On Popularizing Science

by

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INTRODUCTION

Just as the renaissance period saw a rapid growth in the arts and humanities, the twentieth century has witnessed the progress of science. It is characteristic of the scientific technique that whereas the benefits of the renaissance period were confined largely to select parts of Europe, the effects of modern science are being felt all over the world. Indeed such limitations in the applications of science and technology as are seen today, arise not from any significant shortcomings of science but from the apparent inability of man to make the best use of it.

In making this statement I am well aware of the fact that scientific progress has not reached its zenith; indeed it is far from it and is never expected to achieve it. My statement relates to the present state of science and technology with all its draw-back and limitations. Even if it were frozen at the present level, it has enough demonstrated capability in it to transfrom the material existence of man for the better : and in a relatively short time too! The fact that the benefits of scientific progress are not beihg passed along to humanity repidly enough is due mainly to the reluctance on tne part of man to capitalize on what science can provide.

Among the many important issues being discussed in this Symposium, that of science popularization is one that appeals to me most. How can the common man be made aware of what science can provide? How can the benefits derivable from science be conveyed to him? Equally important is the question of making the common man aware of the dangers of the misuse of science. And, finally he is to be made familiar with the so called scientific outlook. For, without a properly cultivated scientific outlook he wiil increasingly find himself a misfit in the science-dominated future.

In this short article I wish to discuss some of these issues as I see them.

THE SCIENTIFIC OUTLOOK

Over the centuries, man the scientist has evolved a certain approach in his search for the answers to the riddies of Nature. This approach is critical as well as pragmatic. It is daring as well as cautious and conservative. It does not claim to provide the perfect solution. yet it often leads to a working approximation to it. It is this approach that is identified with the so called scientific outlook.

Take the example of how quantum theory came into existence. In the last century classical mechanics and the electromagnetic theory had reached maturity; so much so that some scientists were lulled into complacency that most of the basic problems in natural philososhy were solved;that only details needed to be worked out. Yet the scientists were begining to discover phenomena which did not conform with this classical picture. The appearance of Fraunhoffer lines in the solar spectrum was a puzzling feature. The so called black-body radiation was another.

The early twentieth century science showed that these phenomena represented the tip of the iceberg. Improved experimental techniques revealed a host of new problems which necessitated a revision of classical ideas. This reviesion was carried out by several scientists; Planck, Einstein, Baba, Bose, Heisenberg, Schrodinger, Dirac, Born and others. I give this long list of names to show how the appearance of quantum theory was not a one-shot affair but a gradual emergence of a new set of rules which could account for the host of experimental phenomena.

Even today the story is not complete. The quantum theory set out to explain the behaviour of tne small scale behaviour of matter. Deeper probes into atomtc nuclei have led to new discoveries that still need to be explained and understood. I can do no better than quote from a lecture given by G. F. Chu, a leading elementary particle physicist regarding the incompleteness of the present scientific picture:

A key discovery of Western culture has been the discovery that different aspects of nature can be individually "understood' in an approximate sense without evrything s being understood at once. All phenomena ultimately are interconnected, so an attempt to understand only a part necessarily leads to some error, but the error often is sufficiently small for the partial approach to be meaningful. Save for this remarkable and far from obvious property of nature, scientific progress would be impossible.

– Science (1968), 161. 762–5

So the scientist is well aware of the incompleteness of his efforts. While he is confident that he has achieved some success, he knows that his theory will always be 'in the dock,' to be condemned if it fails to account for some new phenomena discovered in the future. At the same time, when something new is reported, he will examine it most critically before concluding that something new has indeed been found.

Jawaharlal Nehru has aptly summarized this scientific outlook in the following words when writing to his daughter from the District Gaol in Dehra Dun on June 10, 1932 about the quest of man :

... Science gives a doubting and hesitating reply, for it is of the nature of science not to dogmatize, but to experiment and reason and rely on the mind of man ...

Nehru was a great advocate of the scientific outlook not just for the sake of science but for the uplift of the common man. Indeed, the common man has a great deal to gain from the scientific outlook as I will later elaborate. It is also not correct to associate this outlook with all practising scientists! Indeed I have come across many professional scientists who are devoid of this outlook. To me these people are not true scientists but are persons employed in the practice of science for their livelihood.

To sum up then, the scientific outlook is an attitude of mind. It is inspired by science, its cultivation is helped by a training in science but it is not the prerogative of the professional scientist. The layman can aspire for it and derive benefits from it.

Science Versus Traditional Dogma

In what way can the layman benefit from the scientific outlook? The answer is provided by considering the contrast between scientific thinking and the thinking rooted in traditions.

Since man became 'civilized' he discovered how a society of human beings can live together in harmony by following a set of rules. These rules evolved from a pragmatic trial and error approach and were supplemented by a set of beliefs which were primarily designed to

answer the unsolved questions about natural phenomena. Gradually, however, these beliefs and rules became deep-rooted. Instead of modifying the rules to adapt them to the changing circumstances and shedding some of the beliefs when the correct answers to some of Nature's riddles were known, the human societies tended to regard them sacrosanct.

