

## **Paradigm shift in Pedagogy: need of the hour to achieve the Curriculum Expectation in Science Education**

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### **Abstract**

*The demand of the society and human being is changing and increasing. This changing and increasing demands are being facilitated by development of science and technology. Life has become smoother with the development in the field of science and technology. These have a major impact on any nation's economy and hence its power. So the impact of science on society, economics and politics cannot be ignored at all. The broader goal of science education is not to make scientist only rather making the people scientifically literate so that they can face the world with logical mind. Therefore the importance of science education is high. According to Kola (2013), "Science education deals with sharing of science content and process with individuals who are not considered traditionally to be member of the scientific community.." Knowledge of science provides unique training in observation and reasoning. It makes one systematic and enables him or her to form an objective judgment. Science education helps to understand the environment around us in a right way. In this changing society and environment a paradigm shift in the process of science education is much needed thing. The curriculum expectations are not same as it were even twenty years ago. So fixing the curriculum expectations at different level and grade is the present requirement in science education. During fixing the curriculum expectations and thereby the process of science education it is important to incorporate the new developments of pedagogical science and it is important to remember that science should be treated more as process than product along with linking to application to daily life, environment, society, economy and vocation. To make it success different stakeholders have to play a crucial role, specifically the teachers.*

**Keywords:** science education, pedagogy, curriculum expectation, science activities

### **Introduction**

We are living in a world where we cannot think about life without the science and technology. In each and every step we use technology e.g. the water system in our house, the electric, television, air conditioner, refrigerator, telecommunication, internet, mobile phone, smart phone and other different kind of electric gadgets. We can go to Delhi from Raiganj (It is the headquarters of the district, Uttar Dinajpur, West Bengal) within a day by taking a car from Raiganj to Bagdogra (Siliguri) and then from Bagdogra to Delhi by flight. In each case we are using the advancement of science and technology. We cannot think about life without these things. It helps our life easier than before. Just think, now a day one can apply for a job within some minutes by submitting the form online through internet. One can buy anything; it may be grocery, garments, electronics and even medicine online. Online market has become a huge success and a real challenge to the off line market. Somebody do not need to go to market for recharging his phone number. It can be done by various e-payments. Somebody does not need to go out for buying bus, rail or plane ticket. It can be done by sitting in home and taking tea within some minutes. This is the blessing of science and technology. We cannot ignore the development of science and technology as it plays a major role in economy. There are some nations which are considered as developed nations. What is the basis of such consideration? The answer is development and advancement in science. Those nations are known as developed nations because they have utilized the science. Most of the scientists who have received the Nobel Prize are belong to these nations or have worked in these nations. Most of the headquarters of world's leading companies are situated in these countries whether it is car, aircraft, software or social networking website. The students of the country like India eagerly wait for getting the opportunity for Ph.D. or post doctorate in these countries. It is an open truth that development and advancement in science and technology is proportionally related to the economical growth of the nation. These economically developed countries are funding more in research, using more advance techniques and hence getting more quality works which directly or indirectly plays a major role in the development of the country. There is the importance of science. It not only eases our life but also plays a pivotal role in growth of a country. In the present context we know it very well that more economically strong means more power in hand. So thereby we even cannot ignore the political aspect of science.

Like every discipline science is also originated from philosophy. It took its shape gradually. We start learning something when we understand the importance of it. The same is true for science. People started to take science seriously when they got the result of it. Hence in 18<sup>th</sup> century science became gradually an independent discipline (*Horacio Capel, 2015*). The knowledge related to science was becoming famed as people started to get the direct benefit of it with invention of different technology useful for mankind.

The journey of natural science as part of school education was started with inclusion of physics in curriculum at 1837 followed by chemistry, botany and geology in 1859 in Rugby Public School of England (Paul and Dhar, 2013). From then steadily science as a part of formal education was getting importance and being shaped. At that time the decision of Oxford and Cambridge University to make natural science as separate discipline expedited to inclusion of science as part of education.

### **What is Science?**

Science is such a discipline which cannot be defined in a single sentence. It is rather easy to experience the scientific phenomena than define it. Science has different aspects, various dimension and nature.

