Constructivism in Science Classroom: Why and How

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Abstract- Constructivism is buzz word widely used in paradigm of teaching-learning. Constructivism emphasises how the learner constructs knowledge from experience, which is unique to each individual. In the present paper the areas of discussion are 1) historical background of constructivism and its importance. 2) Role of mentor and learner in constructivist science classroom. 3) An attempt is made to prepare a lesson plan for science teachers based on 5E's model (one of the model of constructivism) on the topic 'Images formed by concave lenses'. This sample lesson plan will facilitate the science teachers in the implementation of constructivism in their classroom.

Index Terms- Constructivism, 5Es Model, Learning of science

I. INTRODUCTION

As long as there were people asking each other questions, we have had constructivist classrooms. Constructivism, the study of learning, is about how we all make sense of our world, and that rally has not changed. - **Jacqueline Gernnan Brooks**

Constructivist approach in teaching at all levels of school is needed because the conventional pedagogical practices of teaching emphasize learning of answers more than exploration of questions, memory at the expense of critical thought, bits and pieces of information instead of understanding the context, reading in lieu of doing i.e, not efficient to achieve the objectives of teaching science as prescribed in NCF-2005. The conventional teaching-learning methods used in schools especially in science classroom encourages the students to memorize knowledge generally in the form of laws, formulae or theories and enforces them to reproduce as such in the examination. Thus, there are very less scope for learner for insightful learning and develop skills like problem solving and reflective thinking. Learning in constructivism framework contributes to intellectual, social and psychological development of learners to transmit it in different context (Kim 2006). A constructivist classroom provides opportunities to observe, work, explore, interact, raise question enquiry and share their expectation to all (Kumar and Gupta, 2009). Later in 20011, R.K. Nayak & H.K. Senapaty were conducted a study to find out the effect of constructivist approach in fostering creativity of primary school children and found that this approach is more effective than traditional instruction in promoting creativity and enhancing interest of students in mathematics. As earlier knowledge is considered as objective and inert facts or information the epistemology of Constructivism is a different. According to this emerging philosophy knowledge is subjective, contextual and pluralistic in nature, which is actively constructed by the learner in meaning making process in their social and cultural context. Therefore, in constructive science classroom provide ample opportunities for the students to learn science as according to nature of science. M.Cakir also suggests that misconception among students can be resolved under constructivist approach. The constructivist approach had positive impact in improving the achievement in science, science process skills, and scientific attitude among VIII standard students (Sridevi, K.V., 2008). In fact traditional classroom also have constructive approach when it provide chance to students/learner to active participation in construction and reconstruction of knowledge. Dogra. B. (2010) discovered the different activities like concept mapping, T-chart etc. that can be used to design constructivist classroom for biology learning. He also emphasised that group discussion and brain storming play a significant role in constructivist classes. From discussion of above mentioned findings of researches (Miha Lee 2006, Dogra. B. 2010, Sridevi, K.V. 2008, , R.K. Nayak & H.K. Senapaty 2009) it can be infer that constructivism has very significant positive role in pedagogy of science teaching which can develop problem solving abilities, critical and reflective thinking, promoting creativity and scientific attitude among the students.

In the following sections of the article we will discuss first the concept of constructivism and historical background of it. Next, we will discuss role of mentors and students in constructivist science classroom. Lastly, we will discuss one of the constructivist model and its application in science classroom teaching. Further we will conclude by summarizing main point of the article.

II. CONSTRUCTIVISM

"Meaning is not given to us in our encounters, but it is given by us, constructed by us, each in our own way, according to how our understanding is currently organized".

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(Duckworth ,1987)

Constructivism is a theory of how the learner constructs knowledge from experience, which is unique to each individual. Constructivism according to Piaget (1971) is a system of explanations of how learners as individuals adapt and refine knowledge. Constructivism is relatively a new paradigm which is based on the assumption that knowledge is subjective, contextual and inherently partial. It loudly denied the traditional objectivist view of knowledge. The traditional teaching-learning practices which are based on *Objectivism*, represent knowledge as authoritarian and certain, whereas constructivism focuses on the resilience of learner beliefs and social construction of reality. Constructivism represents a paradigm shift from behaviourism to cognitive theory. Behaviourist's epistemology focuses on intelligence, domains of objectives, levels of knowledge, and

reinforcement. While the Constructivist epistemology assumes that learners construct their own knowledge on the basis of interaction with their environment. Four epistemological assumptions are at the heart of what we refer to as "constructivist learning. "The first one is, knowledge is physically constructed by learners who are involved in active learning. Second is knowledge is symbolically constructed by learners who are making their own representations of action; Knowledge is socially constructed by learners who convey their meaning making to others; and last one is, Knowledge is theoretically constructed by learners who try to explain things they don't completely understand.

