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SCIENCE TEXTBOOK: A TOOL TO PROMOTE CRITICAL THINKING AMONG LEARNERS

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Abstract:

Science instruction mostly, involves reading out textbooks to students (Holliday, 1981). Textbooks are frequently used by teachers and students and convey a great deal of information based on the curriculum in science lessons. There are a variety of researches in the literature reviews about textbooks due to the important teaching aids in the classroom. However, only few studies focused on implementation of Critical Thinking in textbooks. In order to meet today's needs in Science education, reforms in Science curriculum has been made by NCF 2005. This study aims to expose to what extent Critical Thinking included in the textbook and how it is congruent with curriculum. Textbook writers may get benefitted from the results of this study as it will be helpful in reading and interpreting the curriculum while writing the textbooks. It is evident that teachers rely heavily on textbooks to present the content that include in science lessons. Therefore, the textbook of science that are prescribed and are used for the students should be well illustrated with respect to "Critical Thinking". Thus, the study is an importance piece of research as it will lay emphasis in modern curricula on the development of Critical Thinking in science education.

Keywords: Education,critical thinking, textbook, science subject

CONCEPT OF EDUCATION

Education refers to any act or experience that features a formative effect on the mind, character, or physical ability of an individual. It is the method by which society deliberately transmits its accumulated knowledge, skills, and values from one generation to a different. It is

also a way to accumulate knowledge to reinforce one's ability to reason and make judgment. There is little question that education is that the most vital input and therefore the most potent instrument for the event of both the individual and also within the build up of the truly democratic society, within the promotion of national integration and unity, and in particular for the transformation of individual within the endless pursuit of excellence and perfection.

UNESCO (2010) has emphasized, "Education is a major catalyst for human development and rapid advances in education can help to achieve all of the Millenium Development Goals (MDGs). Education has potential to achieve these goals by realizing the sensitivity towards culture, environment, economy and changing needs of the global society." Further Nivedita (2010) elaborated another aspect of 21st century and wishes arising thanks to it as, "In this increasingly complex world, where differences need respects, mixture of culture needs understanding and acceptance, learning to live together needs international cooperation and exchange, the world should be seen as an educational laboratory that analyze the factors explaining educational needs, and the learning process will be enhanced." Thus, education should be seen as a mean of shaping the socio-economic and cultural force and determining the direction of growth (Roy and Singh, 1991). Further, it suggests that the curriculum inputs of education, should be reframed within the light of prevailing and future conditions in 21st century and instructional strategies should help in achieving sustainability and MDGs of the 21st century. As outcome of such reforms, skills should be developed that are essential to satisfy the requirements and to cope up with challenges of 21st century.

Report of the Education Commission proposed internal transformation of the educational system in order that it relates to the life, needs and aspirations of the nation. The belief of the country's aspirations involves changes within the knowledge, skills, interests and values of the people as an entire (Education Commission, 1966). Education has fundamental role in the development of citizenry. The goal of education is realization of all the chances of an individual not just for the self but also for the changing society. To teach people is to empower them.

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Consistent with Bloom's Taxonomy, indicators of empowerment are development of varied domains, namely, Cognitive, Affective, and Psychomotor. Education is a dynamic concept because it appears to be of a special nature from various angles. Gandhi had a holistic view of Education. In his words "By education I mean all round drawing out of the best in child – body, mind and soul." The event of social intelligence, emotional intelligence and physical aspect of personality are also as vital as the development of mental ability. Education is to understand all round development which may be done by developing capacities of human beings, such as, affective, psychomotor, health and environment and spiritual along side cognitive. Education cannot be considered in isolation or planned during a vacuum. It has to be used as a strong instrument of social, economic and political change which is important for all times.

But in the present era, education is more oriented for development of cognitive domain as compared to the affective domain and therefore the psychomotor domain. Even in developing cognitive domain plenty of information/knowledge is being loaded and ignoring the opposite aspects of cognitive development. So, there is a requirement of holistic education for developing all the three faculties and relating education with real world and environment. The education system should emphasize the event of fundamental social, moral and spiritual values. Pandya (2007) recommended seven spiritual qualities for an individual, namely, trust, ideals, honesty, ethics, discipline, regularity and commitment.

