

Conceptual development through constructivist approach using Virtual lab in Chemistry teaching

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Abstract:

The focus of this paper is to examine constructivist approach using Virtual lab for concepts and cognitive development. Chemistry is one of the fundamental natural subjects which involve the study of universal law and the behaviors and relationship among a wide range of physical concepts and phenomena. Experiments are the prime in Chemistry. Scientific attitude and vision can be developed by providing opportunities to young minds to perform experiments in lab through constructivism approach. In present scenario, influence of constructivism in Chemistry teaching based on Virtual lab method is emerging as one of the most effective innovative approach.

The present study is conducted to know that two common dimensions of change in learning style that emerged in Chemistry teaching: describing the nature of students' alternative conceptions, the ways of changing cognitive structure, and cognitive aspects of learning and teaching Chemistry 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 development. 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 development when studying separation of mixture, using Virtual lab. The study involved a total of 102 prospective Chemistry students.

Key Words: Virtual Lab, constructivism, Science pedagogy, Conceptual development

1. Introduction:

In modern age functions of teaching are not confined and it is expected to design and manage the courses as well as instruct, train and motivate students to achieve their learning objectives.

Constructivist approach has added new paradigms in learning and teaching with an effective, inventive and meaningful educational process. Learning stimulates an unrelenting, quantifiable, and specified change in the behavioral of the learner to formulate a new mental construct.

Information technology communication (ITC) has offered range facilities and services; and it has immense potential to contribute in effective learning process particularly in science pedagogy.

1.1 Virtual lab: It is defined as "using the electronic models, simulations and a variety of instructional technologies for experimentation to replace or support face-to-face lab activities". Virtual Lab has been also investigated as a means to help learners to improve conceptual change. It is a simulation and animations are important applications that have been developed and appropriately placed in the teaching materials to enhance student understanding of abstract concepts. They provide the capability of training students, as well as enhancing their conceptions.

2. Traditional class room: Any learning activity that is performed in a classroom setting and provided by the teacher.

The utilization of science pedagogy for effective learning is based on different learning theory. Development of scientific temperament is of prime importance and as facilitates young minds to understand any scientific phenomena with the reasoning and experimentation. The fundamental natural science subjects such as Chemistry encompasses several basic aspects like universal law and the

behaviors and relationship among a broad range of physical concepts and phenomena. Thus experiments form basis of Chemistry and labs provide opportunity to identify the hidden concepts, define and explain underlying laws and theories by research and high level reasoning skills.

The concepts are classes of objects, symbols and events that are grouped together in a fashion by shared characteristics. Thus concept means much more than knowing the facts or imitating the operation.

There are limitations in development of concepts in Conventional approach in real laboratory. 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 helps learners to run simulated experiments via the web or as a stand-alone application". A Virtual laboratory can be a set of simulations put together (Examples are applets, flash base demons, animations).This assists the learners to perform the experiments Virtually at any time. For the present study Amrita online Virtual laboratory is used. In study, the researcher used the term conceptual development as defined by Tennyson in term of cognitive development.

2.1 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 Chemistry teaching for promoting conceptual development 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).

It is in the above context, the present paper attempts to study the conceptual development through constructivists approach using Virtual lab in Chemistry teaching particularly in learning of conceptual development in Chemistry. In this study for promoting concepts in Chemistry through constructivists approach using Virtual laboratory, the Kolb's experimental learning cycle model is used to shape the theoretical framework.

The Virtual laboratory in the study refers to Simulations which try to represent laboratory experiments as closely as possible of real laboratory condition. In addition the study also focus on promoting conceptual development in terms of student achievement.

Research studies have indicated that active learning through computer simulations can contribute to student's understanding of Chemistry concepts at the molecular level by attaching mental images to these concepts (Cadmus, 1990). According to Escalada & Zollman (1997), Virtual lab provides opportunities for students not only to develop their understanding and reinforcement of Chemistry 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, Chemistry 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 Chemistry 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. Thus, no firm conclusion can be drawn on the basis of previous researches and further exploration on the aspects is considered necessary.

2.2 Objectives of the Study:

The objectives of the study are;

1. To find out and choose a suitable design of constructivist approach through Virtual lab situations from the available resources i.e. i.e. Amrita online Virtual lab.
2. To study the effectiveness of Virtual lab as a constructivist approach in Chemistry teaching.

