UNIT1:

PEDAGOGICAL SHIFT IN PHYSICAL SCIENCE

Syllabus: Pedagogical shift from science as fixed body of knowledge to the process of constructing knowledge – Critical pedagogy, democratising science learning and role of teachers – Pedagogical shift: planning teaching learning experiences.

Pedagogical shift: Introduction

Science is an enterprise that has been changing continuously over the years. There is a shift from understanding Science as mere collection of facts and principles to the constructivist and inquiry-oriented learning experiences taking learner at the centre stage. The role of classroom discussion in promoting critical, creative and reflective thinking of learners and thus collaborative participation in the classroom have been identified as being centre to the construction of their knowledge. Moreover in the present age of globalisation, information and communication technology has directly or indirectly affected our education system.

Today's pedagogy gives value to the voice of learners and their questions, their abilities of making argumentation and justification, synthesizing and analyzing knowledge and their involvement in the process of inquiring science in a collaborative set-up rather than their ability of rote memorization. There is also a shift in our understanding of process of learning and about learners in the classrooms.

There is a need to understand the epistemic and epistemological dimensions of learning. Pedagogy includes both teaching as well as learning process of learners. Hence, there is a need to understand the nature of learning and nature of teaching with reference to physical science.

Pedagogical shift from 'science as fixed body of knowledge to the process of constructing knowledge

Earlier, nature of knowledge in general and nature of knowing in particular was considered as a fixed entity. However, in the contemporary understanding of nature of knowledge and nature of knowing, these are dynamic entities. The pedagogy which we use to construct knowledge through diverse learning strategies includes previous experiences of the learner, their socio-cultural and economic background along with the content knowledge rather than over whelming emphasis on the psychological characteristics to the individual learner.

The fundamental difference between the acquisition and the construction of scientific knowledge is passive receipt of the knowledge, and active involvement and critical examination based on critical thinking on the part of the learners.

Shift in pedagogy of science from affixed body of knowledge to the process of constructing knowledge has many dimensions. It includes a shift in our understanding of,

- Nature of science
- Knowledge
- Learners, learning and teachers
- Assessment
- Science curriculum
- Scientific method and scientific inquiry
- Importance of critical pedagogy
- Approaches to planning
- Various aspects of inclusive education etc.

In order to understand pedagogical shift in physical science, it is important to have a brief overview of all these aspects related with teaching–learning in science.

1. Pedagogical shift: Nature of science

The knowledge in science is subject to change. It is tentative in nature. This tentative nature of scientific knowledge interestingly does not make it un reliable. We now realize that there is always an element of subjectivity in the development of scientific knowledge, even if we consider that science always strives for objectivity.

Socio-cultural factors also have impact on nature of science. Role of creativity, observation, inference, etc. have been understood to be important in the development of science.

In simple terms, we can say that scientists collect relevant data and use evidences to explain ideas under consideration. They use their own perspective to guide themselves about problems. Scientists can change their ideas on the basis of contemporary development in their fields and create new ideas. In order to understand science, we must know the manner in which knowledge is constructed over time as well as the method used to validate that knowledge and the place of science in society.

2. Pedagogical shift: Knowledge

Science is an enterprise that has evolved over many thousands of years and continues to evolve. Our understanding of knowledge has shifted from a 'static entity' to a 'dynamic entity. We understand that knowledge is actively constructed by learner and cannot be passively received. Scientific knowledge is always subject to change and its modification is not an end product in scientific inquiry. Teaching– learning of science should go beyond presenting the facts and principles and result of investigations. Although knowledge is something personal and individual, the learners construct their knowledge through their interactions and with the physical world, collaboratively in sociocultural settings and linguistics environments. Learners should be facilitated to make observations, collect and interpret data, use the acquired information in critical way to construct their knowledge.

3. Pedagogical shift: Learners, learning and teachers

A more integrated understanding of learners and process of learning and we see them in inseparable form. Learners come to the learning situations in physical science with their existing ideas about phenomena, not just around them but across the real physical realm within their reach. Learners have now taken the central stage. Their view points are sought and valued. Learners get motivated to learn when they discover their own ideas, asking their own questions and trying to find out answers for themselves. Negotiation and mediation by learners, plays a prominent role in learning that takes place in a social setup.