The NCF 2005, focuses more on the creativity and therefore the overall development of children, rather that filling their brains with information. It refers to the report entitled, Learning without Burden (1993), which highlighted the issues of curriculum overload, which made learning a source of stress for children during their formative years. NCF 2005 emphasizes four guiding principles for providing meaningful education (a) connecting knowledge inside the school to the experiences outside the school (b) the shift of learning from rote-learning to understanding (c) going beyond the prescribed curriculum and therefore the textbooks (d) making the examination system more flexible; hence; reaching bent every child with equality,

quality and quantity. Education should aim to create a commitment to democratic values of equality, justice, freedom, concern for others' well-being, secularism, respect for human dignity and rights. It should, also, aim at fostering independence of thought and action, sensitivity to others' well-being and feelings, learning to learn and unlearn, ability to work for developing a social temper and inculcate an aesthetic appreciation.

It states that the kids are often a lively participant within the construction of knowledge, which is facilitated by encouraging children to ask questions, relate what they are learning in school to things happening outside, encouraging them to answer from their own experiences and in their own words, instead of by memorizing. It recognizes the necessity to develop a non-threatening environment, since an environment of fear, discipline and stress is detrimental to learning. It emphasizes that gender, caste, class, religion and minority status or disability should not constrain participation in the experiences provided in school.

The NCF 2005 recommends significant changes in Language, Maths, Natural Science and Social Sciences, with a view to reducing stress and making education more relevant to the present day and future needs of children. It addresses the necessity for the plurality of material, takes under consideration teacher autonomy, discusses curriculum, including the library, textbooks, educational technology and goes beyond the understanding of the normal notions of discipline. It also covers problems with quality and therefore the need for academic planning for monitoring the standard.

In consonance with NCF 2005, Bihar state has developed its own curriculum framework referred to as Bihar State Curriculum Framework, BCF 2008. It states that society are often developed when the bulk of the member attend school level education. School could maximize the chance to transformation of knowledge during a systematic and proper way. BCF 2008 states that each child in school must learn well, without stress and has emphasized upon the following:

- Acquisition and understanding of knowledge, development of problem solving skills, investigation skills, logical thinking and to draw conclusions on the idea of experiments.
- Development of ability to succeed in generalizations and to use them for solving everyday problems.
- Development of ability to understand the inter-relationships of science and society.
- To foster creativity in people, enabling them to hold out innovations in science.

CRITICAL THINKING

Critical thinking is the intellectually disciplined process of actively and skillfully conceptualizing, applying, analyzing, synthesizing, and/or evaluating information gathered from, or generated by, observation, experience, reflection, reasoning, or communication, as a guide to belief and action. In its exemplary form, it is based on universal intellectual values that transcend subject matter divisions: clarity, accuracy, precision, consistency, relevance, sound evidence, good reasons, depth, breadth, and fairness.

Critical thinking can be seen as having two components: 1) a set of information and belief generating and processing skills, and 2) the habit, based on intellectual commitment, of using those skills to guide behavior. It is thus to be contrasted with: 1) the mere acquisition and retention of information alone, because it involves a particular way in which information is sought and treated; 2) the mere possession of a set of skills, because it involves the continual use of them; and 3) the mere use of those skills ("as an exercise") without acceptance of their results.

Critical thinking is self-guided, self-disciplined thinking which attempts to reason at the highest level of quality in a fair-minded way. People who think critically consistently attempt to live rationally, reasonably, empathically. They strive to diminish the power of their egocentric and sociocentric tendencies.They use the intellectual tools that critical thinking offers – concepts and principles that enable them to analyze, assess, and improve thinking.

