Characteristics of a Constructivist Classroom in the Context of Science Education

SHASHI PRABHA*

Abstract

A constructivist classroom of science exhibits some marked features that are different from a traditional classroom. National Curriculum Framework-2005 emphasises on an environment in the science classroom which is conducive for constructivist learning. The classroom environment is maintained in such a way that students actively participate in learning which involves inventing and constructing knowledge and new ideas. Teacher applies various approaches to teaching learning process in order to make her students inquisitive thinkers, who question, reason, reflect, make association with prior learning, imagine and think. In the present paper some characteristics of a constructivist classroom in the context of science education are discussed.

In a traditional classroom teacher transmits knowledge, students passively listen while their minds may be daydreaming. In a constructivist classroom teacher transacts the knowledge, students are actively involved, and their minds construct the knowledge. Constructivism sees learning as a dynamic and social process in which learners actively construct meaning from their experiences in connection with their prior understandings and the social setting (Driver, Asoko, CLeach, and et al., 1994). In the context of science teaching learning process, it is observed that students conceptualise science as making sense of the world around them and as a mean of discovering theories, laws, and principles associated with reality. The constructivist epistemology asserts that the only tools available to a knower are the senses. It is only through seeing, hearing, touching, smelling, and tasting that an individual interacts with the environment. The individual builds a picture of the world from the message from these senses only (Lorbach A. and Tobin,K.,1997). Therefore, constructivism asserts that knowledge resides

* *Reader*, DESM, NCERT, New Delhi- 110016

in students and that knowledge cannot be transferred without any transformation from the head of a teacher to the heads of students. Students try to make sense of what is taught by trying to fit it with their previous experiences. Teacher seeks students' point of view in order to understand the formation of their concepts, not to validate their learning as in a traditional classroom.

Therefore teaching learning process is not only an arrangement of teaching strategies but setting of situations and environment in which learning process is recognised and supported. For this situation to be created for science teaching learning, a constructivist classroom has certain characteristics as discussed below.

A Constructivist Classroom is Child Centred

Constructivist classroom places a child in the centre position of the classroom. Ideas initiated by students are accepted and encouraged. Students' opinions are valued. The National Curriculum Framework-2005 brought out by the NCERT emphasising constructivist approach in classroom states "Teachers should also nurture their classroom spaces as places where children can ask questions freely" (p.82). NCF-2005 establishes the need to recognize the child as a natural learner, and knowledge as the outcome of the child's own activity. Students' experiences, their voices and their active participation are valued. Students are not ridiculed or rebuked for asking questions. They are allowed to ask questions, make mistakes and to correct those mistakes. They learn from the positive experiences of social set up of the classroom. Focus is given to what students are learning rather than what the teacher is teaching. They are involved in all the activities of classroom and at all stages of teaching learning processes. Understanding of scientific concepts becomes important to them than memorising them. Learning no longer remains like a treasure haunt to guess what is there in teachers mind but what thoughts are being generated in their own minds. Lindfors (1984) advises that how we teach should originate from how students learn.

Students' Prior Knowledge is Acknowledged and Valued

Students form some concepts pertaining to natural phenomena prior to their experiences in school. It might be correct or incorrect. Often the scientific interpretation of natural phenomena differs from the students' interpretation. During teaching learning process students construct meanings that fit with their experiences and expectations. This can lead them to construct meanings different from what was intended by a teacher. As a result students experience a cognitive conflict. They often resolve this conflict by separating school science from their own life experiences. In other words, students distinguish between scientific explanations and their "real world" explanations (Driver, 1989). For example, students imagine that matter is destroyed during burning; they think that constant motion requires a force to maintain it and electric current is used up in lighting a bulb

(Driver, R., et al.1994). Awareness and acknowledgement of students' prior knowledge are essential for teaching learning process in a constructivist classroom. Teacher needs to provide an encouraging environment in which students are comfortable with what is not yet known to them and feel at ease to share their ideas with their peers and teacher. She should ask open ended and probing questions in order to know their existing cognitive structures. It facilitates students to construct and reconstruct their knowledge relating it with their previous knowledge. In this regard the concept mapping can be a powerful tool to dismantle the naive ideas and prevent their enrooting which can also be a big hurdle in the process of assimilation of scientifically accurate concepts of reflection and refraction.

