

Science Education Values in Holistic Approach

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Science and Technology is one of the most powerful and formative forces of our modern age. Much has been said and written on the beneficent and destructive potentialities of this great power of our age. But what is not fully recognized is that much of the destructive impact of modern science could have been minimized and its beneficent potential maximized, if the modern mind has bestowed a greater attention to the task of shaping the right values in science education. For the scientific method is only an intellectual framework and technology is just a tool. How they are used depends on the values of their users. And these values, to be truly effective, have to become integral part of science education. This article examines the problem of shaping values in science education in a holistic perspective, which means science education is viewed in a systematic perspective as an important subset of the prevailing culture or environment of science. In this article, the word "Science" is used in a broader sense to include the physical and life sciences, social and applied sciences and their applied versions like technology.

Values of Science:

If values are defined as guiding ideals or principles, of action or enquiry Science is not value-neutral as some people think. Quest for truth and understanding of the laws of Nature are the central values of Science. As the Noble Laureate in physics Charles H. Townse points out "Science is the search for truth, it is meant to understand nature". (Townes, C.H, 2003). The scientific mind of man, at its best and highest, has pursued the following values, ideals or principles: Quest for Truth and Understanding the laws of Nature.

- Unbiased, impartial and impersonal objectivity and a firm foothold on facts of life.
- Freedom from personal biases, prejudices and preferences
- Openness to new ideas and willingness to change, correct and modify our present opinions, ideas or conviction based on new facts or evidence or progress in knowledge
- Constant questioning of established ideas, assumptions or paradigms
- Intellectual rectitude in using reason which means to be vigilant that reason is not used or driven consciously, subconsciously or half-consciously to justify our preconceived notions, conclusions, preferences or desires
- Persistent seeking for the how and why of thinking and for the deeper causes, laws and patterns behind observed phenomenon
- Not to be satisfied with the status-quo and a relentless push towards the uncharted territories of knowledge.

These are the values or qualities, which constitute the scientific temper and each of them, have to be internalized in the mind of the student of science through illustrative examples from the scientific and intellectual history of the world and the biographies of great scientists. One of the ironies of science education in India is that while the student is stuffed with garbage of information, concepts, laws and equation, not much attention is given to inculcate these basic values, qualities attitudes and methodology of science, which creates the true scientific temper.

And when we move from pure science to applied science or technology, here also it is not value-neutral. The applied sciences have always pursued values like utility, efficiency, productivity and innovation. Here again, these values are pursued only in business, industry and in research and development laboratories but not in technical education. Most of the technological education in India, except perhaps in some premier institutions

are predominantly theoretical. For example if I am an undergraduate student of electrical engineering, I learn about electromagnetic theory, electrostatic theory, electric machine theory, but after passing the course and enter into an industry I do not know how to trace even a simple fault like a blown-out fuse or a flowed push-button in a motor!

But what modern science and technology education is lacking is a positive and definite ethical and spiritual orientation. If we consider this ethico-spiritual orientation as the essence of values, then modern science is value-neutral. Truth is a spiritual values and the quest for truth gives a certain spiritual orientation to science. But without a more comprehensive ethico-philosophical foundation, which leads to the beneficent use of truth for the highest well being and fulfillment of the human and terrestrial life, a mere intellectual quest for truth doesn't have sufficient moral and spiritual force to prevent the misuse of “truth” for wrong and selfish ends. This is a major lacuna in modern science and science education which has to be corrected if we want science and technology to become a beneficent goddess showering her blessings on humanity, and not a Frankenstein's monster pouncing upon his own maker. As Richard R. Ernst, a Noble Laureate in Chemistry, states with conviction:

“I am convinced that by purely rational thinking, based on the value-free laws of science, we cannot find ultimate solutions and we cannot create a lasting global order that prevents violent conflicts. Science and technology alone cannot solve the problems of the new millennium. We need additional guidelines for our actions, for the selection of our research projects and research goals. These guidelines have to do with ethics, with philosophy and faith” (Ernst R.R, 2001)

The first step in bringing values to science education is to enlarge and broaden the scope and meaning and methodology of science we have to include this broadening of the horizons of the human mind as an important part of the values of science education. This value or virtue acquires a special significance for modern science because of its increasing, tendency to specialize in more and more narrow domains of knowledge.