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TEXTBOOK: AN EDUCATIONAL TOOL

Textbooks and blackboard are still common resources and material employed by maximum teachers. Overdependence of Science teachers on textbooks is well documented (Stake and Easly, 1978; Weiss, 1993). In their study, Stake and Easly (1978) found that 90 per cent teachers use textbooks or other instruction materials 90–95 per cent times in their classrooms.Due to lack of other facilities like, laboratory, equipment etc., the textbooks assume a central place within the teaching–learning process of science and dictate the curriculum followed by the teachers and students (Gottfried &Kyle , 1992; Chiappette Sethna &Fillman, 1993). This has been also the experience of Indian schools. It is evident from the status study of science education, Department of Science and Mathematics, NCERT (1999) that the science syllabi and textbooks are 90% alike in India. Textbook is an important and major educational tool for the scholars. In India, textbooks occupy most of the tutorial space in schools. They are not just teaching manuals, they shape the minds of youngsters in their youth, and have a profound influence on how young minds interpret reality. For this reason, the content of textbooks or instructional material may be a deeply contentious issue in several countries round the world. Indeed, questions of curriculum and textbooks are so contested because they are at the guts of debates over national identity, and over who will define and control what is worth knowing. This is often probably why during a country as diverse as ours the difficulty of textbooks may be a site of much contestation and conflicting interpretations. In one sense, the content of our textbooks may be a crucial disseminator of fundamental values of citizenship, values that we need like to pass on to the subsequent generation. Thus, the content of textbooks is of vital importance and features a significant impact on the tutorial development of scholars.

Guidelines developed by NCERT for preparation of textbooks

NCERT guidelines is employed by the Textbook Development Team and the Chief Advisors and eventually by the National Monitoring Committee to finalized the textbooks. It is these guidelines which are employed by the Review Committee also for the review of the

textbooks. The NCERT guidelines are of three types. Guiding principles of NCF 2005 are designed so that it can apply to all subjects.There are objectives which are used just for subjects in Sciences. Then there are objectives which are laid down for every of the textbooks in Science subjects.

1. **Guiding Principles of NCF 2005-**

The following guiding principles of NCF 2005 were kept in sight while preparing the textbooks for all subjects.

- Connecting knowledge to life outside the school,
- Ensuring that learning is shifted faraway from rote methods,
- Enriching the curriculum to supply for overall development of youngsters instead of remain textbook centric,
- Making more flexible and integrated examinations in classroom environment and,
- Nurturing an over-riding identity informed by caring concerns within the democratic polity of the country.

2. **Other Guidelines for the Preparation of Syllabus and Textbooks-**

- Resonance of the values enshrined within the constitution of India
- Sensitivity to gender, caste, and class parity, peace, health and therefore the needs of youngsters with disabilities,
- Infusion of environment related knowledge and workrelated attitude altogether subjects and in the least levels
- Linkages between school knowledge in several subjects and children's every day experience,
- Appropriateness of topics and themes for relevant stages of children's development and continuity from one level to subsequent,
- Inter-disciplinary and thematic linkages between topics listed for various school subjects, which fall into discrete disciplinary areas,

- Nurturing aesthetic sensibility and values by integrating the arts and India's heritage of craft altogether aspects of the curriculum.

3. Objectives for the Preparation of Textbook in Sciences-

- To understand the society within which they live – to find out how society is structured, managed, and governed, and also about the forces seeking to rework and redirect society in various ways.
- To appreciate the values enshrined within the Indian Constitution like justice, liberty, equality and fraternity and therefore the unity and integrity of the country and the building of a socialist, secular and democratic society.
- To get older as active, responsible, and reflective members of society.
- To learn to respect different types of opinion, lifestyle, and cultural practices.
- To question and examine perceived ideas, informations, institutions, and practices.
- To acquire joy and pleasure while reading, by providing them with enjoyable reading material and content.
- To undertake activities which will help them develop social and life skills and make them understand that these skills are important for social interaction.
- In textbooks and within the classroom, the content language, and pictures should be comprehensible, gender-sensitive, and important of social hierarchies and inequalities of all types.

Guidelines employed by the Committee to review the Materials and Visuals of the Textbook

The Review Committee reviewed the six textbooks keeping in sight the above mentioned guidelines and principles, namely guiding principles of National Curriculum Framework – 2005, objective of Teaching of Sciences at Secondary and Higher Secondary Stage. Further the subsequent criteria were also taken into consideration while reviewing the tutorial materials, consisting of both printed content and visual including the cartoons.

