Historical Discourse of Science in India

Colonial Reflections on Present Education System

Shweta Tanwar*

Abstract

The pervasive impact of colonisation on today's education system can be seen through many lenses. Navigating through the journey of science in India during colonial rule, the paper tries to explore the impact of western ideology on the education system of India in contemporary times. The present education system, specifically science education grapples with many issues and challenges that emerged from colonial times. Some problems which require attention in regard to the above discussion are being explored and discussed in the paper.

Keywords: *Science education, colonisation, history of science*

Introduction

Focusing on the historical discourse of science in India, particularly the colonial period, the paper attempts to develop a theoretical perspective. Reflections of colonised actions on the relationship that science acquired with the Indian education system, has also been dealt within this paper. For better understanding of the scenario, the paper is split across two parts. The first part outlines the journey of science in India during the colonial rule along with the impact of western ideology on the education system of India. The latter part focuses on the reflections of colonial ideology in today's education, specifically with science as the central theme.

Historical Discourse of Science in India: Impact of Colonisation

Science is an enterprise that works not in isolation but in the context of social, economic and political activity of a nation and hence, its historical discourse can be studied in the backdrop of these factors. As put by Arnold (2000), science is "a highly social activity…that cannot be sealed off from the values of the society in which it is practiced" (p.1).

**Assistant Professor,* Department of Gender Studies, NIE, NCERT

Apart from its history worldwide, science also has a historical background with respect to India, which was once a British colony. Kumar, D. (1980) explored the journey of science in India during the colonial time and pointed out the social dimension of science rather than being a simple product of experiments. Arnold (2000) also mentioned that science carries with it a social character and cultural plurality which makes it necessary to look at its history with respect to a particular region. Moreover, the culture of a region shapes the discourse of science according to its requirements or necessity.

Initially, it was Europeans who brought modern science to India (Kochhar, 1992). Their scientific activity was mainly motivated by commerce and curiosity but with the advent of British rule, it came as a means of empire building and institutionalisation. As noted by Kochhar (1999), science played an immense role in building the British Empire. It helped in understanding the physical means of acquiring land and thus, its control.

Moreover, the development of modern science gave the British a sense of superiority providing the legitimisation of colonial rule. The introduction of western science in India took place in three stages, namely colonial tool, peripheral native and Indian response stage according to the model proposed by Kochhar (1992). The colonial tool stage displays the introduction of science by the British as an imperialist tool. During the peripheral native stage, which began when British rule was firmly established, the natives were given the role of cheap labour to colonial science enterprises. The Indian response stage witnessed Indian natives, desire to exercise scientific activities freely and independently.

The Colonial Tool Stage

The colonial tool stage signified the introduction of geography as it helped in the survey of lands, navigation, revenue and proper administration. The British were not interested in science as such but were using it for their own interests. There was a self-proclaimed sense of superiority among the British with the thought that they can give nothing to the Indians but their superior knowledge (Kumar, D. 1982; Arnold, 2000). Kumar disagreed with the historian George Basalla on consideration of India as a non-scientific society. He reasoned that no society can be called as non-scientific, as every society has some scientific tradition which might be crude in form. Arnold also mentioned that India had a well-established scientific and technological tradition of its own much before the intrusion of European colonial rule. As mentioned by Kumar, D. (1983), the first stage highlights the role played by science in establishing and maintaining British political advancement over India. The rulers developed and skilfully

employed the 'ideology of science', which dealt with the attitudes of a certain class or group towards science, especially in promoting its own interests or otherwise. This ideology was best exemplified by the Geological Survey of India which signified the use of science for colonial purposes. The evolution of colonial science came into being for the first time when a committee was formed for the investigation of coal and mineral resources of India. It was mainly done with the aim of linking science with imperialism specifically with the help of the Geological Survey of India (Kumar, D. 1982).