The student of science has to be awakened to the fact that science is not merely a method or technique nor can it be confined to the laboratory, equipment's, university or the various streams of scientific knowledge like physical, life, social or psychological science. Science is in its essence way of thinking, which can be applied, to any activity of life. This is something, which is recognized by all matured scientific thinker. As a standard textbook on sociology edited by two leading sociologists point out:

“Science is not to be defined by a single method or routine, such as a the before after experiment or the use of special implements such as glass tubing or lenses. Each of the old and established sciences has developed more or less distinctive technique, instrument and routines. The specialized routines and equipment of the scientific enterprise, which vary from discipline to discipline and from time to time, should not be confused with science itself. All science is characterized more nearly an attitude, an approach a point of view, then by a special technique.” (Broom.L, Selznick. P, 1963).

This broader perspective on the scientific method has to be imparted to the learner through illustrative examples. One of the examples could be the great creative work of Fredrick Taylor, the founder of Scientific Management. Taylor has no formal education in science or technology. But he is one the most creative scientific minds of our modern age. He is a pioneer in applying the scientific method for organizing a social system like an industry. Through a rigorous process of observation, testing, experimentation, Taylor evolved a system of thought and practice, which gave birth to an entirely new field of modern knowledge, called Management. Taylor constantly emphasized in his writing that scientific management is not merely a method or technique but a way of thinking. Its aim, said Taylor, was to create a “mental revolution” in the thought of owners, managers and workers of industries. (George C.S, 1974)

So, the student of science has to be made aware that scientific method is not the sole prerogative of the professional scientists working in the laboratory nor the scientific community is the only authentic inquirers of truth. Not all professional scientists are good scientific inquirers. On the other hand there may be many who are not professional scientists like for example Journalists, detectives, historians or executives, entrepreneurs, but who may pursue their profession with as much scientific thoroughness as any scientist. As Susan Hack writes in Times Literary Supplement: '----so successful have the natural science been the words like “science” and “scientific” are often used on honorifically as all-purpose terms epistemic praise unfortunately, unfortunately this honorific disguises the otherwise obvious fact that not all, or only, scientists are good, honest, thorough, imaginative inquirers. Some scientists are lazy, some incompetent, some unlucky, a few crooked and plenty of historians, journalists and detectives are good inquirers.’(Hack.S)

There is another category of inquirers who are perhaps as scientific in their quest as any great scientist, but they are not recognized as such by the traditional scientific establishment. They are the yogis, seers and sages of the eastern spiritual traditions. Not all eastern spiritual traditions and paths can be called “Scientific”, For example, an unquestioning faith in the Guru and God is an integrate part of the spiritual traditions of the East But in general eastern Yogis pursued a scientific and systematic approach in understanding the inner worlds of consciousness and applying it to the psychological and spiritual developments of the individual. This is the essence of Indian Yoga which as Sri Aurobindo points out “nothing but applied psychology”¹⁰ Recently, some of the modern scientific thinkers are beginning to recognise this scientific dimension of eastern spirituality and admit that spirituality can be also as much scientific as any other quest. For example as, the well-known exponent and writer on transpersonal psychology, Ken Wilbur states:

“These eastern disciplines such as Vedanta, or Zen are not theories, philosophies psychologies or religions — rather they are primarily a set of experiments in the strictly scientific sense... To refuse to examine the results of such a scientific experiments because one dislikes the data so obtained is in itself a most unscientific gesture”(Wilbur, 1997)

This bring us to the question of validation can these inner spiritual discoveries be verified? Are they not subjective? The answer is yes, they can be verified, provided we are willing to follow the inner discipline, fulfill the inner conditions and develop the inner moral and psychological capacity. This inner discipline or condition or capacity may be difficult to follow or fulfill for the average man. And in the present condition of human evolution, these spiritual realisations and experiences may not be normal but exceptional, achieved only by a small group of mystics and yogis. But this applies to any scientific theory or phenomenon.