Learners enter into dialogue and argumentation in learning science to construct their knowledge. Thus, for an effective pedagogical design, a teacher has to take care of the existing ideas of the learners and the difference in nature of their ideas with the scientific explanation of those ideas. She should develop the habit of listening to learners, giving value to their ideas and motivating them to bring their own ideas about their observation and interpretation of phenomena in their own context.

The learning of science must help them nurture their curiosity, rather than their ability to reproduce textual knowledge. This shift is necessary to make learning atmosphere conducive and learning more meaningful.

Teacher is no longer considered as custodian and manager of all teaching learning processes. There is a major shift in the teacher's role from where she assumes apposition of centre stage as a source of knowledge as to being a facilitator of transforming knowledge and as a supporter in enhancing learning through multiple exposures, encouraging the learners to continuously achieve their educational goals.

4. Pedagogical shift: Assessment

In addition to learner's achievement in various subject areas that can be tested easily, assessment needs to encompass attitudes to learning, interest and the ability to learn independently. Furthermore, to test all the learners through a written test of the same type in all subjects is unfair to those who several proficiency is superior to their writing skills or those who work more slowly but with deeper insight.

NCF-2005 recommends a shift in modes of assessment by making it more flexible. It emphasizes various modes of assessment including all meaningful aspects of performance, e.g. activities, experiments, journals, illustrations, oral presentations, peer evaluation, self evaluation, group work assessment, models, portfolios, and other art if acts of learning. Learners may be involved in selecting learning indicators and evaluation criteria to provide a sense of ownership in learning.

There is shift in emphasis from testing rote memorization to understanding and application to the knowledge and from examination-centered classroom processes to learning-centered classroom processes. The focus of question should move from mere plug-in type problems to genuine application type problems and questions demanding organization of thoughts in to arguments to demonstrate interpretative skills and critical thinking.

5. Pedagogical shift: Science curriculum and scientific inquiry

Earlier scientific method was as summed that scientific inquiry is related with the development of process skills such as observing, inferring, classifying, predicting, measuring, questioning, interpreting and analyzing data. After a pedagogical shift, It was about engaging learners in scientific investigations to find answers of self indentified questions.

The scientific inquiry varies widely within scientific disciplines and also across various disciplines. Inquiry as a teaching-learning approach will thus mean placing learners in situations that are very similar to something that scientists experience during the daily journey of scientific endeavour. In terms of science curricula, we need to emphasize the importance of merging classroom experiences of a learner in science with the experiential construction of scientific knowledge by the learner outside the classroom boundaries. Instead of strict adherence to curriculum, pursuit of learners' questions needs to be emphasized.

Pedagogical shifts recommended in NCF-2005

- Teacher centered and fixed designs →to → Learner centered, flexible process
- Teacher's direction and decisions →to → Learner's autonomy

- ❖ Teacher's guidance and monitoring of learning → to → Teacher's facilitation, support and encouragement for learning
- ❖ Passive reception in learning→ to→ Active participation in learning
- ❖ Learning within the four walls→ to→ Learning in the wider context of the classrooms
- ❖ Knowledge as 'given' and 'fixed' →to → Knowledge as it evolves and is created Disciplinary, Multidisciplinary and educational focus
- ❖ Linear exposure →to → Multiple and divergent exposure
- ❖ Short and few Assessment→ to→ Multifarious and Continuous Assessment

6. Pedagogical shift: scientific method to science as inquiry

Science is both the study of knowledge and the process of acquiring and refining knowledge. Learners of science should be exposed to scientific method which helps them to develop the power of reasoning, critical thinking, creativity, collaborative learning and application of scientific knowledge.

Scientific methods are ways of thinking and inquiring that allows investigating and explaining natural phenomenon and solving problems scientifically. A scientific method does not prescribe series of steps to be followed rigidly; rather it is a series of dynamic and flexible steps by which reliable evidence can be gathered.

National Curriculum Frame work for Teacher Education (NCFTE-2009) also recommends adoption of process-based teacher education. The student-teacher should also be provided with ample opportunities for self-learning, reflection and assimilation.

