theoretical Framework of constructivist approach in physics teaching through virtual lab

The virtual laboratory taken in the present study refers to Simulations which attempt to represent laboratory experiments as closely as possible of conventional laboratory .The study besides looking promoting conceptual change in terms of student achievement.

Research studies have indicated that active learning through computer simulations can contribute to student's understanding of physics concepts at the molecular level by attaching mental images to these concepts (Cadmus, 1990). According to Escalada & Zollman (1997), Virtual lab provide opportunities for students not only to develop their understanding and reinforcement of physics concepts, but also to develop their skills in scientific investigation and inquiry. Inquiry-based science experiences conducted in relevant, meaningful contexts have been shown to develop higher order thinking skill in students (Roth & Roychoudhury, 1993). This is further supported by Cakir and Tirez's (2006) study that found inquiry-based science teaching and learning, with the support of computer simulation and collaborative contexts help learners to develop critical thinking and inquiry skills. Lawson (1995) cites literature indicating that the Learning Cycle approach that consists of Exploration, Concept Introduction, and Concept Application phases is an inquiry-based teaching model which has proven effective at helping students construct concepts as well as develop more effective reasoning patterns. Interactive learning environment by using simulations base virtual lab for abstract topic, where students become active in their learning, provide opportunities for students to construct and understand difficult concepts more easily (Demirci, 2003). In this, content appropriate simulations and applications based on simulations generally increase learning speed by allowing students to express their real reactions easily (Karamustafaoglu, Aydin and Ozmen, 2005). Better designed virtual labs provide students opportunities to express their cognitive style and to choose from the computer screen. Such opportunities allow students to develop their own hypothesis about the topics and develop their own problem solving methods (Windschitl ve Andre, 1998). According to Isman et al (2002), complex information given to the students is simplified by technology and provides them opportunities of learning by doing. Therefore, use of virtual laboratory overcomes some of the problems faced in traditional laboratory applications and make positive contributions in reaching the objectives of an educational system. But, Miller (1986) did not found a significant relationship between students' biology achievement and computer assisted education or traditional teaching methods. On the other hand, physics laboratory lessons are the most favorite and preferable for students in daily life, students' benefit from the laboratory applications. Besides, students who are taught with laboratory-assisted education are more successful than students who are taught with traditional methods and also the learning with laboratory practices parallel with its theoretical knowledge in physics course increases the achievement. The laboratory applications also increase the permanence of students' knowledge. Some researches (Geban, Askar & Özkan, 1992; Svec & Anderson, 1995; Redish, Saul & Steinberg, 1997) revealed that computer simulation experiments are more effective than traditional experiments: but some researches (Miller, 1986; Choi & Gennaro, 1987; Jimoyiannis & Komis, 2000; Bayrak, Kanli & Kandil Ingeç, 2007) did not find any difference between their effectiveness. Therefore, no conclusions can be arrived at on the basis of previous researches hence some more researches are needed.

The present study was conducted with this aim in mind. The main purpose of this study is to investigate the conceptual change through constructivist approach using virtual lab in physics teaching

Objectives of the Study

1. To identify and design constructivist approach through virtual lab situations from the available resources (Java Applets phet)
2. To Study the effectiveness of virtual lab as a constructivist approach in physics teaching

Methodology of the Study-

The present study employed pre- post experimental design. This experimental design enables the manipulations of the variables to be observed under the control of the researcher in order to investigate cause and effect relations. The variables under study are:

• Dependent Variable: Achievement Gains on Lissajous Figure

• Independent Variable: Virtual and real laboratory Experiments on study of Lissajous Figure

• Intervening Variable: Previous achievement in Physics.

Identification and significance of Topic Physics is full of 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 virtual experimentation provided through constructivist approach could be promoting conceptual change. Cathode Ray Oscilloscope (CRO) was found very difficult to understand without any additional efforts of instructional tools. CRO are commonly used to observe the exact wave pattern 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 constructivist approach through 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.**

Sample of the study

Looking in to the nature of the study, Purposive sample was selected. The participants of the study were 102 undergraduate students ranging in age from 19 to 23 and taking "Physics Laboratory" class at Department of Physics of a College in Bhopal during the fourth semester of 2016-17 academic year.

Tools employed

The present study employed following tools:

1. Virtual Lab Experiment on the topic of Study of Lissajou Figure on CRO.
2. Pre and post achievement test on the topic of Study of Lissajou Figure on CRO
.3. Achievement of students in Previous semester
5. Statistical Analysis of Data

To study the effectiveness constructivist approach through virtual lab, the independent samples t- test, were used for testing the data obtained in the study. The SPSS 11.00 (Statistical Package for Social Sciences) statistical program was used to evaluate all the data collected from pre-and post-tests.

Findings

Statistical results about the comparison of pre-test and post-test scores of the experimental and the control group students in the PAT are given in Table 1.1

Table 1.1: Comparison of Achievement gain scores of students of the experimental group(Constructivist approach through virtual) and control group(conventional approach through real lab)

Group	N	X	SD	df	t	p
Experimental**(Constructivist approach through virtual)**	51	1.5	2.02	100	2.32	0.01
Control**(conventional approach through real lab)**	51	0.2	2.73			

Results and Discussion

In Table 1.1, the mean gain of the achievement in the experimental group and the control group was 0.2 and 1.5 respectively. Students in experimental group who learned the concept of lissajous figure on CRO through virtual experiment gained more compared to control group, who learned the same through conventional approach through real lab experiment. Independent t-test was employed to investigate further whether this difference in achievement gains between two groups is really significant .Independent t-test results, clearly shows that there is a significant difference groups, scores of the achievement gain (t=2.32) is in favor of experimental group. Therefore, it can safely be concluded that student learned concepts of lissajous figure on CRO through constructivist approach by virtual lab in a better way compared to real lab. The present study found that student learned concepts of lissajous figure on CRO through constructivist approach using virtual lab in a better way compared to real lab. The constructivist learning approach using virtual lab is more efficient than the conventional approach .The findings of the study corroborate with the findings of earlier studies such as constructivism help students to process new contents effectively. It will activate students' motivation and meet their expectations. According to result of this study, it can be argued that if the constructivist learning approach is used in physics teaching would promoting conceptual change. The evidence of this study is consistent with these researces's results: Sengül (2006), Saygın, Altınboz and Salman (2006), Atam (2006), Özerbaş (2007), Bay & Karakaya (2009), Demirci & Yavuz (2009). The responsibility of the teacher in the new millennium is to provide an appropriate approach for self-learning. Hence, teachers should master and use the diverse science teaching approaches to suit various learning situations and thereby empower the learners.

Suggestions:

The suggestions can be given according to these research results.

1. It shouldn't be forgotten that this study is related to undergraduates' physics teaching. In the different grades of school education and different concepts of science similar studies can be done.
2. This study is limited to "lissajous figure and CRO" concept of physics. It can be researched different activities of constructivist learning on the effect of students' achievement.
3. Teachers can use diverse strategies and techniques, which support constructivist approach.

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