According to Fitzpatrick, “Science is a cumulative and endless series of empirical observations which result in the formation of concepts and theories, with both concepts and theories being subject to modification in the light of further empirical observations. Science is both, a body of knowledge and the process of acquiring and refining knowledge” (Naseema, 2012). Conant defined science as, “An interconnected series of concepts and conceptual schemes that have developed as result of further experimentation and observation and are fruitful of further experimentation and observation” (Mohan, 2013). From analysing the above two definitions it can be said that science consists of two things: a body of knowledge and the process by which that knowledge is produced. This second component of science furthers another nature of science i.e. it provides a way of thinking and knowing about the world (Carpi and Egger, 2013).

### **Science Education**

According to Kola (2013), “Science education deals with sharing of science content and process with individuals who are not considered traditionally to be member of the scientific community; the individuals could be students, farmers, market women or a whole community.”

Thus a good science education program focuses on helping all students gain a solid foundation of core science knowledge and skills and must be oriented to meet the challenge of today's generation by promoting scientific knowledge and attitudes. Science education helps in developing an understanding and appreciation of the fundamental principles of the natural and physical phenomena (Secondary Education Commission, 1952-53). It can be said that science education deals with what is happening, how it is happening, why it is happening. It encourages one's creative, logical, spatial, critical thinking. It is worth to mention that as science is related with human's daily life so it is needed to study science for making our life smoother. Hence there require science education for systematic study of science as the modern civilization is a scientific civilization and science has become an integral part of our life and living. A good science education program focuses on helping all students gain a solid foundation of core science knowledge and skills. What is essential for a good science education program is: clear and specific learning goals for all students; textbooks and tests that are carefully aligned to those goals. This view only emphasizes on the only one dimension of science i.e. a body of knowledge. It is a narrow view. In modern days science education is not about providing students with the scientific knowledge only rather it is more focused on giving the students the knowledge of scientific process i.e how that knowledge comes. It is more focused on the method of enquiry and the way of investigation i.e. focused on what scientists do rather what scientists found. On year wise analyzing different National Curriculum for Science of England it was found that these days they are giving more importance on developing the skills and attributes of a scientist among pupils rather giving only key scientific facts. These skills and attributes include observational and measuring skills, the abilities to select and use resources, analyze data, spot patterns if they exist and then communicate their findings to other effectively (Kerfoot, 2009).

In Indian context science education has various dimensions and attributes which is clearly mentioned in Position Paper on Teaching of Science, NCERT (2006). It remarked that, "Good science education is true to the child, true to life and true to science." This has a very depth meaning as it is pointing out different basic criteria of validity of science education. The content, process of teaching should be according to the age of the students and their cognitive ability. It should encourage the students for acquiring the scientific method through sensitizing their natural curiosity and creativity. That means nature of science education should not be

informative rather engaging them in learning through activity and providing opportunity to construct their own knowledge.

### **Importance of Science Education:**

As the human mankind lives in world of scientific discoveries they cannot neglect the importance of science. They have to know science behind the natural phenomena. Through science education the future generation can be prepared for living and understanding the scientific endeavor. Science has practical value. Through science education child can be trained to use his/her leisure properly. According to Prakash, J. (n.d.), “Understanding of the methods of observation and experiment in science helps pupils to develop a logical mind, a critical judgment and a capacity for methodical organization.” Knowledge of science provides unique training in observation and reasoning. It makes one systematic and enables him or her to form an objective judgment. Science education helps to understand the environment around us in a right way. Development of these characteristics in the future citizen further helps in the development of the nation and society. Thus one of the importances of science education that is helps to make student good citizen. Improvement in the area of science and technology will not be possible without science education; for instance subjects like engineering, medicine, architecture etc would not be developed if there is no one to teach the students the core subjects needed for these courses (Chukwuma, R., 2015). Without the proper science education development of information and communication technology would not be possible.