For example not every Tom, one can verify Einstein's theory or the existence of an electron. To verify these scientific truths requires above average scientific and mathematical abilities which have to be acquired by education, study and training. Similarly to verify the spiritual truths discovered by mystics requires a certain moral and psychological preparation and the capacity for introversion, which have to be acquired by following a psychological and spiritual disciplines. However, even before attaining these great spiritual realisation, a sincere seeker in the spiritual path can experience and verify some of the intermediate psychospiritual benefits like inner peace or detachment, equality, endurance, power of faith and prayer, self knowledge, intuition, visions and experiences of the subliminal worlds in the course of his inner journey to the goal. And these inner psychological and spiritual experiences are not entirely subjective. These are a remarkable similarity between the inner experiences of mystics separated by space and time and belonging to different religions and cultures. For example the experiences of Vedanthic seers of India are very similar to that of German – Christian mystic Meister

Echart. Similarly there is a striking correspondence between the experiences of the devotional mystics of the Sufi, Christian and Hindu tradition...

We are now brought to the strength and limitations of the scientific method. The advantage of the scientific method lies in its emphasis on facts, experimentation and application and its pragmatic orientation to the quest for knowledge. Its weakness lies in its too heavy emphasis on external or empirical facts and analytical reason which shuts off the scientific world from vast domains of knowledge which are beyond the senses and reason and prevents the flowering of other faculties which may lead to a deeper and more holistic insight into the truth of things. To overcome these limitations we have to retain the essence of the scientific method but enlarge its scope. The essence of the scientific method is a triune process. First is the process of observation, or formulating the problem. Second is a process, which leads to insight into the underlying patterns or laws behind the data or the nature of the problem or the solution. Third is the process of testing, validation or practical application of the insight for the development, progress and well being of the individual and the collectivity. We may also broaden the scope of the method to include the inner being and the outer life of man or Nature or in other words all the three processes can be performed either within the confines of a scientific laboratory, or in the outer world of Nature or in the laboratory of our own consciousness or in the outer life of work, action and relationship.

The process and instruments of insight need not be limited to deductive and inductive logic or analytical reason. We may include other faculties like imagination and intuition and the emotional, aesthetic and philosophic intelligence. Why should we limit our potentialities of knowledge by confining our consciousness to a single faculty? Why not we use every faculty of knowledge available or manifest in us in our quest for truth and knowledge? Why should we even restrict the possibilities of knowledge to the faculties of an individual? Why not we base our research on the highest collective wisdom of humanity?

The other important factor, which the student of science must know, is the actual process of scientific discovery and role of intuition science. The traditional scientific methodology of Observation, Classification, Analysis and Hypothesis is useful as a general framework for understanding the process of science and therefore has to be taught to every student of science. However when we study the biographies or accounts of great scientists we find the actual process of scientific enquiry, which leads to, discovery never follows the rigidly logical and graded methodology. This actual process runs through trial and error, frustration and disappointment of barren effort, patient and persistent plodding, flights of imagination, a bit of luck and chance, and at the end of it a leap of intuition and joy of discovery. It is now beginning to be recognized that behind almost every great scientific discovery there is a leap of intuition. As the great physicist and mathematician Henry Poincare says, "It is by logic we prove, it is by intuition we invent--logic remains barren without intuition". And Poincare recounts in one of his books how he had a total insight into an obstruce mathematical problem when he was traveling in a bus; suddenly he saw the whole theory in an instant (Sudershan ECG). This real process of scientific enquiry shows that mere intellectual brilliance of the logical or rational mind is not enough to become a great or even a good scientist.

Other psychological qualities like persistence and patience, which are qualities of the will, and the rational faculties like intuition, are also needed. Here comes the importance of some of the ethical and psychological disciplines of Indian yoga like equanimity under all circumstances, disinterested pursuit of truth without seeking for personal gains, renunciation of the fruits of action, and mental silence for receiving intuitions. All these attitudes, values and practices of Indian yoga can be of great help in moulding the inner character required for a successful scientific career.

