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Progress of science learning in India: A discussion from past to present

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Abstract
Today the world is facing three major problems of population increase, pollution and poverty. The developmental efforts of the developing countries, such as India are being nullified by increasing pollution and increasing poverty. Although science and technology have improved the lot of large number of human beings, some of the worst problems of humanity today such as mentioned above have either been brought about or aggravated by science and technology. Education is one of the potent instruments in the development process, if it is properly geared for that purpose. Science education being an important component of the education system should contribute in the solution of the problems of the country by developing desirable understanding, skills, abilities and attitudes. The greatest challenge is to 'humanize' science that is to make it relevant to human needs and aspirations.
Science is being taught in our country from early days. If we look at the development of science in India, we find that very early in her civilization India developed a great interest in mathematics and Ayurveda; during British Empire introduction of modern science in India was extremely slow; and the development of science in India was greatly accelerated after independence.

Keywords: science and technology, pre independent India, post independent India, five year plans

Introduction
Science and technology have been central to India's development efforts since achieving independence. Jawaharlal Nehru, the first Prime Minister, was a firm believer in the crucial importance of science and technology for economic growth and social transformation and helped to lay a firm foundation of science and science education in the country. Along with a focus on industrialization and rural growth, India's development plans over the subsequent six decades have channeled substantial resources to education, training and research in science and technology (S&T). The country today has a vast science and technology infrastructure comprising large number of national libraries and institutions, universities and colleges with its flagship nuclear and space programs, and high profile information technology services and pharmaceuticals. Indian science and technology has come a long way from its modest beginnings. The knowledge based society sets the pace at which new scientific and technological innovations take place and determine how quickly these innovations are converted into marketable products, processes and services. Now trade and patent regime adopted recently also underscore the importance of intellectual property-rights and their role in the new world order. Technological change and competition will only accelerate in the decades to come, posing an immense challenge if the country has to become a global leader in the 21st century. Science and technology are the drivers of economic growth and science education forms backbone of all science and technology efforts in any country. Today it is being increasingly realized that the only way to improve the nation's competitiveness is through better science and technical education. Educational training in pure and applied sciences has had a flourishing tradition in India dating back to over 2600 years. The development of modern science education can be credited to the British although during that time the role of science education was rather limited and as with education per se, the only aim was to turnout men competent to serve the civilian administration.
It was only in 1857 that the universities of Bombay, Calcutta and Madras were established and the foundations for basic sciences were laid. Some of the most well known scientists who engaged in globally competitive research belong to this area are J.C Bose, P.C. Mahalnobis, S.N. Bose, P.C. Roy and S. Ramanujan and they inspired students of many generations towards science. After independence, science education in India received a front line. Jawaharlal Nehru's vision of India was based on the wings of science. Nehru's vision was translated into working plans through different policy frames that has evolved over the years. Science education in schools as well as higher received great emphasis and the pragmatic policies followed over the years ensured that the country came to posses one of the largest and one of the most diverse science education infrastructures.

Why science learning is important?
Modern civilization is a scientific civilization. This is an age when the modern society is completely drawn into the scientific environment and science has become an integral part of our life and living. Now we cannot think of a world without science. The wonderful achievements of science have glorified into the modern world. A citizen of a modern world sees the countless manifestations of science all around him/her. There is no aspect of wo/ man's life today which has not been influenced by science one-way or the other. This is because we are living in an age of scientific culture. Science

has shrunk the world and totally changed the human outlook. In fact, science now has an all prevailing influence on every sphere of human activity. Further, modern science is no longer confined to the surface of this globe, its sphere of achievement reaches beyond the earth.

In recent times, there has been rapid addition of knowledge to the world of science. Great achievement of science and technology brought radical change in the mankind of present world. Application of science in the field of industry, communication, engineering etc. has made contemporary life more important than even before. Science has in fact radically transformed the material environment of the citizens of modern world. We see around us an outstanding array of labor and time saving gadgets and appliances, because of the uses and applications of science.