The Peripheral Native Stage

Science was completely dependent on the state and was largely driven by profit, aiming at the full exploitation of raw materials and resources at minimum cost (Kumar, D. 1980). But the British company had a clear policy of exploiting the resources to the fullest without leaving any impression of science on the Indian soil. The company also adopted secretive policies as it never wanted to spread the knowledge of science within India. The British policies as mentioned by Kochhar (1993), necessitated science in establishing its power over India, which required Indians to understand the lay of land, without which it was impossible to explore the resources. Although the use of natives was economical, the company was not in favour of their education, viewing it as risky. The reason was that, in making Europeans knowledgeable, Indians could become more knowledgeable or may give the information to other rivals like French or Dutch.

The Indian Response Stage

With time, most of the Indian men started emphasising that they are no less than their English brothers (Kochhar, 1999). This sparked the desire in Indians to have improved status through cultivation of physical sciences. As a result, the scientific departments were allotted to natives depending upon their family, social position and achievements. This led to the beginning of the second stage, where Indians were restricted to lower and middle posts only. Higher education was introduced among selected Indians only rather than removing mass illiteracy. Very few got the chance to enter the scientific field though in a superficial manner. Great Indian achievers were not given the actual position, which they deserved as advancement given to few Indians could have provided a spark to others as well, who might wish to do better (Kumar, D. 1982). Also, Indians were not allowed to reach higher positions in scientific hierarchy as it is evident that despite having great achievements in science, Indian natives like P.N. Bose, Radhanath Sikdar were excluded from participation in government scientific undertakings. Officers like Medlicott were not in favour of including Indians in higher government positions,

as they believed that Indians were incapable of original work, suitable only for lower ranks, and viewed them as cheap labour. Natives assumed that a better system of education in various branches of science might work in favour of Indians. As a result, the company did put emphasis on mathematics but still ignored sciences because mathematics did not pose any threat to the British policies and fit well with imperialism. Excessive control of the government over scientific undertakings hindered the development of western science in India.

Overall, there was a total neglect of pure or theoretical research in India under the British rule. These instances created a feeling of suppression among those, who were not allowed to work properly in their respective fields. This discrimination against Indians made them retaliate in opposition which led to the beginning of the last phase of development of science in India. Local people tried to establish their self-reliance in scientific matters as education provided by the British was inadequate. The third phase, namely, Indian response to modern science, started initiatives, such as industrial art society where Indians could learn practical skills. Nevertheless, such efforts were very few and ineffective. J.N. Tata pioneered Indian initiative in technical education with the establishment of the Indian Institute of Sciences at Bangalore. After the initiatives of J.C. Bose, Ramanujan and P. C. Ray, Indians pursued pure scientific research themselves and carried Indian pure science to a golden period during 1920–1930. Kumar, D. (1982) summarised some features of the British policy that emerged out of all these issues in three distinctions. Firstly, the promises made were huge but implementation was far from reality. Further, the much existent thought of racial superiority among Europeans hampered participation of Indians in any scientific endeavour. Lastly, officers had conflicting opinions about Indians. This situation of conflict mostly went in favour of those, who were doubtful of the capabilities of Indians. According to Kumar, D. (1983), much could be done by the government of India but no attention was paid to inculcate scientific temper among the Indians through the education system. Though the inclusion of science in British India was mentioned in the Charter Act of 1813 but the confusion about the system to be preferred, delayed the entry of science in India. On the contrary, the British recommended that already existing science professorship must be discontinued.

Major Impacts on Science Education Emerged During The Colonial Period

During the colonial time, research in science was not preferred in a curiosity-oriented manner but as result-oriented research only, which catered to the class of manufacturers.

Pure science did not fit in the policies of the company but at the same time, there was a need for a system where workers were required to serve as assistants, surveyors, mechanics, etc. There was a controversy whether pure science was to be emphasised or not. Consequently, physical science was removed from the list of necessary subjects at the university level education. Much popular, Woods Dispatch also ignored scientific education and research in India.