2.3 Methodology of the Study:

For the study pre and post experimental test was designed. In order to investigate cause and effect relations in experimental design and enable the manipulates the variables to be observed under the control of the researcher,

The variables under study are;

- Dependent Variable: Achievement gains by the students on separation of the components of a mixture i.e. sand, common salt and ammonium chloride
- Independent Variable: Virtual and real laboratory experiments on study of components of a mixture i.e. sand, common salt and ammonium chloride
- Intervening Variable: Previous achievement of the students in Chemistry experiments

Chemistry is the study of physical matter, which is classified in several different ways, such as state of matter (gas, liquid or solid), chemical form (element, mixture or compound), chemical structure (atoms or molecules, etc.) and so on.

Elements are the basic substances that make up matter in the universe. Each element is a chemical. Mixture is one such concept crucial for understanding which is based on the element nature and also foundations of inorganic Chemistry.

Mixture consists of two or more different elements and/or compounds which are physically intermingled, and can be separated into their constituent parts by physical means (e.g. distillation of liquids or separating magnetic and non-magnetic solids using a magnet). The separation of components of the mixture is a significant concept which helps students build an understanding of the chemical bonding.

Years of experience in teaching indicates that students usually face difficulties in understanding even some of the most basic aspects i.e. difference between the mixture and compound. The Virtual laboratory offers opportunities to the students to carry out experiment, receives immediate feedback on the results and also incorporates the changes. With an adequate guidance, students can easily use the online Virtual laboratory for the experiment of separation of the components from a mixture of sand, common salt and ammonium chloride.

2.4 Sample of the study:

In the view of the subject and objectives of the study, purposive sample method was selected. The participants of the study were 102 school students of standard 9th who were studying in "Chemistry Laboratory" of 7 schools of Bhopal.

2.5 Tools used :

Following research tools used in the study;

- i. Virtual Lab Experiment on the topic of separation of the components i.e. from a mixture of sand, common salt and ammonium chloride.
- ii. Achievement test (Pre and post) on the theme of separation of the components of a mixture of sand, common salt and ammonium chloride
- iii. Achievement levels of students in previous class
- iv. Statistical Analysis of Data of the study finding
- v. To analyze the effectiveness constructivist approach through Virtual lab, the independent samples t- test, were applied on the data received 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.

2.6 Findings:

Statistical results of 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 Lab)	51	1.5	2.02	100	2.32	0.01
Control (conventional approach through real lab)	51	0.2	2.73			

2.7 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 on separation of the components of a mixture i.e. of sand, common salt and ammonium chloride through Virtual experiment, achieved more as compared to control group, who learned the same through conventional approach i.e. through real lab experiment. Which implied Virtual lab is more useful in terms of achievement gains. .

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 in group scores of the achievement gain ($t=2.32$) is in favor of experimental group.

Therefore, it can be concluded that student learned concepts of on separation of the components of a mixture i.e. of sand, common salt and ammonium chloride through constructivist approach by Virtual lab in a better way as compared to real lab.

The findings of the study corroborate with the findings of earlier reaches that constructivism help students to process new contents, effectively. The evidence generated in the study is consistent with these reseraces's results: Sengül (2006), Saygın, Altınboz and Salman (2006), Atam (2006), Özerbaş (2007), Bay & Karakaya (2009), Demirci & Yavuz (2009)

The aspiration of the students and parents are high with the expectation from the teachers to provide an appropriate approach for self-learning. On the basis of the study results, it can be assumed that if the constructivist learning approach is used in Chemistry teaching, it would encourage conceptual development. Hence, if the teachers and students acquire and use the constructivism approach in Chemistry in varied learning situations, it would improve achievements.

2.8 Suggestions:

The following suggestions emerged on the basis of the research results;

- I. The focus of the study is only on school students in Chemistry teaching. Similar studies can be undertaken in the different standards of school education with varied concepts of science.
- II. This study was limited to "on separation of the components of a mixture i.e. sand, common salt and ammonium chloride" concept of Chemistry. Further research can be taken-up on different aspects of constructivist learning and its effect of achievement of students.
- III. It is useful if the teachers use diverse strategies and techniques, which support constructivist approach.

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