III. Historical Background of Constructivism

The concept of constructivism has roots in classical antiquity, going back to Socrates's dialogues with his followers, in which he asked directed questions that led his students to realize for themselves the weaknesses in their thinking. The Socratic dialogue is still an important tool in the way constructivist educators assess their students' learning and plan new learning experiences but it became an emerging philosophy of 21st century. Jean Piaget, David Ausubel, Bruner and Lev Vygostky had very significant role in foundation of this philosophy. Jean Piaget, who is considered as a founder of individual constructivism, believed that learning is strongly influenced by learner's developmental stages. Later philosopher considered that knowledge is acquired through social interaction. Learner is subsequently move from definite stages of physical, intellectual, emotional and social development and each stage is associated with specific learning experiences which determine what learner can learn with those experiences and up to what extent. Dewey and later, Vygotsky, recognized that the construction of knowledge was rooted in group context (oxford, 1997). Vygotsky believed that learning is social in nature, which employs that learning occur via interaction with other people i.e., interaction among learners or peer group and also with teacher. During this interactive process, meaning is shared and information is exchanged and provides opportunity to learner to compare, examined and redefine his/her knowledge with knowledge and understanding of other group members. All these learning theory drastically change the **concept of learner** who was considered as **"subject"** by behaviorist psychologist into **"active participant"** of learning activity who can controlled their own learning by active meaning making process. Modern educators who have studied, written about, and practiced constructivist approaches to education include **John D. Bransford** , **Ernst von Glasersfeld** , **Eleanor Duckworth** , **George Forman** , **Roger Schank** , **Jacqueline Grennon Brooks** , and **Martin G. Brooks** .

IV. Role of Mentor and Learner in Constructivist Science classroom

There is paradigm shift in traditional role of teacher as well as students in constructivist science classroom. The teaching methods used in traditional classroom is based on objectivist view of knowledge which is grounded on the assumption that knowledge is objective, universal and complete and can be transfer from head of teacher to the head of students. While in constructivist classroom role of teacher is shifts from *transmitter* of knowledge to *facilitator* of knowledge construction and role of students changes from *knowledge gainer* to *knowledge constructor*. Classroom environment is not 'authoritarian' where supreme power is vested in the teacher who is considered as expert of knowledge and his duty is to pours knowledge into passive students, who wait like empty vessel to be filled. In this approach classroom environment is much more democratic, students are encourage to ask questions, his/her ideas and previous knowledge is respectfully invited and carefully listen by the teacher. Teacher provides opportunities to learner to discuss and shared their ideas freely to each other, probing, doing own experiments and other problem solving activities. National curriculum framework (2005) also recommends that curriculum should help learner to become constructor of knowledge and emphasises the active role of teachers in relation to process of knowledge construction by engaging the learner in process of learning through well-chosen tasks and questions. In the words of Brooks & Brooks (1999) 'In a constructivist classroom, the teacher searches for student's understanding of the concepts and then structures opportunities for students to refine or revise these understandings by posing contradictions, presenting new information, asking questions, encoring research, and/or engaging students in inquired designed to challenge current concepts." Thus in constructivist science classroom, the teacher is not the sage on the stage but *mentor* or *guide* on side of students, who not provide instruction to passive students but designing learning situations for the active learner of science.

There are ten basic guiding principles of constructivist thinking that educators must keep in mind: 1) learning is an active process in which the student constructs meaning, 2)People learn to learn3) Learning involves language 4) Learning is a social activity 5)Learning is contextual 6) The act of constructing meaning is mental 7) Everyone needs knowledge to learn 8) Learning is not the passive acceptance of knowledge it takes work 9) Motivation is a major aspect of learning and 10) It takes time to learn.

V. Constructivist Models

In the early 1960's, Robert Karplus proposed a teaching/learning model for instruction based upon the work of Piaget which represented a systematic application of psychology to science education materials. There are several constructivist models available that can be used for designing the proper learning experiences to the students. The 5 E's model proposed by Roger Bybee can be conveniently implemented in science classroom. This model was developed under the Biological Science Curriculum Study (BSCS) project. The 5 'Es' employs for Engage, Explore, Explain, Elaborate and Evaluate.The each of the 5 E's describes a phase of learning, and these five "E"s can be further explain as:

Engage: This phase createsa connection between previous and present learning experiences and anticipate activities that focus students' thinking on the learning outcomes of current activities. Students should become mentally engaged in the concept, process, or skill to be learned. Here, the role of the

teacher is to present the situation and identify the instructional task.