The attitude of critical questioning is an important quality of the scientific temper or character. But the student of science should not hesitate to apply this attitude to the

dogmas and prejudices within his or her own field of science. For there is within the scientific establishment, orthodoxies which can be as dogmatic and rigid as religious fanaticism. As the leading bio mathematician, Roger U. Jean points out: “In many cases our official science has become a religion in the meaning of the word, with us credos and its priests.” For example when the eminent biologist Ruper Sheldrake's “A New Science of Life”, which presents a vision of life, which goes against the traditional scientific theories, was published, it received two contrasting reviews from two reputed science journals. While the journal “New Scientist” complemented the book as an important scientific enquiry into the nature of the physical and biological life”, the other journal Nature, the prestigious citadel of scientific orthodoxy condemned it as “candidate for burning”. (Sheldrake. R, 1997) Is this attitude any different from the fanatic religious clerics who burnt Giordono Bruno and Joan of Arc in the stakes?

The Present Condition and Emerging Trends in Science:

All values proceed from a specific psychological and spiritual orientation, a metaphysical mindset. So the best way to change or initiate new values is to change the metaphysical mindset. Let us now briefly examine one of the main reason for the ethical neutrality of modern science is that at a certain stage in its evolution, there was a hardening of its mind and heart and its philosophical orientation towards materialism. And with the advent of Industrial Revolution, the culture of science had become more and more materialistic, utilitarian, fragmented and indifferent to higher values.

For example, at the beginning of the twentieth century, the noted biologist Joseph Needham who was late converted to the organic view of Chinese philosophy wrote, “In science, man is a machine, or if he is not, he is nothing at all”. (Capra.F, 2001) Then came the momentous discoveries of quantum physics which shook the foundations of the materialistic philosophy of science.

In the quantum world-view, the world appeared like a whirl of energy of Shiva's dance, and their whirl of energy in turn seemed to be more like mathematical waves rather than physical movements. This prompted scientist like James Jeans to speculate that world is more like a Thought rather than a Machine. Some pioneers of new physics like Erwin Schrödinger found parallels between the discoveries of quantum theory and the insights of eastern philosophy. This lead to a spate of popular books on this subject of new physics and mysticism and opened a few windows in the scientific mind of humanity to the realms of the Spirit. In the realm of technology the ominous possibilities of the weapons of Mass Destruction and the advent of Green movement have awakened the more sensitive section of the intelligential to the perils of misuse of science and technology. The science of ecology and the environmental movement has given a more positive ethical and philosophical orientation to science and technology. But still there is not yet a comprehensive rethinking on the cultural, philosophical and methodological foundation of modern science and science education. A good beginning has been made by the well-known physician and author Fritjof Capra, in his book Turning Point which examines critically some of the cultural basis of modern science. Many such attempts are needed for evolving a new foundation for a future science. A large portion of the scientific community in spite of all the new develops in scientific thought, is afflicted with the early materialistic legacy of science and remains atheistic, materialistic, empirical or ambivalent, uncertain and confused about the moral or spiritual implication of the new thinking in science. Some of them keeping their religious or spiritual belief in private but maintaining the traditional scientific attitude in their professional or public life.

As Mathematician and an authority on bio-mathematics, Roger U Jean states:

What about our science today?---It always surprises me to see specialized scientists with infantile religious views, thinking of religion as magic, and desperately holding stiff positions instead of being open to alternatives”. (Jean.R, 2001) And the Nobel Laureate

Chemist Richard R. Ernst, brings out this ambivalent attitude of the scientific community with admirable clarity:

“Many of our scientist have a split and ambivalent relation to the spiritual aspects of existence. Some of us are completely disinterested in religion and spirituality and refuse to even think about these subjects. Others are pronounced atheist finding only contradiction between belief and knowledge. A few are agnostics claiming that proof of the existence of super-natural forces is forever out of our reach. And, finally many scientist lead truly a double life, adhering to a rather simple minded belief on Sunday and acting in a strictly rational manner on week days”(Ernst RR, 2001)

If a scientist openly states in favour the spiritual view or approach he is either frowned upon or considered as outspoken in the scientific community. For example, in an interview with Nobel Laureate scientists Werner Arbour, when the interview mentions some of the views of Einstein on science and religious, the Nobel Laureate comments cautiously “some of his views are very outspoken”. (Singh. T.D, 2002) And Albert Einstein is perhaps the first among the later scientists to break this ambivalent attitude and speak openly in favour of a reconciliation between science and spirituality. His famous and oft-quoted remarks “Science without Religion is blind. Religion without Science is Lamé” sums up the Einsteinian point of view on the subject of religion. There are many more such statements by this great scientific mind, which boldly calls for incorporating the spiritual view in Science, like for example the following statements.