The foregoing discussions make it evident that "we live in a world of accelerated change, produced, to a large extent, by science and its application in technology." In such a world all of us knowingly or unknowingly are constantly affected by science. The temper of the age demands that wo/ man should learn to adjust to this tremendous and all pervading changing world produced by science. S/he has to have a clear understanding of the impact of science on human affairs. And this is possible through a sound process of training in science. A grounding knowledge in the basic principles of science can help man to adjust to the changes of modern life. The economic and social development of a country requires a climate of wide spread and popular acceptance of science and technology. Science has also had such a profound effect on modern life at the practical and philosophical levels that no wo/ man can consider himself/ herself in the main stream of modern thought if s/ he remains a "scientific illiterate". Thus it can be said that science and modernity are synonymous. A country desiring to join in the community of modern nations has to embrace science in all its dimensions.

The modern civilization has a scientific base. Science has now become a part and parcel of our life. In a developing country like India, science education is considered as a powerful instrument for bringing about social change. It helps in strengthening national economy, creating new resources, providing new opportunities for employment, developing scientific temper and attempting to bring about a global outlook. The inventions of science which have taken place in the present age have made our life easy and comfortable. Wherever we look, we find the wonders of science. Science has changed the face of the earth and the world has been changed more during the last 150 years than during 4000 years previous to that. So, in order to cope up with the present situation, it is very essential to have some knowledge about science, without which human survival will be a difficult one.

At the school science education has become one of the core subjects. Since the very dawn of civilization, man is curious to know about the things around him. This curiosity led the wo/man to establish certain knowledge based upon facts or science. Knowledge, skill and other aspects acquired through science education has been considered essential for all the categories of learners at school and further stage of education. It has been realized that science education is essential for the learners' right from the beginning of school education. According to Burkey, the educated citizens are really the safe guards of the country; they are more powerful than vast standing army. So, our children must be aware of the scientific and technological inventions.

Progress of Science Learning in India

Progress of Science Education in Pre Independent India

With a long and chequered history of education and training in pure and applied sciences dating back to over 2600 years, India has had flourishing tradition of scientific research and technological development. The education system which was evolved first in ancient India is known as the Vedic system of education. In other words, the ancient system of education was based on the Vedas, and therefore it was given the name of Vedic educational system.

If we look into the past, we note that science was always given its due place in Indian education. We had great scientists and mathematicians like Nagarjuna, Aryabhatta, and Varahmihira in past days. Vedas occupy a very important place in the Indian life. Vedas means knowledge. Vedic knowledge is concerned with physics, mathematics, astronomy, logic, cognition and other disciplines. The basis of Indian culture lies in the Vedas which are four in numbers – Rigveda, Samveda, Yajurveda and Atharvaveda. Rigveda, which is considered to be the oldest Indian scriptures, contains detailed mention of the healing powers of medicinal herbs. Among these four Vedas, Atharvaveda is more applicable to modern society since it deals with different subjects like science, medicine, maths, engineering, technology etc. Vedic science is the earliest science that has come down to us. The reconstructions of our earliest science are based not only on the Vedas but also on their appendices called the Vedangas. The six Vedangas deal with: Kalpa, performance of ritual with its basis of geometry, mathematics and calendrics; shiksha, phonetics; chhandas, material structures; nirukta, etymology; vyakarana, grammar; and jyotisha, astronomy and other cyclical phenomena. The Aryans increased their knowledge about precious metals like iron and silver during Yajur-veda period. The Arthashastra, written by Kautilya (321-300 B.C) mentions the process of oxidizing and melting of different minerals. At the end of Iron Age, the use of medicine, science and technology came to be accepted as an important part in the life style of the people. Taxila (6th century BC), one of the earliest Indian Universities in the world, attracted students from across the continents. Major fields of study at Taxila included mathematics, astronomy, medicine, surgery and metallurgy. Atraiya taught medicine in the 6th century. Later on many of his disciples like Jeevak, Parashar etc contributed to the development of medicine. Charakasamhita which is supposed to be written in 600 BC suggests the use of purgatives in the treatment of fever, toxicity, leprosy, jaundice, cholera, piles, diabetes and cataract.