In addition and more importantly, there should be scope for articulation of new ideas, ability to enhance thinking and work efficiently in groups. One understands the intricacies of nature of science by the process of observation and experimentation. To inculcate scientific temper to the learner, the science teacher has to facilitate the learners to think like a scientist and get actively involved in the inquiry through learning process.

The learners should be encouraged to question and learn to observe carefully, interpret their observations to understand the situation. This motivates the learners to learn more and more themselves and to explore the world around them.

Democratising Science Learning – Critical Pedagogy

Critical Pedagogy is child-centered pedagogy. It facilitates collective decision making through open-mindedness and by encouraging and recognizing multiple views of the learners. It emphasizes to

move beyond authoritative role of the teacher by promoting sharing of power with the learners by encouraging critical thinking and commitment to democratic form of interaction.

It is a pedagogy that takes into accounts the experiences and perception of learners and helps them to learn in a fear free and independent form.

In the context of critical pedagogy, NCF-2005 recommends following guidelines:

- Participatory learning and teaching, emotion and experiences need to have a definite and valued place in the classroom.
- Children need to be made aware that their experiences and perceptions are important.
- Children should be encouraged to develop the mental skills needed to think and reason independently.
- It is important to value what learners learn out of school-their capacities, learning abilities and knowledge.
- More importance for the children of under privileged class
- Children are critical observers of their own conditions and needs.
- Children should actively participate in discussions and problem solving related to their education and future opportunities.
- Teacher's engagement with children is critical in the classroom, because it has the power to define whose knowledge will become part of the school-related knowledge and whose voice will shape it.
- When children and teachers share and reflect on their individual and collective experiences without fear of judgment
- If children's social experiences are to be brought into the classroom, it is inevitable that issues of conflict will need to be addressed. Conflict is an in escapable part of children's lives.
- To use conflict as a pedagogic strategy is to enable children to deal with conflict and facilitate awareness of its nature and its role in their lives.
- A pedagogy that is sensitive to gender, class, castes and global inequalities is one that does not merely affirm different individuals and
- Collective experiences but also locates them within larger structures of power and raises questions
- Other literary sources in their own environments can be facilitated by encouraging learners to compare, think and communicate about elements that exist in their own environment.

- Repository of knowledge exist in different mediums, hence all these forms, whether television programmes, advertisements, songs, paintings, etc. need to be brought to create a dynamic interaction among learners themselves.
- Critical pedagogy provides an opportunity to reflect critically on issues in terms of their political, social, economical and moral aspects. It entails the acceptance of multiple views on social issues and a commitment to democratic form of interaction.
- This is important in view of the multiple contexts in which our school functions.

Thus, we observe that critical pedagogy provides an opportunity to reflect critically on issues in terms of their political, social, economical and moral aspects. It entails the acceptance of multiple views on social issues and a commitment to democratic form of interaction. This is important in view of the multiple contexts in which our school functions.

Role of teachers in critical pedagogy

- The role of teachers is to provide a safe space for children to express themselves, and simultaneously to build in certain form of interactions.
- Teachers need to step out of the role of 'moral authority' and learn to listen with empathy and without judgment
- Teacher should enable children to listen to each other.
- While consolidating and constructively stretching the limits of children's understanding, they need to be conscious of how differences are expressed.
- A safe space of an atmosphere of trust would be made by teacher in the classroom
- Chances for children can share experiences and where conflict can be acknowledged and constructively questioned, and provided solutions, however tentative can be mutually worked out.
- In particular, for girls and children from under privileged social groups will be given priority
- Schools and classrooms should be spacious for discussing processes of decision-making, for questioning the basis of their decision, and for making informed choices.
- Teachers need to cultivate an understanding of the cultural and socio-economic diversity that learners bring with them to school.

Pedagogical shift – planning teaching learning experiences

There are so many aspects that should be considered for planning effective teaching-learning environments. It is important to listen to learners and encourage them to engage in assessing and

evaluating their own ideas. There is an urgent need to build up activities and strategies that are effective not just for arrange of science content areas but also productive for exploring and challenging learners' conceptions.