“I assert that the cosmic religious experience is the strongest and the noblest driving force behind scientific research.” (Prabupada, 2002)

“The most beautiful and most profound emotion we can experience is in the sensation of the mystical. It is a shower of all science.”(Singh TD, 2003)

Thus with the advent of Einstein and other pioneers of quantum physics like Erwin schoredinger or Werner Hisenberg openly advocating a synthesis of science and spirituality, more and more scientists are veering round to the view that science should open its doors to the spiritual paradigm. As a leading neuroseistist Karl H. Pribram sums up this new development in science.(Pribram,K, 2002)

“Over the waning years of the twentieth century a return of interest in holistic issues has begun to emerge. Today there are stirrings especially in quantum physics and cognitive sciences that bode well for such renewal of science in a holistic and wholesome modus operandi. I think that in this century, science will be admitted to the spiritual aspect and vice versa.”

For example, John Eocles, the Nobel Laureate in Medicine and Physiology use strong words when he says “I maintain that the human mystery is incredibly demeaned by scientific reductionism with its claim in promissory materialism to account for all the spiritual worlds in terms of patterns of neuronal activity” (Singh. T.D, 2002) and declares boldly”. This belief must be classed as superstition----we have to recognize that we are spiritual beings with souls existing in spiritual worlds with bodies and brains existing in material worlds”. And another Nobel Laureate scientist and inventor of Laser, has no hesitation in saying “In this search for truth, it will be certainly beneficial if scientists can incorporate spiritual principle in their scientific works”.

Towards Integral Unity and Wellness:

This new turn of thought in contemporary science paves the way for a reorientation of the mindset and values of science and science education. All these new and higher thought in science has to become part of science education We may also include the thoughts of great moral and spiritual leaders of humanity, past and present, on the higher aims and values life and topics related to science like evolution, ecology, learning and the role or aim of science and technology in the fulfillment of the evolutionary destiny of our planet. In other words, the student of science and technology has to be

awakened to the ecological, moral and spiritual values and aims of human and terrestrial evolution and the role of science and technology in fulfilling these higher aims. However, this awakening, to be truly effective or creative, has to be achieved mainly through dialogue, discussion and debate and not by stuffing the mind of the student with heavy, moral or philosophical information through text-books and lectures. And this debate or discussion, to be fair and just, must include the views of some of the latest and able exponents of atheism in Science like Richard Dawkins and his “Goddelusion” hypothesis.

The most of important part of this debate or discussion has to be on the practical implications of these higher thinking for choice and decision-making. There is at present much debate on some of the dangers facing humanity, like proliferation of nuclear weapon, accumulation of weapons of Mass Destruction (WMD) and global warming. Much of these dangers to humanity can be neutralized, if the scientific, technical and professional community takes a firm decision, individually and collectively, not to work for companies, which makes ethical, ecological or social responsibility.

Towards Integral Unity and Wellness:

This brings us to the question, what are the new values, which have to be added on to the list of values, which we have outlined earlier, that will lead to the most beneficent result for humanity? The answer perhaps lies in the value of integral unity for theoretical sciences and integral wellness for applied sciences.

The highest collective wisdom of humanity perceived a thread of unity connecting all creation. The ancient wisdom of the East perceived a spiritual oneness of Being and Consciousness as sustaining principle of creation. In our modern age, the New Physics has perceived an underlying and interrelated unity of energy in the subatomic world. As the physicist Fritjof Capra points out “Subatomic particles are not separate entities but interrelated energy patterns in an on-going dynamic process (Capra.F, 1982). Similarly the new thought in ecology, called as “Deep Ecology” finds a similar interrelated unity in the process of physical and biological Nature as a whole. “Deep Ecology” writes Capra “is rooted in a perception of reality that goes beyond the scientific framework to an intuitive awareness of the oneness of all life, the interdependence of its multiple manifestation and its cycles of change and transformation”(Capra.F, 1982). Similarly modern depth psychology postulates a “Collective Conscious” as the underlying or common substratum of human consciousness.