All the policies left a long-term impact on science education in India. Kumar, D. (1984) pointed out five major problems that affected development of science education at higher levels. Firstly, the government aimed primarily at character-building. Therefore, general education was prioritised, as the introduction of science and original research was considered a premature step. Secondly, much less emphasis was put on laboratory work, which is an essential requisite for studying science. Thirdly, the shortage of funds posed another problem for advancement of science. Fourth problem was the formulation of suitable curriculum and medium of instruction. Since it was limited to the English language, the lower classes could not get access to science. Finally, there was a problem in administration and management, with no clarity regarding which college fell under which department or affiliation. The time when Europe reached a professional stage in science, India was nowhere with some exceptions like J.C. Bose and P.C. Ray. Kadambini Ganguly also emerged as the first female Indian physician to graduate and practice western medicine in India during the nineteenth century. Her entry into the formal medical education and the medical profession was no small feat, as she created a space for herself in a field traditionally dominated by men, both in India and the west. Another Indian woman, Anandi Gopal Joshee, also contributed significantly in the field of medicine despite facing fundamental structural barriers in pursuing medicine and became one of the first female doctors in the Indian subcontinent.

When the matter of education got extended to the masses, the colonial powers had to educate them in exact forms of knowledge which is the wests' scientific tradition to overcome its enemies (Kumar, K. 2014). Indian minds were considered as driven more by passion than reason. Therefore, it was justified with a reason that ignorance among Indian minds can be removed with the help of scientific reasoning and rationality. So, it was assumed that when a child is exposed to a curriculum, they will not accept anything that is not based on facts and reason. But children found it difficult to unlearn whatever they had learnt through their surroundings and social environment. This led to the emergence of a positive self-image among Indians, where they appreciated their own knowledge

systems and cultural roots. Overall conflict between curriculum and culture was and still continues to exist in the education system leaving people in a confused state even after achieving scientific education which disregards any orthodox practice. Science education was introduced as a means to enlighten the ignorant masses but the actual reality was to introduce the English language through science as it can be imparted through that language easily. Kumar, D (2013) also mentioned the fact that English is the language of the scientific world which is required at higher education and publication of research which cannot be denied.

The next section relates the history of science, specifically colonial time with the present situation of science education at school level, highlighting the loopholes of the education system which does not allow science to blossom in a full-fledged manner.

Present Scenario of Science in India: Reflection of Colonisation

The present section highlights the pervasiveness of colonial ideology on the education system of India in the present scenario. The machinery introduced by colonial rule in India continues to persist creating a state of confusion between India's own knowledge domain and western ideas. Knowledge systems are tools of domination and science is one of those systems. It stands apart from other systems due to its domination over both nature and people, irrespective of the culture and ethnicity. It is the colonial experience of India that helped in the formation of its attitude towards science after independence.

When it comes to people's attitude towards science, India can be seen as having mixed attitudes, i.e., of acceptance as well as rejection. The effect of colonial education according to Kumar, K. (2014) can be seen in both ways as some natives were socialised into colonial values, whereas others went against it. Many studies done so far in this context, focus on understanding the impact of modern science on traditional Indian society. But Raina and Habib (2004) emphasised the need to shift the focus. The authors pointed out the modes of percolation of science into the cultural and socio-political matrix of nineteenth century India with the focus to see how recipient culture perceived science and located it within the framework of social transformation of its own society. It thus, points out to a quality of science, i.e., of dynamism that leads to social conflict and struggles in a society. Raina and Habib (2004) also emphasised on the erosion of indigenous knowledge which is not to be blamed on tenets of scientific method but on the colonial encounter of traditional norms of the Indian society. Samuel Lobb, British personnel, reasoned that "scientific modes of thought were not in consonance with Indians' way of thinking and its characteristics"

(Raina and Habib, 1989). Therefore, the role and function that science acquired in India were partly derived and partly adapted to meet indigenous requirements, resulting in a state of confusion. The impact of such confusion is extended to the education system as well. J.C. Bose expressed concern over the science curriculum in Indian universities, since vast areas of important topics were excluded. Too many textbooks became a source of confusion rather than of help to the students. Along with the defective curriculum, the medium of instruction was a foreign language which had the capability to kill the originality of the thoughts of natives.