Also the importance of the socio cultural perspective that focuses on the way learners' differentiation and cultural back grounds shaping their learning experience cannot be undermined. For the learning environments to be effective, learners' willingness to engage with learning, the effect of assessment, nature of school environment, learners' perception about relevance of science in their lives should be planned.

It is important to reflect upon the shift in planning that can be visage in the light of the learner's need and society expectation. Centralized plans to be followed by all the teachers in different schools of the state/region, so that there is uniformity in what is going on in the classrooms across the state or region. If that sort of plan could not be followed for any reason, actions were taken against the teachers. This sort of centralized action on the teachers' role in the classroom still prevailing at some places, however, is to be done away in the interest of learners.

Teachers need to develop the ability to plan 'units' of four or five lessons for each topic. They need to understand how to develop lesson design, so that learners are challenged to think and try out what they are learning and not simply repeating what is told to them.

In fact teachers could also consider involving learners in planning the class work. Such variety can bring tremendous richness to the classroom processes. The paradigm shifts have however encouraged the teacher to shift the focus from traditional to the constructivist approach.

Planning teaching-learning: Before shift

- What will be teaching?
- How much do I know the syllabus?
- How do I prepare the students for the upcoming exams?
- What serialization of theconceptsshouldIconsider?
- What objectives are to be used for measuring performance of the students?
- When and how to plan the measurement of the learning integrating with teaching experiences with respect to my lesson plans?
- How do I control the students?
- How can the knowledge I have to transmit be the best?

- Who are the students who have succeeded?

Planning teaching-learning: After shift

Following are the respective changes in the questions that need to be answered in order to plan teaching-learning process in physical science:

- What are the learning needs and previous experiences of my learners?
- How much I am acquainted with the learning needs of my learners?
- How do I facilitate each learner's learning?
- How do I incorporate the differential learning pace of my learners?
- What is the progress of the learner as compared to her previous learning experiences?
- How do I analyse the present learning evidences to plan further learning experiences for the learners?
- How do I facilitate and support each learner in learning?
- How best can knowledge be constructed by all learners?
- What next?

The shift to the new frameworks also means that the teacher obviously has a lot of liberty in choosing the planning approaches and strategies. This liberty of planning provides flexibility to the teacher to consider students' learning needs; their existing concepts; the context of their learning; local and national needs; nature of curriculum; etc. in designing teaching-learning experiences

PEDAGOGICAL SHIFT- INCLUSION

A policy of inclusion needs to be implemented in all aspects of teaching learning of science. A pedagogical shift is required to identify diverse capabilities and talent of all learners. For an inclusive educational setup, the following will be taken in to an account as pedagogical shift.

Science curriculum

Equal opportunities and full participation to all learners including learners with special needs, and learners learning with different paces should be provided in the theoretical and practical activities conducted in science classes. Through adaptation of the curriculum (what learners learn) and modification of the approaches of teaching learning (how learners learn), access to science curriculum can be made possible for all these learners.

Changes may be made at teaching-learning level, in the content, or in the performance criteria. Such changes are made to provide a learner with meaningful and productive learning experiences, environments, and assessments that are based on her needs and abilities acquired proficiency.

Diversity in class

Inclusion is centrally a pedagogical issue, since it creates the most significant barrier to learning and exclusion for many learners. These barriers to learning arise from various interlocking parts of the curriculum and pedagogy, such as the content of learning programmes; the language and medium of teaching and learning; the management and organization of classrooms; learning style and pace; time frames for completion of curricula; the materials and equipments, that have been available for conduct of theoretical and practical sessions; and assessment tools and techniques.

Pedagogical principle that teacher should use a variety of approaches and strategies that promote meaningful learning, active participation of all learners, recognition of their knowledge and previous personal experiences, autonomy in their learning process and self control and collaboration among learners.

A number of assistive and adaptive devices such as Braille equipments, adapted science kits, hearing aids, communication aids, mobility aids, for transaction of curriculum contents as per the needs of the students. The pedagogical shift in science education should be based on giving respect and value to individual differences and providing opportunities for scientific exploration, manipulation, experimentation and discovery of scientific phenomena which ultimately enhance the personal development of every learner.

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