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Criteria to Review the Content of Textbooks

i. Convergence: While reviewing the textbooks the Committee examined whether the printed content or contents were in consonance with the illustrations.

ii. Clarification: The teachings were reviewed to ascertain whether the content both verbal and nonverbal and examples are intended to clarify the concepts and content. Whether there have been distortions in explanation and interpretation? Whether the illustrations, diagrams and pictures were relevant to "event specific or person specific."

iii. Sense of proportion in presentation: Balance in content, illustrations, visuals, cartoons and other visuals.

iv. Analytical and synthesis mode: Whether the content of the teachings focuses only on analysis or on synthesis also.

v. Positive and negative examples: Is there a balance between positive and negative examples – case studies, cartoons, visuals, collage etc.?

vi. Quality of illustration: Quality of the illustration was seen in terms of being eye-catching and stimulating the imagination

vii. Sensitivity: How sensitive are the cartoons and illustrations towards communities, castes, ethnicity, religions, women, language and other groups and minorities?

SCHOOL SUBJECT: A MEANS TO ACHIEVE EDUCATIONAL OBJECTIVES

School curriculum is a defined and prescribed course of studies, which students must fulfill in order to pass a certain level of education. It is designed in the form of separate subject areas or disciplines like Mathematics, Science, Languages, Social Science, Music etc.

All the school subjects assume that students must have the ability to engage in higher order thinking processes. For example, In Mathematics, students are expected not only to be able to learn the processes of Mathematics, but also have to be able to apply those processes in problems with which they are unfamiliar, that is they have not seen anything like them before. Science as a school subject is a systematic process of understanding nature and the dynamic

relationship between human and nature, and Science education aims to help learners understand this process by acquiring certain types of knowledge, skills and thinking abilities. "What is the basic goal of Science education" is always the beginning point of educational inquiry. Engagement with this question also necessitates exploring "what is Science all about". Science is an evolving and expanding body of knowledge derived from many investigations. The point that needs to be emphasized is that it is not just a body of knowledge, but also comprises a set of methods and practices that lead to knowledge generation. Inquiry-based and problem-solving approaches form the heart of all scientific methods. It is about relating theories to the evidence using the body of scientific knowledge and practices, critically evaluating and challenging existing theories, and/or modifying them as per evidence. Senior Science as a subject requires a student to gain knowledge, develop scientific processes, and display complex reasoning. This is far beyond the knowledge of scientific facts. The objectives of the science continue to encourage the development of these skills and promote the students' development of critical attitudes concerning the impact and limitation of science, being concerned for the wise application of science, its ethical use, being open-minded and critically respectful of data and being skeptical, and willing to shift in the face of evidence.

In the context of 21st century, Hurd's two major aims of Science education, knowledge and enterprise can be best articulated as:

- to impart knowledge, abilities and values that enable students to work in a specific local context, and
- to develop scientific attitude and temper that promotes thinking in a global perspective (Hurd, 1960). Fulfillment of these aims is crucial for sustainable growth and development of societies.

The nature of Science is neither universal nor stable (Lederman, 1992) and the same holds true for the aims of Science education. Evolution of scientific knowledge is most often driven by societal (or global), economic, political and cultural forces. With increasing role of

Science and technology in everyday life, questions like "what is it that children should know?", "why they should know", and "how they should acquire and utilize their knowledge for individual and social well-being" are gaining much attention of social scientists. In knowledge-and-intelligence-based-economies, Science education aims to enable and empower young minds solve problems of day-to-day life in a logical and meaningful manner; to promote well-being of individual(s) and societies. It is strongly believed that scientifically aware and literate citizens have the potential to bring about societal transformation. Engagement of students with scientifically-oriented questions is the most essential component of scientific inquiry and asking questions have been considered as the first and the most important scientific process in the Science framework for K-12 education by the National Research Council, US (NRC, 2012). At the same time, Science teaching must ensure to cultivate and sustain the joy, wonder and motivation of learning (NCERT, 2005).

Scientific inquiry has always been placed a significance in education policies. The Education Commission, 1964 highlighted the need for developing a spirit of scientific inquiry among students (NCERT, 1971). In 1976, spirit of scientific inquiry, temper and humanism was included in the Constitution as fundamental duties of all citizens. It was also endorsed by the Programme of Action (1992) for the National Policy of Education, 1986 (MHRD, 1992). The Position Paper by the national focus group on teaching of Science (NCERT, 2006) also emphasized the need for inculcating scientific inquiry and temper among school children and stressed on a student-centric teaching learning process.