The incongruence between culture and curriculum thus, resulted in a complete dissociation between school knowledge and everyday life of the Indian children and reality that surrounds them. Sabareesh and Reeta (2022) emphasised that science had been used as a tool of subjugation in India during colonial times and had impacted the societal structures and education as one of the most affected ones. The result of such deviated focus and use of science only for subjugation rather than for the betterment of the people and improvement of the education system, led to the deterioration of science and its development. Kumar, K. (2014) studied the present situation in schools and revealed that knowledge, i.e., what is to be taught in schools is a result of cultural and economic stress created by colonial rule. Only whatever a superior outsider considered valuable was included in the school curriculum, while the knowledge possessed by the natives was considered inappropriate. Some problems that require attention in the context of the above discussion include the discontinuity between a child's exposure at home and school, the teacher's role in the process of learning, the pedagogy adopted by most schools, and the language used in the transmission of knowledge and the structure of the syllabus. These issues are examined with a focus on science education at the school level.

Incongruence Between School Knowledge and the Daily Life of a Child

The pervasive impact of colonisation on today's education system can be seen through many lenses. First is the discontinuity of knowledge attained in school with knowledge gained outside school. An ethnographic study by Sarangapani (2003) highlighted the gap between home and school. The author, while trying to help students connect school knowledge with the world outside, noticed a surprise and disbelief among students as if there is no possibility of this to happen. This could be attributed to the lacunae of both curriculum and pedagogy which keep students' life distant from school knowledge. Knowledge attained in school is portrayed as the only superior knowledge, considering everything else as invalid. Everyday knowledge is

negated and regarded as illegitimate, deemed irrelevant to the context of school. There is no feeling of enjoyment, rather, it is like a burden to them resulting in memorisation of facts to pass the exams. This leads to superficial learning, resulting in inefficiency of students to apply the school knowledge in daily life. Kumar, K. (2014) highlighted that despite the emphasis put by many educational policies on making syllabus and textbooks relevant to the lives of learners, the gap between an Indian child's life at school and home still exists. There is no bridge between the knowledge at school and life outside school which makes school a boring place. Dwivedi (2020) also emphasises on the point that "examples from daily village life illustrating scientific principles would enable far-more effective learning than those from urban or foreign settings". But the inefficiency in relating science curriculum and textbooks with the daily life of learners leaves many confused with the concepts and thus, affects their education. The author also highlights that the practical applications of the scientific concepts and facts in textbooks must find a place in the science curriculum as an important aspect.

The Subordinate Role of the Teacher

Second problem concerns the role of teachers at the school level. As put by Kumar, K. (2014), the concept of knowledge in today's education system of India is much confined and is not understood in an extended sense by the teachers. Colonisers changed the authoritative role of teacher to merely a subordinate so that, they could not interfere with the hidden agenda of colonial policies of education. At present, the situation of teachers is still the same as they have no power in decision making regarding curriculum and policy formulation at school level. The reality cannot be ignored, as at the root level, teachers are the ones who deal directly with the students in the classroom and are responsible for the process of knowledge formation among the students. While imparting knowledge to students, teachers have to keep in mind the prescribed limits set by higher authority. A report by NCERT (1993) mentioned that, with few exceptions, teachers felt that, they are bound to teach within a time limit, prohibiting them from experimenting or going beyond the textbooks. Only the pictures shown in the textbook are seen as enough to illustrate any concept, rather than giving it a practical lens. Since colonial times, maintaining order has been a central concern of education policy (Kumar, K. 2014). This order can be in terms of discipline within the class or to teach within the limits of the prescribed curriculum and textbooks, or to limit oneself to the classrooms only to understand a concept, which might require out of the class experience. Not abiding

to any of these might disturb the order at the cost of effective teaching and learning. Science as a subject is rather based on practical learning, which requires field visits, laboratory experiments, demonstrations and activities that require time. It is not possible to practise scientific skills within such a narrow boundary.