The modern economic and management thought talks about the economic interdependence of the global economy. So there seems to be an integral unity, which is sustaining all creation at every level of human and terrestrial, creation material, economic, ecological, social, psychological and spiritual. As the human science progresses with the growth of human consciousness in the future, more and more of this integral unity will be revealed to the scientific mind of humanity. To pursue this intuition of unity and interdependence of life and its material, practical, social, moral and spiritual implications to its utmost details and possibilities is perhaps the best and the most effective path for modern science to progress towards the spiritual dimension or the divine.

Each field of science can do this in its own domain, physical sciences in the realm of Matter towards the Unity of Matter; ecological and life science in the realm of life towards the unity of life; psychological sciences in the realm of Mind towards the unity of consciousness; spiritual sciences in the realm of the Spirit towards the unity and universality of the Spirit in Man and the Oneness of God. The Nobel Laureate in physics Brian D Josephson, makes the following interesting observation on including the concept of God in science:

“Now there are two way in which one could approach the issue whether God has an influence on Nature. One is to continue following the traditional, materialistic line of explanation, seeing if it really explains everything. That would be a very long job. It might

be couple of centuries, before we would get the answer that way. An alternative approach for the scientist says 'Let's investigate the opposite view, that perhaps we should be taking God into account in science; what would a science look like which has God in there playing a part accounting thereby for particular phenomena'"(Josephson B.D, 2003)

The thinkers and educators in science must give a serious consideration to this alternative approach suggested by Brian Johnson. But the success or effectiveness of this approach depends on the concept of God on which it is based. If we creator sitting in some remote heaven and creating or overseeing the universe, it may not lead to any positive scientific results. On the other hand, if we conceive Man, God and Nature in the Indian spiritual perspective, then it can give an entirely new and discipline for arriving at an experiential realization of this unity. But this inner realization of unity may be difficult aim, far away from most of us. However, even a conceptual understanding of this spiritual conception of unity, along with its implications, can somehow be inculcated into the mind of the student of science, it can give a positive ethical and spiritual orientation to science. For when we understand clearly that we are, individually and higher orientation to modern ecology and environment. In this Indian perspective God is the infinite, eternal and universal consciousness, which is the creative source of the Individual and the Universe, Man and Nature. He is the deepest and innermost Self of our own being and the Universe and in which we can feel our unity with all creation Nature is the creative Energy of God and the source of all energies in the Individual and the Universe-physical, psychological and spiritual. Thus God in this conception is the spiritual Unity and Wholeness-Unity of Being, Unity of Consciousness, Unity of Energy-which sustains all creation. The other important and positive aspect of Indian spiritual thought is that it provides not only a deep conceptual insight into this highest law of unity which governs life, but also the inner collectively, linked together in a mutually interdependent unity and parts of a larger whole, and therefore our well being of others and the whole, it gives an enlightened ethical orientation to the intelligence. This intellectual understanding, may not be enough to provide a dynamic ethical turn to the whole being, especially in terms of action, behaviour and decision-making. For this to happen, the idea has to enter into the emotional and dynamic parts of our being. This is one of the great educational challenges of the future. But still intellectual understanding provides a good initial foundation.

We are now brought to the other values, well-being. As we have indicated earlier, applied sciences have pursued mainly pragmatic values like utility, efficiency, productivity and innovation. These are legitimate values, which are in harmony with the dharma of applied science. But modern applied sciences, except perhaps medical science, have neglected the value of well-being, which is also a pragmatic value. So for a more beneficent use of science and technology this value or ideal of integral well-being have to be brought to the front as the central ideal of applied sciences in theory, practice and education.

Most of us have a vague notion that Science and Technology should serve human well-being. This notion has to be made more and more clear, precise and comprehensive. What are the factors, values, ideals or principles which will lead to a positive, integral and highest well-being of human life in all its dimensions-material, economic, social, psychological and spiritual and in what way the various streams of sciences like the physical, social, psychological or spiritual sciences can work together to bring about this total well-being of human life? This question pursued with clarity and precision in all its details and in the light of an integral vision of human development, will perhaps give a new and positive direction to the future of Science and science education.

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