Students and Teacher are Interactive in a Constructivist Classroom

This is another feature of a constructivist classroom. Meaningful learning of science cannot take place by reading, listening to the teacher or memorising information from the textbooks. Belenky, Clinchy, & Tarule (1986) observe that constructivists distinguish didactic talk (where participants report experiences but no new understanding occurs) from real talk where an interaction between teacher and students creates an environment within which emerging ideas can grow. Learning takes place within a net of social relationships as teachers and pupils interact both formally and informally. Teacher creates interactive situations for understanding students' concepts and then refines or revises those concepts by asking questions, posing contradictions, engaging them in inquiries and/or encouraging research. Meaning of the words and the concepts not yet comprehended emerge after discussions of those activities. There is no domination of teacher and learning takes place in a collaborative environment and experiences. Collaborative teaching, group discussion, group work and assignment and project work are some of the essential elements of an interactive classroom. Teacher makes all possible efforts to make her classroom interactive. This interaction is multidirectional. Students interact with their peers as well as teacher.

'Others' are Important in Constructivist Classroom

Learning is restructuring the knowledge that students already have. For this, students must realize that their existing conceptions of the world need a change. Then they try to make sense out of the situations based on what is already known. Their existing knowledge is based on their experiences, i.e. their interaction with events, phenomena, objects or persons. Students learn science by observing those phenomenon and events and performing experiments and activities and interacting with others. As others are part of students' experiential world, those are important for constructing their knowledge. Interaction with others constrains their thinking; hence they make adaptation in their thinking to make new meaning of the world. Others are part of their

experiential world. Thus, "others" are important for constructing their knowledge (Gray, A., 1997).

Negotiation is Compulsory for Constructivist Teaching

Negotiation is an important element for constructivist classroom. It brings teacher and learner on a common platform. Boomer (1992) explains that when negotiating, it is important for the teacher to talk openly about how new information be learned and about various constraints such as curriculum and available time. He comments on the meaning of negotiating curriculum as deliberately planning to invite students to contribute and to modify the educational programme so that they will have real investment in terms of learning process and the outcomes. Students can negotiate themes that may require integration of different topics of science or even social sciences, literature or arts. Negotiation also involves selection of reference books from the provided piles of books in the classroom. Students may participate in the design of assignments and its evaluation too, although the teacher may fix the parameters. Negotiation in classroom also means providing opportunity to compare students' new experiences with previous one, discovering discrepancies between them and achieving equilibrium by resolving them. Here equilibrium implies that there will not be any curiosity with respect to their previous knowledge. It may take place during discussion and attentive listening to others, making meaning to it and comparing personal meaning. When a student understands how his peers are making sense of a point of view, it is then possible to discuss similarities and differences between the theories of peers within a group. Justifying one position over another and selecting those theories that are viable can lead to consensuses that are understood by those within a peer group. The process of learning should not stop at what has been learned in the negotiation of a class consensus. It is important that students learn to compare their knowledge constructed in class with knowledge constructed by the community of scientists. This process can involve accessing other learning resources such as books, videotapes, etc. By engaging in such a process students can realize that what is regarded as a viable theory depends on what is known at the time and the context in which the theory is to be applied. In this process they understand how to select the best theoretical formulation for use in a particular set of circumstances (Lorsbach, A., Torbin, K 1997). Cook (1992) explains why negotiating the curriculum is important. Students work harder and better and what they learn mean more to them if they are discovering their own ideas, asking their own questions and fighting hard to answer them for themselves. Out of negotiation comes a sense of ownership in students for the work they are doing. Therefore they become committed to learning. In a constructivist classroom the teacher trusts her students, offers them options and choices about learning, invites them to construction of their knowledge. Active involvement of students in their own learning as well

as in other actions such as doing activities and at the same time maintaining discipline is a vital reality of constructivist classroom. Regarding discipline NCF-2005 mentions "It is necessary to involve children themselves in evolving rules, so that they feel responsibility in ensuring that it is followed." (p.87)