### **Science Education in India**

History of science education in India has a very deep root. Taxila (6th century BC) was one of the universities at the ancient time where many students from across the world used to come for study. The modern era of science education started at the time of British rule and so influenced by western education system. But the science education was provided at that time lacking of objectives and British used it for their own benefit. Science education did not reach the masses which one of the main reason of backwardness of our nation in science and technology at time of British era. There was no option for further research or study and the science graduate had to take clerical or teaching as job. The status of science and science education at time of British rule can be understood from the speech of Professor Abdus Salam, a Nobel Laureate in Physics. He said in a lecture delivered on Sept. 23, 1975 at the University of

Stockholm, “The next hundred years of India’s history were a chronicle of a more subtly benevolent exploitation . . . I was brought up as a young man in British India. The British set up something like 31 liberal High Schools and Art Colleges in what is now Pakistan, but for a population then approaching 40 million people just one College of Engineering and one College of Agriculture. The result of these policies could have been foreseen. The chemical revolution of fertilizers and pesticides in agriculture touched us not. The manufacturing crafts went into complete oblivion. Even a steel plough had to be imported from England.”

After independence it was realized by first Prime Minister Mr. Nehru that without the development science economical growth of nation cannot be up to the mark. Once he said (Subramaniam, 1982), “It is science alone that can solve the problem of hunger and poverty, of insanitation and illiteracy, of superstition and deadening custom and traditions, of vast resources running to waste, of a rich country inhabited by starving people. Who indeed can afford to ignore science today? At every turn we have seeks its aid. The future belongs to science and those who make friends with science.”

### **Development of science education in Independent India**

The report of secondary education commission (1952-53) played a pivotal role in spreading science education in independent India. It recommended making general science as compulsory subject up to secondary. But before 1975 there was no uniform pattern of education in India. At that time science was a compulsory subject as part of general education up to class VII or VIII. It was taught as general science but at secondary stage science was an optional subject, which was offered either as combination of physical science and biology or as physics, chemistry and biology. At that time the syllabus and textbooks of science were prescribed by respective state agencies thus the content and process both varied from one state to another. The Education Commission (1964-66) is the important landmark in the history of education in India. This was the first commission about education after the independence to evaluate and reform the total education system from primary to higher education. On the basis of the recommendation of Education Commission 10+2+3 pattern of education was introduced uniformly in whole nation. Here we should remember that 1976 was year when responsibility of education shifted to concurrent list from that of state. Education Commission recommended all subjects including science and mathematics were to be compulsory for all students up to class X as a part of general

education. At primary stage science and social science would be taught as a single subject that was 'Environmental Science'. Science was to be considered as one composite subject at upper primary and secondary level. The commission observed that "The quality of science teaching has also to be raised considerably so as to achieve its proper objectives and purposes, namely, to promote an ever deepening understanding of basic principles, to develop problem-solving and analytical skills and the ability to apply them to the problems of the material environment and social living, and to promote the spirit of enquiry and experimentation. Only then can a scientific outlook become part of our way of life and culture." It further recommended that the science curriculum should be flexible so that science teaching in rural areas and urban areas would be based on agriculture and technology respectively. The next happening thing in the history of education in India is National Policy on Education (NPE-1986). On the basis of which 'National Curriculum for Elementary and Secondary Education – A frame-Work' (NCF-88) was developed. The guidelines provided by the NCF-88 were further elaborated in a brochure titled 'Science Education for First Ten Years of Schooling – Guideline for Upper Primary and Secondary classes'. Major modification we got here for first time science was treated as single subject at secondary test rather than three separate disciplines like in the past. Then 'National Curriculum Framework for School Education – 2000 comes. Its important recommendation are teaching of environmental studies as a single subject of study at the primary stage instead of environmental studies (science) and environmental studies (social studies), teaching of 'Science and Technology' in place of 'Science' at the upper primary and secondary stages. Then comes another revolutionary work in Indian education system i.e. National Curriculum Framework 2005 (NCF-2005). About science education NCF-2005 observation is "Good science education is true to the child, true to life and true to science." That is it should have certain validity such as cognitive validity, content validity, historical validity, environmental validity, ethical validity.

### **Curriculum Expectation in Science Education**

Curriculum Expectation defines what each child should know, be able to do and the disposition that should be acquired over a period of time. These are not to be assessed class wise but need to be achieved by the end of a particular stage as these are long term targets of the curriculum expressed in terms of abilities, attitudes, values etc. What our students are expected to learn from the curriculum is known as Curriculum expectation. So what our students are expected to learn from science curriculum is known as curriculum expectation in science education.