The Position Paper has stressed that aims of Science education should follow directly from the six criteria of validity for the curriculum, viz. cognitive validity, content validity, process validity, historical validity, environmental validity and ethical validity; with an emphasis on developing scientific temper (NCERT, 2006). Use of scientific methods, inquiry and problem-solving approaches of learning in secondary stage Science classrooms have been explicitly recommended by the focus group (NCERT, 2006). Acknowledging the challenges and

issues in achieving these aims, the Position Paper recommended major infrastructural and qualitative changes in Science teaching, so that the classroom practices are in sync with the notion of "learning to learn", "nurturing curiosity and creativity" and "building scientific temper".

Memorizing the content given in textbooks, in order to help students, score better in examinations neither relates to the nature of Science nor to the aims of Science education. Science is also not about reproducing the steps of an experiment, as emerged during the investigation. Highly-structured experimentation techniques enlightens the facts on thinking skills and scientific attitude.

Classroom practices are one of the strongest indicators of teachers' understanding about "Aims of Science Education" as well as "how do students learn Science?" Traditional education system with closed classrooms discourages the natural inquisitiveness to question and as students grow in age and grades, they pose less questions. The teaching practices promote listening and reproducing instead of observing, questioning and exploring. Reasons might be manifold, but it is very clear that students are getting minimal chances of knowledge construction, through scientific methods. Dominance of rote learning methods encourages the students to receive and reproduce the information without any processing, and thus restricting their creativity and problem-solving abilities. The scene does not seem to have changed over decades. It was further found that 25 per cent teachers adopt teaching-learning methods that provide students opportunities to use their basic instinct to observe and explore. In such circumstances, focus of the project revolves only around the end product and process aspect part remains ignored. They fail to engage students in thinking and/or working in a scientist-like manner. Findings indicated very limited use of scientific methods and inquiry learning in the classrooms. Most crucial consequence of such practices is that students start visualizing Science as a source of knowledge. There is ample evidence that students hardly get any opportunity of asking questions; formulating hypothesis; testing to validate them; and, communicating their findings. Learning

Science requires students to engage in a scientist-like manner within and outside the classroom; and most involve observation, imagination, hypothesis and reasoning. There is a need to develop a culture promoting discovery of new knowledge that marks a significant shift from the existing trend to transfer established knowledge.

When students are encouraged to construct their own knowledge and understand the relevance of Science in their coursework and life, their attitude towards Science improves (Novak, 1988). The National Knowledge Commission has expressed concerns over a talent crunch in Science, with the economic growth (NKC, 2009). There is an urgent need to reduce information-transfer and shift towards meaningful methods of learning Science. The Report to Nation (NKC, 2009) has recommended systemic change in Science pedagogy at all levels of school education, and has emphasized the need to revisit curriculum to make it more interesting and engaging for students. Curriculum, teaching-learning and assessment are considered as the three integral components of education, so a systematic approach integrating all components is desirable to achieve the required changes in the education system. Irrespective of class levels, standards should explicitly state what is it that "students should know, can do and think". Standards (or content standards) and performance expectations (or performance standards) need to be articulated with underlying principles that (a) students cannot properly understand scientific concepts without engaging in the scientific processes, and (b) they can demonstrate competence in scientific practices in the context of specific content.

By the time reaching the secondary education stage, children acquire sufficient knowledge base, experience, language abilities, and maturity to experience knowledge in their full sense: concepts, structure of body, to investigate, and to validate. Therefore, the science subjects could be more closely linked with the HOTS and there is a need to focus on the development of high order thinking skills (HOTS) among the students, then only the aims and objectives of teaching science can be achieved.

CONCLUSION

Education that inculcates a critical faculty and a stress on reasoning is by its very nature secular education. There is some evidence that teachers rely heavily on textbooks to present the content andCritical Thinking aspects that they include in their science lessons. Therefore, textbook writers may give enough importance to the Critical Thinking aspects of science in their textbooks. Moreover, the aim and values of education are often realized only whenCritical Thinking are reflected in science that forms a part of the school curriculum.Critical Thinking are often realized within the school curriculum through some activities, programs and instructional materials, of which text book forms a crucial factor.

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