Process Approach is Emphasised in Constructivist Classroom

Process approach in science is methods and techniques of learning science. In a constructivist classroom process approach is emphasised. A context is created within which students are able to explore new ideas and experiences (Langer and Applebee, 1987). Students are provided opportunities to perform and participate in various activities and experiments. Teacher may design simple or complex activities depending on the contexts and contents. She leads her students to the path of construction of knowledge and helps them to become inquisitive learners. They are encouraged to generate tentative hypotheses, singularise the hypotheses, making observations, collecting data, drawing conclusion, and communicating. They learn to handle and manipulate apparatus and materials. They make lively uses of their senses. They may reject some information and accept other observed information to arrive at correct conclusion on their own when teacher acts as a facilitator of learning. They learn to develop an orderliness and reasoning in their thinking. When they draw same conclusions from different sets of experimentations under similar conditions they generalize those conclusions and become equipped to apply them in new situations in their everyday lives. In this context they get chance to focus on their ideas and develop more complex thinking and reasoning skills as they participate in the discussion and defend their ideas. The processes of learning science become more important than the product of learning science. Students enjoy learning as they get ample opportunities to interact among them selves and their teacher and to explore the environment. They learn how to learn. At the same time they get familiarised with the process of process skills of science. Thus, from a constructivist perspective, science is not a search for truth. It is a process that assists us to make sense of our world. It is an active, social process of making sense of experiences, as opposed to what we now call "school science." Indeed, actively engaging students in science (we have all heard the call for "hands-on, minds-on science") is the goal of most science education reforms. Using constructivism as a referent can possibly assist in reaching that goal. From a constructivist perspective, learning science becomes more like the science that scientists do (Lorsbach, Tobin, 1997).

Management of the Classroom is Democratic

Democratic environment of the classroom facilitate constructive learning. Such environment emphasises shared responsibility in learning and decision-making. Students are directly

involved in all the activities of the classroom. Students on both extremes of learning levels are provided equal opportunities. Teacher in a constructivist classroom designs and manages her activities in such a way that students are eager and ready to exchange their ideas. They are not afraid of being ridiculed. Teacher encourages her students to ask and share the thought processes going on in their mind. She assures to her students that no question is silly one. Getting familiarised with students thought patterns help her to help students in constructing their knowledge. Relationship among students and teacher is also democratic and responsive. It stimulates interest in the subject matter and develops a sense of self-achievement in students. Rules are made flexible and teacher's focus is on students learning rather than on her own performance.

Students Learn from Whole to Part in a Constructivist Classroom

Teacher presents the curriculum holistically in a constructivist classroom, not in bits and pieces. She organises the instructional materials in conceptual clusters, or themes. For example, Energy, Air pollution, Greenhouse Effect, Global Warming, Measurements, etc. may be considered as themes expanding in the domain of different subjects. The boundaries between different subjects get softened in a constructivist classroom. Subjects are not treated as watertight compartments. Students' way of viewing world is emphasised. Instructions in the classroom are provided inter-relating many contents area at once. Students construct their knowledge by breaking the whole into parts and in this process they get equipped to apply their knowledge in everyday life situations. They understand relationship between science, technology and society. Emphasis is given on primary facts rather than on a set of disconnected discrete facts.