Explore: In this phaseteacher designed some learning activities so that students have common, concrete experience upon which they continue building concepts, processes, and skills. Engagement brings about disequilibrium; exploration initiates the process of restoring equilibrium.The aim of this phase is to establish experiences that teachers and students can use later for formal introduction and discussion of concepts, processes, or skills.

Explain: This phase of the 5 E's helps students for explaining the concepts they have been explored in previous step.Here, the teacher tries to focus student attention to specific aspects of the engagement and exploration experiences.The key to this phase is to present concepts, processes, or skills briefly, simply, clearly, and directly and move on to the next phase.

Elaborate: This phase of the 5 E's extends students' conceptual understanding and allows them to practice skills and behaviours.

Evaluate: This is the last phase of the 5 E's encourages learners to assess their understanding and abilities and lets teachers evaluate students' understanding of key concepts and skill development.

VI. Implementation of 5Es Model of constructivism in Science Classroom

The authors make an attempt to develop a systematic framework/ a draft of lesson plan on 5E model for seven standard students on the **topic "Images formed by concave mirror"** as follows:

Content Area: Science
Grade Level: VII Grade
Topic: Images formed by Concave Mirror

Objectives:

i. Students will observe the images formed by concave mirror.

ii. Students will understand the difference between real and virtual images.

iii. Students will demonstrate the process of image formation by concave mirror.

Key Idea: children are familiar with the different type of mirrors and enjoy the images formed in them.

Performance Indicator: students will observe and then demonstrate the real, inverted and enlarge images is formed by concave lens.

PHASES	WHAT TEACHER WILL DO	WHAT STUDENT WILL DO
I. ENGAGE	Teacher will provide different kind of mirrors to the students who are already divided into group of 4-5. Teacher asked students to write what differences they observed when they look there face in different type of mirrors. Now, the teacher will performed experiment with concave mirror, candle and needle point to each group asked them to observe the images of candle and needle point by altering the distance between mirror and candle.	Students observed differ type of mirror and enjoy to see their images in it. They became curious while writing their experience and try to find answer of question why did this happen? Students will carefully observe the experiment performed by the teacher and the images formed in the mirror.
I. EXPLORE	Teacher asked to repeat the same experiment as he/she already demonstrated. Teacher provides a cardboard to each group asked them to observe the images of candle on it.	Student will enjoy the activity and discuss on it in their respective group. Then they record their observations and ideas.
II. EXPLAIN	Teacher will asked each group to explain what they observed during experiment. Teacher asked probing questions for the justification of real and virtual images.	The students carefully listen each other observation and explanations about the experiment and attempt to redefine his/her own understanding. Students will provide suitable justification on the basis of their activity on images obtain on cardboard.

	Teacher will clarify the concept nature of images formed by concave mirror is real and inverted and erect and virtual.	
III. ELABORATE	Teacher asked for the other examples from day today life where students can observe the same images. Here, he may prompt the students to give correct responses.	Students can give examples of spoon, head lights of vehicles etc.
IV. EVALUATE	Teacher may use group discussion to discuss how and which type of images is formed from concave mirror.	Students during group discussion self evaluate his/her own progress.

VII. Conclusion

In modern era, science education is the key component of curriculum. The traditional methods used for teaching science in contemporary Indian science classroom only transact knowledge from the head of teacher to the head of students. Here science is considered only as a body of knowledge and product end is given more importance than the process aspect of science. These conventional methods are not efficient to develop true knowledge and understanding of science and prove futile exercises to inculcates problem solving abilities, critical and reflective thinking among the children. Therefore, there is urgent need to reform our teaching practices in light of recommendations of NCF-2005. In this framework child is viewed as “discover”, who actively construct his knowledge and build his understanding by meaning making process. Hence, the framework advocates the use of constructivism at every stages of science teaching. Many researches evident that constructivism encourages learner to reflect and question their own understanding via active meaning making process. Thus, constructivism is helpful in learning of science in true sense i.e., not only as a body of knowledge but also as process for making sense of surroundings. In this model emphasis is shifted from “teacher” to the “students”. Teacher is no longer behaving as a sage on stage but has to act as “facilitator” of learning. Students are not just a passive gainer of knowledge but became active learner who themselves construct knowledge through experience, observation, documentation, analysis and reflection. Among the different available models on constructivism, the 5Es model developed by Roger Bybee is most conducive among the several available constructivist models. A typical lesson plan based on this 5Es had been frame by the authors that is an attempt towards design learning strategy for VII standard science classroom may prove helpful in realizing the primary goal of constructivism i.e.; helping students learn how to learn science in the class and outside the class.

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