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INNOVATIVE STRATEGIES FOR SCIENCE TEACHING

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ABSTRACT

The paradigm shift in science education at the turn of new millennium envisages learning as a 'treasure within' and learner centred approaches. Science can be taught effectively using the constructivist strategies in which the learner involves actively. In this paper, various constructivist strategies like peer tutoring, simulation, team teaching, experiential learning, cognitive apprenticeship, discovery learning have been discussed.

Key Words: Constructivism, Experiential learning, Cognitive apprenticeships, Peer tutoring, Discovery learning

INTRODUCTION

Science education has undergone a paradigm shift at the turn of new millennium. It is not a passive process but is an active construction and interpretation of experiences. Learning is a 'treasure within' and scientific knowledge is being actively built up and constructed by the learners. For constructivists, learning is viewed as an interaction between the learner and the learning environment. During this interaction prior knowledge becomes the basis to interpret and construct new understanding. In effect, learning is a process in which the learner invents new ideas. Viewed from this context, learning science becomes a process of conceptual change and knowledge navigation. Learning involves the restructuring of students' conceptions, and the educators need to appreciate the ideas that children bring to the learning situations. They should also understand the processes by which the conceptual change occurs in order to design the learning programmes. In a learner centred approach, learning is not a

passive process but is instead an active meaning-making problems solving process. New learning depends on learner's previous knowledge, which may sometimes interfere with the understanding of new information. Learning implies the organization of prior conceptual schemes.

AIMS AND APPROACHES IN SCIENCE EDUCATION

- Development of process skills like observation, classification, communication, measurement, estimation and prediction.
- Acquisition and understanding of knowledge, development of the skills for problem solving and investigation.
- Ability to think logically as well as to draw conclusions on the basis of experiments.
- Development of the ability to reach generalisations and to apply them for solving life problems.
- Development of understanding of inter-relationship of science and society.
- Fostering creativity for innovations in science.

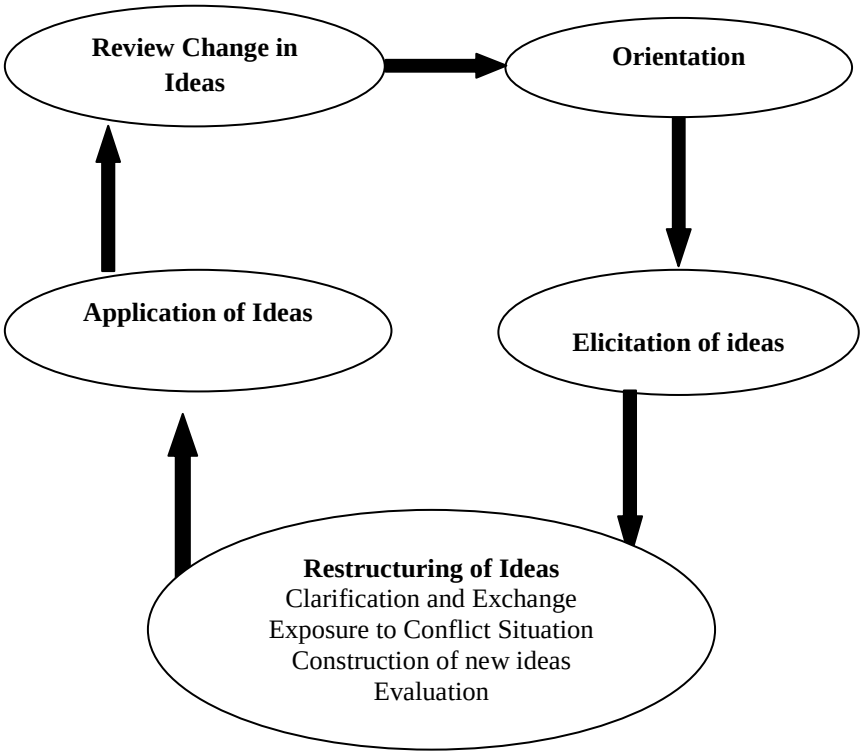

Fig. 1. Approaches in Science Teaching

Framework for Teaching Science

Approaches	Teaching Exercise
Orientation	Teacher introduces the topic
Elicitation of ideas	Opportunities are provided for pupils to explore and explain their ideas.
Clarification and Exchange	Pupils are given a chance to recognize scientific ideas and examine their own ideas.
Exposure to Conflict Situation	Pupils are provided with situations in which to test their ideas and recognize the limitations of these ideas.

Construction of new ideas	Opportunities are provided for pupils to restructure (extend, modify or replace) their ideas.
Evaluation	Pupils are provided with opportunities to test out the validity of their newly constructed ideas.
Application of ideas	Pupils are provided with opportunities to apply their ideas in new situations to reinforce these ideas.
Review Change in ideas	Pupils are provided opportunities to reflect upon how and why their ideas have changed.

Cognitive Constructivism

Teacher requires an understanding of how children think and construct scientific knowledge, to be successful in their teaching. Learning is viewed as an interaction between the learner and the learning environment. During this interaction prior knowledge is used as a basis to interpret and construct new understandings. According to Rosalind Driver (1989), "The key feature of a constructivist epistemology is that human beings construct mental models of their world and new experiences are interpreted and understood in relation to existing mental models or schema." From the constructivist perspective, learners are seen as developing ideas through an active process in which current ideas have a fundamental role. In this light, children's ideas become highly significant as they potentially form the basis of future thinking and understanding.