Power in a Constructivist Classroom is Shared

Empowering students to learn themselves is basic in constructivist philosophy. Teacher makes every effort to develop skills and abilities to become an autonomous learner. Calkins (1986) laments that in most classrooms we neither teach students to ask questions nor allow them to ask questions but only allow them to answer our questions. It is not realised that asking question is challenging and part of thinking and learning process. When some question pops up in their mind and they are encouraged to make a query, they develop a control over their thinking. Emphasis is given on students thinking rather than on their answers and memorization of facts. She allows them to make mistakes, as she understands that those mistakes are critical in learning. Students and teacher together, develop teaching aids and materials from locally available materials. Working with concrete objects they investigate the concept of science themselves. It helps them to think critically and gain confidence in problem solving abilities (Paulu & Martin, 1991). Concepts are not swallowed from prescribed texts like

capsules. Students enjoy their hands on experiences. Learning takes place naturally. It provides students the power to construct their knowledge. Teacher in a constructivist classroom keeps on exploring ways and means and situations of asking questions. She controls her class indirectly but involves her students directly in all the activities of the classroom. Contrary to the popular belief a constructivist classroom is highly organised (Gray, A.1997). Students are given a lot of choices in their activities, curriculum and behaviour, but within certain parameters. In such a classroom control comes from involving the students in responsibilities and not from imposing strict rules. Thus the teacher can focus on students learning.

Assessment is Interwoven with Teaching Learning Process

In traditional classroom, teachers assess students by paper-pencil test, grading assignments, worksheets and rating students' work as right and wrong answers. In contrast, in a constructivist classroom of science, assessment of students learning is done in the context of daily teaching. It is continuous and comprehensive. NCF-2005 suggests that maintaining a daily diary based on observation helps in continuous and comprehensive evaluation. Assessment is not considered as separate and patchwork, but interwoven in teaching learning process of a constructivist classroom. It is done in totality of learning experiences. Instruction itself is based on inquiry process. Providing plenty of spaces for interaction helps the teacher to diagnose faulty mental schema of her students. She obtains immediate feedback. These evidences of learning serve to guide the teacher in further lesson planning too, and may indicate the need for modification or change of strategies of teaching learning process. For example, if a teacher perceives clear evidence of some faulty cognitive structures, she can revisit the concept to enhance clearer understanding and accordingly she can plan learning experiences to take remedial measures. Not only scholastic but co-scholastic areas of students learning are also assessed. Process skills of science are assessed by making the students perform various activities and experiments and projects. Learning process is managed to be open ended and open to change by using suitable tools of assessment. Science teacher in a constructivist classroom embraces "alternative assessment" strategies also, in order to truly understand what students are thinking and to identify the steps they have taken to construct meaning out of their learning experiences. Alternative assessments strategies include teacher observations structured by checklists, interviews, rubrics (preconceived expectations of learning), concept maps, journals, performance assessment tasks, open-ended problems, drawings, and portfolios (Chiappeta, Koballa, & Collette, 1998). Novak and Gowin (1984), Novak (1991) also describe the use of concept mapping strategies in order to analyze and assess the changes that occur in students' cognitive structures as a result of instruction. Concept maps are particularly useful as alternative

assessments because they can be used to identify misconceptions held by a learner both prior to and after instruction (Roth, 1992). Asking to contribute one more alternative to multiple-choice questions, solving crosswords and puzzles, framing questions from given situations or paragraph, making labeled diagrams, etc. can be some other ways of alternative assessment. Position Paper NFG on Examination Reforms suggest open –book and on-demand examination for the reform in the present system (p.2). Alternative assessment complements the constructivist approach to teaching by providing ongoing assessment of learning and more accurate measure of students' actual understanding. Displays of attainment and progress by assessment enhance understanding of concepts of science, which can become jumping off points for further enrichment of the students' learning.

Lester & Onore (1990) propose that genuine learning comes not disregarding all prior learning but reassessing our existing belief about the world. Reflecting on one's teaching practices enable a teacher to transit from transmission to transaction mode of her classroom. She creates an environment in which she can challenge the beliefs and practices of a traditional classroom and become a facilitator and provider of experiences to her students in which they can construct their knowledge in a constructivist classroom.

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