Language as a Barrier

Moving on to the third problem, i.e., language, a child learns it first from their surroundings and then gets a formal understanding from the school. Kumar, K. (2014) mentioned the two points of inconsistency between the Indian and English system of education as noted by William D. Arnold in his report on education during 1857–58. His first observation was on language and literacy and second was concerned with science, which includes geography and mathematics. Here, the discussion is restricted to language only. In the present scenario, the majority of schools in India give preference to language other than the mother tongue, which makes it difficult for the child to understand complex topics. Hence, there is an incongruence between the language a child uses at home and school, which has its roots in the colonial times when English was introduced. Kumar, K. (2014) reported that the colonial powers made sure that a new language, i.e., English must be introduced, which will leave no scope for any possibility of linking school knowledge with a child's home and society. It leaves the child in a confused state as in the process of learning a new language, the actual knowledge becomes alien to the child leading to difficulty in grasping the actual meaning of the content. Extending this problem to scientific language, Harlen and Elstgeest (2010) focused on letting the child learn in his own language first and then moving on to difficult terms. Though it is a fact that a child recalls any activity or concept in his mind in his own words to better understand it but Indian education system most of the time does not give space for words other than those used in the textbooks, on the pretext that usage of simple words will result in trivialisation of concepts. Parida and Mohapatra (2015) also pointed out explicitly the impact of English language on the performance of the learners as "studying science in English poses problems for those whose native language is not English". The authors had observed that many studies have tried to find the difficulties such learners face while comprehending and communicating scientific concepts, facts and ideas in English.

The Curriculum Framework and the Pedagogical Constraints

Fourth issue is the pedagogy and curriculum framework adopted in the majority of schools explained by Sarangapani (2003) via Bernstein's concept of framing. The two types of framing are strong and weak, whereas a weak framework allows fusion of

two or more different concepts or subjects to understand a particular topic in a collective manner which a strong framework does not allow. Most of the Indian schools follow the process of strong framing, where knowledge is closely packed in a tight boundary, which cannot be jumped, thereby not giving space to the child to relate things done in the school with the world outside. Another aspect of strong framing is the textbook culture, where textbook is considered as the only legitimate source of knowledge beyond which students should not jump. The prescribed limit of textbooks kills students' creativity to learn out of the box. There are many examples in science textbooks that display only factual information, which is difficult for a child to understand and requires an extra effort by the teacher to explain it and make it easy for children. All this points out to the narrowness imbibed in the education system, which does not allow children to relate one subject to another, or think out of the textbook or beyond school knowledge. Hence, it becomes difficult for a child to expand their horizon as the exposure given to them is itself a narrow one. Ultimately, a child becomes a passive learner in the process of teaching and learning, where there is no space for their own creativity or feelings. The recent policy of education, National Education Policy (NEP) 2020 has put a strong emphasis on multidisciplinary and interdisciplinary approaches to break the boundaries of subjects so that children can learn things in a holistic manner rather than in a segregated manner as the case is.

The effort by educational bodies to establish a connection between science and society through the EVS subject also failed to serve its purpose, as it has been implemented only in a superficial manner. Sarangapani (2003) pointed out that the EVS curriculum is meant to collaborate science and social science but its segregation into parts prevented this from happening, as these two parts dealt with science and society separately and not as a whole. Students look at science and social studies in a closed boundary, where there is no scope of fusion as science to them means mainly biology and a little bit of hygiene, whereas social studies mean issues related to society. Relatedness with physics is also very minimal, which is attributed to its abstractness and also the pedagogy is such that it does not allow students to relate with it or see it in an interesting manner.

The theory of learning is based on the fact that new knowledge is acquired by building on what is already known. It focuses on understanding and not on rote memorisation. Science is one of those subjects which are based on such assumptions. Here, the children are the ones that must create and recreate knowledge, whereas in reality, they have to receive whatever is provided by the authority. The root cause of

the problem as highlighted by NCERT (1993) is 'knowledge explosion' and 'catching up' syndrome, which means that India being a developing country has to catch up with the developed countries, which have already reached a stage where their children have the opportunity to learn things at their own pace. Indian children face an explosion of knowledge to be in race with the developed countries. Children are given loads of information, which they are able to recall but without understanding the actual meaning of it. Hence, are unable to apply the knowledge gained out of it. This does not affect their results as the education system is such that it looks for testing memorised facts rather than the application of knowledge.