During Mauryan period, the science of metallurgy and civil engineering made significant progress. In Gupta period, Aryabhatta and Varahmihira studied astronomy and revealed various secrets of the universe. During medieval period, India had contacts with Arabs and Europeans. Working out the calendar, dates of eclipses, casting horoscopes for astrological purposes and development of water clocks were important achievements of that period. The archeological excavations at zawar in Rajasthan suggest that Indians knew the process of

isolation of zinc by about the first century A.D. With the arrival of Muslims, Indians started practicing Greek (Unani) system of medicine which is still widely practiced. On the whole we find that the development of science in medieval India was slow. In the educational system introduced by the British, science was never given a high priority. Science education was lacking and science was looked upon as an appendage thrust by the British, for their own benefit. Until a few decades towards the end of the British rule, the role of science education, and scientific and technological research in economic growth and social transformation was rather limited. Only such developments were introduced that did not lead to a conflict with the interest of the colonial power. The only aim of education including that of science education was to turn wo/ men competent to serve the civilian administration. Consequently science education and research was uneven and patchy with no facilities. When freedom movement gained momentum, people became more conscious about science. In Bombay, Jamshedji Tata favored science education and research at higher level. Efforts in this direction led to the establishment of Indian Institute of Science at Bangalore in 1909. In the modern era, our noted scientists like J.C Bose, Acharya P.C.Roy, Novel Laureate C.V. Raman and S. Ramanaujan have contributed much to the development of scientific knowledge and innovations. In 1938 a National Planning Committee was framed under the chairmanship of Pt. Jawahar lal Nehru. This committee dealt with various technical subjects for example, education, industries, irrigation and public health.

Progress of Science Education in Post Independent India

In India, the pattern of education was influenced by what happened in England; the only difference is that things moved at a much slower pace. The reviews issued by the Government of India in the years 1877-92 gave an insight into poor state of science teaching. Even in the beginning of this century, science was not a school subject in our country and it was only in name in the universities. Indian Science Congress was formed a few decades back but it also did not do any notable work towards the Teaching of Science in schools. The major recommendations of the various commissions and committees regarding science education are given below:

The University Education Commission (1948-1949) recommended inclusion of general science (physics and biology) as courses of study in secondary schools.

The Secondary Education Commission (1952-53) recommended compulsory inclusion of general science and mathematics as core subjects at the middle as well as secondary level and reoriented specialized science course with physics, chemistry and biology as independent subjects at higher secondary stage.

All India Seminar on Teaching of Science, Taradevi Report, 1956 dealt with almost all the aspects concerning teaching of science in schools viz. syllabus, equipment and apparatus. This was the first agency in India to suggest acquaintance with 'scientific method' and development of 'scientific attitude' among the learners as one of the aims of school science teaching.

The Indian parliamentary and scientific committee was formed in August, 1961 to study the problem of science education in Primary, Secondary and Higher Secondary Schools. The commission recognized the gap between what is taught and what should be taught at various levels.

In 1963, USSR experts of the UNESCO Planning Commission visited India on technical assistance projects; they suggested teaching of science as a separate discipline at the middle stage.

Indian Education Commission (1964-66) recommended that science education should become an integral part of school education with provision for compulsory teaching of science and mathematics to all its pupils as a part of general education during the first ten years of schooling. Further it noted that science should be linked to agriculture in rural areas and technology in the urban areas.

National Policy of Education, 1968 gave much greater attention to science and technology and in the school curricula, science and mathematics were incorporated as compulsory subjects.

Report of the Ishwarbhai Patel Committee (1977) recommended that objectives of secondary education should be acquisition of a broad based general education consisting of science, mathematics, social sciences, languages and socially useful productive work.

The National Policy of Education 1986 has reiterated the importance of Mathematics and Science Education in schools as well as inculcation of scientific temper among the children in schools.

National Policy of Education (1992) has stated specially about strengthening of science education and the relationship of science with health, agriculture, industry and other aspects of daily life.

The national curriculum framework (NCERT, 2000) suggested that instead of science, science and technology should be taught at the school level. It observes science and technology should be relevant and should meet the social needs.

Science and Technology Policy Resolution - 2003 hopes to build a new India, which uplifts the Indian people and in need all of humanity.

The National Knowledge Commission (NKC), 2005 recommended reformation of education sector, research laboratories and also to promote creation of knowledge in science, technology and laboratory. A National Science and Social Science Foundation (NSSF) has been recommended by NKC to look at all knowledge as one seamless entity. NSSF suggests policy initiatives to make India a leader in the creation and use of new knowledge in all areas of natural, physical, agricultural, health, and social sciences.

Prof. Yash Pal Committee Report (2009) recommended vocational education sector to be under the purview of universities and colleges. This committee also recommends to provide necessary accreditation to the courses available in polytechnics, industrial training institutions, and so on.