The cognitive development model by Jean Piaget (1977) suggests that knowledge cannot be imparted and development of thought is a process of equilibration of cognitive structures through assimilation, and accommodation. Piaget laid emphasis on the sensorimotor, preoperational, concrete operational and formal operational stages of cognitive development from childhood through adolescence and learning is primarily a personal enterprise. The key processes in

the construction of knowledge include schematic representation and mental operations, conservation of thought, classification and deductible reasoning. The new knowledge is assimilated to the existing knowledge based on our past experience. If there is a conflict and we are unable to do it then we restructure our cognitive skills to a higher order and adjust to the new environment. The teacher as a facilitator and guide should support the child to discover knowledge. The learner-centered approach seeks to identify, through scientific study, the natural path of cognitive development (Vadeboncoeur, 1997).

Creative Role of Teacher

The teacher plays a predominant role in creating a constructivist approach adopted by the teacher will depend upon the beliefs and attitudes towards the teaching-learning process. A constructivist learning climate is influenced not only by the teacher's belief about the nature of the learner. Teaching cannot be separated from learning. Teaching and learning go hand in hand and cannot be compartmentalized. If learning is by rote and examination oriented, then teaching has to follow in the traditional behaviourist mode. Gow and Kember (1993) suggest that most approaches to learning can be subsumed as a quantitative increase in knowledge, memorization, and acquisition of facts and procedures which can be retained and/or used in practice, abstraction of meaning and interpretative process aimed at the understanding of reality. The teacher can decide the constructivist reality of the classroom based on any of the above points. Constructivism lies in the heart of such endeavours a s it gives insights into the cognitive and affective dimensions of the relationships between the teacher and the taught. Teaching is not meant for depositing knowledge and thrusting information but should inculcate scientific temper and values.

Classroom Climate

The students can have an optimal learning experience if they are provided opportunities by the teacher to construct their own knowledge instead of having

knowledge constructed for them. This is the essence of the constructivist learning. A democratic climate in classroom can make the constructivist teaching strategies effective. Constructivist teacher and his constructivist beliefs get reflected in the classroom. Teachers should create an environment that requires the student to state their point of view. Participation of students to construct knowledge is to be maximised and the evaluation should be made based on active participation and performance of the learner. Students have freedom and autonomy within the pedagogic parameters. The focus is on pupil-pupil interaction and teacher-pupil relation can empower the learner in a constructivist classroom.

Learner Centric Pedagogic Strategies

Peer Tutoring:

Peer learning can be of three types. Peer tutoring, cooperative learning and peer collaboration (Damon & Phelps 1989).Tutoring by the peer group has immense potential for learning. Fellow students can be effective tutors. Teaching can be done by same age students or older peers. This is a two-way process. Not only the taught, but the fellow teacher also learns effectively. Students must be encouraged to play the roles tutors and tutees. They must experience the feelings of helping and being helped.

Simulation:

Simulation is getting reality into the classroom. Different activities based on different themes can generate a sense of fun in the classroom. Multisensory resources can be used and lively activities can be introduced. The learner learns to identify with the reality which he would come across in the real world. Simulation exercises help to prepare the learner in the most meaningful ways.

Team Teaching:

Team teaching is shared accomplishment of integrative teaching built around topics resulting in the integration of subjects. This method is suitable whenever there is a need to pool resources, interests and expertise in order to devise and implement a scheme of work suitable to the needs' of the pupils and the facilities of the school (Warwick,1971).

Brainstorming:

Making each member of the group give free expression to his/her ideas by withholding all criticism or evaluation, making explicit and stating all ideas in writing, categorizing to eliminate unwanted ones, listing all major ideas from the important stages in brainstorming. This method serves the purpose of collective or individual generation of ideas as possible solutions to any particular problem. The essence of the brainstorming technique is the solution generation rather than solution evaluation.

Experiential Learning:

"Experiential learning means the learning that occurs when changes in judgments, feelings, knowledge or skills result for a particular person from living through an event." (Chickering, 1977). 'Experiential learning' connotes learning from experience. Learning by doing and performances of the learners can maximize the knowledge and understanding among the students.

Cooperative Learning:

Cooperative learning known as small group learning can be integrated into normal schools for teaching science without disruptions in regular classroom routine and schedules. In cooperative learning students interact face-to-face and will be close together within a classroom. Group members experience positive interdependence. They need each other for support, explanations, and guidance. Learning can be enhanced in cooperative groups through rehearsal and

elaboration, creation and resolution of disequilibrium, or scaffolding of higher mental processes. Cooperative learning methods vary in the extent to which they encourages individual versus collective learning activities. Aronson's 'Jigsaw teaching', Sheran's 'Group Investigation', and Slavin's 'Student teams achievement divisions' are some of the methods of cooperative learning.

Cognitive Apprenticeship:

Cognitive apprenticeship is a relationship in which a less experienced learner acquires knowledge and skills under the guidance of an expert. Knowledgeable guides provide models, demonstrations, and corrections, as well as personal bond with the new learners.

Discovery Learning:

The term refers to a process of self-learning whereby learners generate concepts and ideas. In a larger framework, discovery may be thought of as a psychological construct which is based on the concern to provide necessary motivation for students to participate in the generation of new ideas. In the knowledge construction process, learners use discovery processes in the initial perplexing phases of thinking, whereas inquiry processes in the more advanced formal verification phases.

Conclusion

A paradigm shift in pedagogical strategies is essential for effective science education. Inquiry based instructional strategies are emphasised in classroom constructivism. The role of the teacher is changed from transmitter of knowledge to facilitator and guide in the exploration of knowledge. The student role shifts from passive receiver to one of knowledge creator. Students take initiative in the learning process and become scholars in designing experiments, testing hypotheses and drawing conclusions in learner centred science classroom. Constructivist approach in teaching and learning stress the importance of

enquiry, observation, investigation, and evaluation of scientific knowledge. Innovations in science teaching can be brought in with discovery learning, cooperative learning, experiential learning and peer tutoring.

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