Extending the above discussion to the experiments and laboratory set-up, Sarangapani (2003) focused on the purpose of experiments in the science curriculum. She mentioned that experiments invoke fruitful discussion among students to enhance their curiosity and creativity, and are not limited to just validation of already established facts. This process allows students to be an active participant and not just a passive receiver of the given knowledge. However, it cannot be denied that the infrastructure of most of the school laboratories doesn't cater to the needs of the students. As put by NCERT (1993), the science laboratory, if at all well-equipped, is not used to give exposure to children, so that they can get a practical experience. This leaves no scope for their innate desire to discover and learn on their own. Sarangapani (2003) also reported that students do not have any idea as to why experiments are done. Also, their understanding of the activities is very superficial as they can recall what has been done but without any comprehension. This clearly implies that students are not used to logical reasoning about why a particular activity is undertaken and the purpose it serves. Moreover, the terminology used often creates an ambiguity among the children as the teachers are sometimes not able to explain complex words with clarity. This pushes students more towards rote memorisation than learning. In all this process, children get ignored and suffer later in life due to unfledged cognitive abilities or lesser understanding. The misconceptions, particularly in science concepts, carry on to the next grades resulting in the accumulation of doubts which remain for lifelong.

The teacher alone cannot be held responsible for this as the curriculum is loaded with lots of information, which is to be finished within a time limit. As a result of time constraint and difficulty in some of the topics, teachers tend to recommend private tuitions to students (NCERT, 1993). This may help those students who can afford expensive tuition but it leaves the majority of the students behind who face financial constraints. The report particularly

mentioned esotericisation in case of science, as only a few students can understand it. It implies that the knowledge of science is available to only a few who could understand or find other sources which help in understanding the concepts of science. Here, the term 'order' can be applied to the availability of a specific subject to children belonging to different classes. This order was maintained through two different aims for the elite class and the masses. Former had access to intellectual and aesthetic education, whereas masses were inclined to moral enrichment as put by Kumar (2014). This segregation persists even today, as science is offered to higher classes. Children of the poor who go to government schools, do not even have enough teachers and proper infrastructure, leave alone subjects like science which are mostly unavailable in such schools.

Curricular Contradiction and Gaps

Fifth is the arrangement or structure of the syllabus, which contains gaps and repetitions across the lower and higher secondary stages. Science curriculum in particular has displayed such gaps and contradiction between secondary and senior secondary level (NCERT, 1993). There is a sudden jump in the level of abstraction especially in physics. Subjects like mathematics and science are so packed with information that it leaves no scope for any enjoyment. The disorganisation of the contents at lower, secondary and higher secondary level can be seen as a result of non-coordination among those who prepare the syllabus at different levels. Another important aspect is the connection between historical developments in various branches of science and the present innovations, showing what led to a particular invention. There is no space for such interrelatedness which leaves a gap in understanding the concept in a hierarchical manner. Along with the gaps within science concepts in a particular grade, there are gaps in the objectives of science among lower and higher grades as well. Kumar, K. (2016) reflects a confusion among science and scientific temper as there is a vast contradiction between objectives of science and environmental studies. The author emphasised on the fact that reorganisation of environmental science into environmental studies have not brought any significant change in the ways of learning science. It rather leads to conflict between perspectives and values concerning the relationship between nature and humans. The conflict across primary and later science grades is that, while earlier grades cultivate a concern for nature, later stages teach that nature should be controlled for betterment of human life. Such a discrepancy within the science curriculum between early and later grades, creates confusion among students.

Conclusion

The pervasiveness of the ideology since colonisation that focused on giving an ambiguous experience to Indian minds is still prevailing. This ambiguity does not allow Indian minds to think in an innovative manner rather distance them from attaining the actual understanding of science. It can be said that existing challenges and issues that the present education system, specifically science education, is the result of the colonial setup that shaped the Indian minds according to their own requirement and not for the Indian masses. The National Education Policy (NEP) 2020 has shown a new and fresh perspective to deal with these prominent problems but it will require continuous efforts on the part of all stakeholders. However, at present, the situation of science education at school level restricts learning of science in a meaningful manner. In a nutshell, one can say that, "A lot is taught but a little is learnt or understood" (NCERT, 1993, p.4).

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