Now the question is whether we are able to achieve those expectations. Different reports suggest that we are far away from that. Wipro EI Quality Education Study 2011 reported that even the students of top elite schools exhibit rote learning. The performance of such top schools was lower than that of international average (*source: <http://www.ei-india.com/quality-education-studies/>*). They are only good on such questions which required straight answers only because of rote learning. Recently Bharat Ratna recipient C.N.R. Rao (2014) commented on an occasion that “Science we teach in schools and colleges is no longer the science we actually do in advanced laboratories. What we teach is most boring. The science which is taught is completely outdated.”

### **Need of the hour: paradigm shift in pedagogy**

The reports of various studies and comments of eminent personalities clearly show that we are far behind in achieving the curriculum expectations. For achieving such goals, one of the basic requirements is to change the pedagogy, i.e. the way we teach science in the classroom. In most cases, it is authoritative. The lecture method is followed to teach science. Students are not getting the freedom in class to ask questions. Science education is not all about sharing factual information only. We need to understand that teaching science is not only about imparting some information. It is about acquiring the skill and understanding the processes and methods that lead to the generation and validation of scientific knowledge (National Curriculum Framework, 2005). It is about making the students curious, nurturing their creativity and generating an aesthetic sense. It is about cultivating scientific attitude, objectivity, critical thinking and freedom from fear and prejudice. It is about making them understand what they learn has a connection with their life and society where they live. For achieving such expectations, we need to change the way of teaching science and activities. We need to incorporate more student-centric approaches like project method, problem-solving approach. Students should get the chance to do hands-on experiments and activities to verify the theoretical knowledge. The teacher should encourage them in making various models, small machines and gadgets. Students should be encouraged to inquire. The role of the teacher should not be autocratic but democratic. They should know giving freedom means not losing their control over the class. Students should be provided the chance to construct their own knowledge. Teachers should take the help of new technology like ICT. The internet provides a vast platform of knowledge. The teacher and the student should utilize that. Like, they can discuss, take help of professionals through the internet. There are many websites and blogs related to science education.



Various software and mobile app are available which the teacher can use. They can show such experiment through ICT which they not able to show in reality due to economic and environmental constraint. The student can be encouraged to read the science magazine and article. This will open up vast area of science. They will come to know what is going on around the world which definitely encourages them towards science. These curricular aspects will not be fulfilling unless there is a place for co-curricular activities. Co-curricular activities always help to achieve curricular expectation. Therefore school should have an active science club. The science club may organize different kind of program throughout the year like debate, quiz, demonstration of scientific experiments, science exhibition. The teacher should get full autonomy for arranging, managing such activities and financial support from school. Students should be encouraged to take investigative science projects, develop innovative science model and small machine or gadget. They should be encouraged to participate in science exhibition, fair and science model competitions. Local resource person (scientist, professor, farmer, mechanic, electrician etc) can be invited for lecture or demonstration or simply sharing his experience to motivate the students. This will also provide them the knowledge of different vocations. Students should be encouraged to participate at local/state/national level activities like the Children's Science Congress.

### **Conclusions**

Achieving the curriculum expectations will be remain hypothetical if the teachers are not able to understand the importance of that. Teacher is the most important factor in any teaching learning activities. They should be motivated. It may be intrinsic or extrinsic. The stakeholders should play a supportive role. Teacher should not be involved in any other work except teaching. They should get the autonomy otherwise how can they think about doing new things. Many schools not pay handsome salary which again a de motivating factor. They should be provided time to attend the workshop related to science. The workshop should be designed with giving emphasis to modern techniques of teaching science. Teacher education program should be in accordance to the school education program. That means if there any change in school curriculum that should be reflected in teacher education program. The teacher education program should incorporate more practicum aspect than theory. Last but not the least, all the stakeholders should change their mentality first otherwise it is not possible to change the scenario. Everybody should feel that, *“Good science education is true to the child, true to life and true to science.” – NCF 2005.*

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