An Overview of Science and Technology Development under Five Year Plans

The First five year plan, launched in 1951, emphasized the establishment of scientific infrastructure. It provided funds for the promotion of scientific and industrial research in already existing institutions; building of new laboratories; installation of necessary equipment to enable laboratories to function;

exploration and survey of resources; introduction of standardization; and improvement of techniques in cottage industry.

In the Second plan (1956-1961), efforts were directed towards strengthening the existing research facilities, training and generation of scientific manpower in sufficient numbers and their utilization. It was during the Second plan period that the Scientific Policy Resolution was adopted in 1958. The resolution clearly spelt out the priority to science in the national plans.

The Third plan (1961-1966) emphasized on encouraging basic research in universities; development and manufacture of scientific and industrial instruments in pilot plan trials and full scale field experiments. During the third plan, scientific and technological research is started to have made perceptible contribution to the development of the country.

The Fourth plan (1969-74), emphasized on purposeful research and development programmes and the priority areas identified under the plan were steel, chemicals, instruments etc. The plan also stressed on the utilization of indigenous expertise and materials in the nuclear power projects. Space department also got proper attention.

The Fifth plan (1974-1979) attempted to restructure the research programme into projects with predetermined time spans, costs and benefits. In agriculture, special emphasis was laid on programmes to control crop diseases, dry farming and agricultural implements, surveying and research of natural resources.

The Sixth five year plan (1980-85) included the task of creating a scientific temper for growth of science and its utilization in developmental process. A close nexus between science, and technology and space was envisaged. The plan also aimed to creating new research institution in the field of plasma physics, immunology and applied microbiology.

Seventh five year plan (1985-1990), emphasized on policies and programmes to accelerate the growth in food production and to raise its productivity. It recognized an emerging world scene such as, micro-electronics, informatics, telemetric, robotics, biotechnology, material science and instrumentation etc.

The Eighth five year plan (1992-1997) sought to integrate science and technology with socio-economic sectors and more particularly rural areas to meet basic needs of water, nutrition, health and sanitation, shelter, energy, education and employment. The plan also emphasized to set up sophisticated infrastructure, instrumentation and trained man power.

Ninth Five Year Plan (1997-2002) suggested that the science and practitioners of science need to be made central to all our planning and operations. For Indian science to flourish, the administrators and govt officials should act as facilitator of science and not masters of scientists. They should create conditions that encourage young scientists.

Tenth five year plan (2002-2007) outlines the approach to science and technology governance, optional utilization of existing physical and knowledge sources, development of innovative technologies, system and technologies for mitigation and management for natural hazards, generation and management of intellectual property and creation of awareness among general masses about the use and benefits of science and technology.

The Eleventh five year plan (2007-12) accorded high priority for investment in science and technology to derive maximum benefits for society and for knowledge generation for capacity building. The major priorities of the eleventh plan for the science and technology sectors include setting up a national level mechanism for evolving policies and providing direction to basic research, enlarging the pool of scientific manpower, stringing the science and technology infrastructure, and attracting and retaining young people in careers in science, new ways and means of catalyzing industry etc. Further, this plan also addressed for employing modern tools and technologies for education in general and for development of human resource development at school level.

During Twelfth Five year plan (2012-17), the science and technology undergo a paradigm shift from the current input driven model to an output directed development strategy. This plan recommends for strengthening science and technology education system in the country to develop high quality science and technology human resource.

Conclusion

Science has been wo/ men's greatest alley since the dawn of civilization. It has created innumerable pathways to progress that have taken man from his primitive cave habitat to the moon, indeed a very long journey in terms of both space and time. The scientific and technological breakthroughs along with the changing attitudes of the Indian society towards scientific thinking have led to a change in every walk of life.

India is one of those rare civilizations, which has formal education since time im memorial. Indian education was founded with strong emphasis on logic and mathematics. British brought the Greco-Roman system of knowledge to India in early 19th century, which is the foundation for modern science. India quickly picked this up and many Indians significantly contributed to science and mathematics. When India became Independent in 1947, the literacy was as low and might be lower.

Recognizing the crucial role played by science and technology in the process of economic growth and social transformation, major emphasis was laid on higher science education during early years of Independence. India today possesses one of the oldest, the largest and the most diverse infrastructure in the field of science. For science and technology education and training several institutions comprising the Indian Institute of Technology (IITs), Indian Institute of Science (IISc), about a dozen institutes of national importance are established. These infrastructures have made a substantial impact on the country's scientific, industrial and economic development.

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