Some of the traditions and rituals of the Hindu religion had their origin in some very sensible practices which were relevant to living conditions two or more millennia ago. The same traditions and rituals in today's living conditions appear meangingless, time consuming and energy-wasting. Yet they are followed blindly today. The belief in the divine power of the planets was understandable in the days when planetary motion was a mystery. The mystery was resolved by Newtonian gravitation more than two centuries ago; but the belief in astrology still persists.

I have given these examples to illustrate my point of view. The tradition-blinded attitudes are not confined to one particular cult or religion, or to the poor or the uneducated. It is to be found in the well-to-do and among the highly trained professionals all over the world. Two years ago a numer of leading scientists in the United States felt impelled to write a communique in the humanist, warning against the dangers of practising astroiogy which is gaining popularity among the professionals in that country! These days we are very sensitive about the gulf separating the rich from the poor. We are striving to reduce the gap between the educated and the uneducated. Yet how conscious are we of the differences between the scientific outlook ahd the tradition-bound attitude? Such is the state of affairs today that many educated peopie today are not only ignorant of this difference but would not be prepared to attach any importance to it even if they were made aware of it.

Social scientists are well aware of the role of traditional dogmas in hampering the progress of human society. Science has tantalizingly offered means to uplift the standards of human existence. But the acceptance of these means depends on man himself. He has to ask himself the following questions. To what extent are the rituals I follow really essential for me? Can they be replaced by new inputs from science? Should I accept everything that science has to offer? Are the new inventions of science worth the price I may have to pay in tampering with nature?

Such questions are born out of the scientific outlook. Notice that they do nor advocate a blind acceptance of the gifts of science! In this sense the scientific autlook may work against science. But this is how it should be.

How to popularize this outlook among the masses? In the following part of this paper some constructive suggestions are made. Briefly the three levels at which action can be taken are as follows.

1. Formal Education : This method employs technipues suitable for those who aspire for school and/or college education.

2. Adult Education: This approach is more informal and is directed at those who may not have further opportunity of formal instruction.

3. Informal approach: This is unorthodox and may be suitable for the uneducated as well as the educated masses.

Science through Hobbies and Recreations

It is often the case that the introduction of of new material in the formal educational syllabus, even though inspired by the most enlightened motive, turns out to be counter-productive. Just because he has to learn it as 'a part of the course' the pupil develops

antipathy towards any new idea. For this reason new methods are needed for inculcating a genuine liking for science and for developing a scientific outlook among the students of science.

I recall the excitement I felt when my class teacher demonstrated how the siphon works by bending a glass tube on a flame and using it to transfer water from one beaker to another. After the demonstration the teacher explained the principle behind it through a series of questions and answers. No amount of text-book reading and mugging the so called principles would have equalled the effectiveness of this approach. Later, I remember trying the experiment at home with rubber tubing.

One reads in books about how James Watt realized the power behind trapped steam by seeing the lid of a kettle of boiling water pop over. It is a simple enough experiment to repeat; and I am sure that an actual demonstration will be far more effective than mere reading out from a book.

In these examples above I am not simply advocating the use of experiments in teaching science. This is already being done. However, most 'practicals' have developed a routineness about them so that the student performs them mechanically. Sometimes we encounter the ludicrous situation where the student fudges out the 'expected' answer from a wrong experiment! Such practicals do more harm than good. What I would like to see being done is the creation of experiments which genuinely convey the excitement of scientific discovery to the pupils.

In this instance the hobby centres and recreations have a major part to play. Given a set of lenses can a pupil construct a telescope or a microscope? How can the experimentalist modify the given apparatus to extend the range of his results? Such questions can generate more inputs from the students.

Mathematics, the queen of sciences, teaches us the importance of logical reasoning, precision of statements and the limitations of what can be said under a given set of assumptions. These attributes are necessary for success in life - far beyond the narrow range of text book maths. Yet, how many students really learn these things from the regular courses in mathematics? By following the routine courses they may end up as competent mathematicians wthout catching the spirit which drives a really good worker in this field.

It is here that mathematical recreations have a constructive part to play. Mathematical paradoxes, fallacies and puzzles are ways of introducing mathematical concepts without intimidating the novice. There is an expanding library of books of this type, which the student and the teacher should draw upon. Care must be taken, however, that the 'should' is not changed to 'must' with the result that these items again become routine and lose their charm by becoming 'part of the course'!

Adult Education

In this section I am not talking of educating the uneducated but of educating the educated! These are people who have had education upto various stages but who are still driven by traditional dogmas. How to make them receptive to new ideas? This in my opinion, is far more difficult than educating schoolchildren.

How do you convince a graduate that if he wants tc undertake any important task he need not wait for an auspicious hour dictated by an astrologer? If a hard-headed businessman being a firm believer in the miraculous power of self-professed 'holy' men insists on believing that a watch (or some such item) has been produced by the miracle worker out of nothing; how do you disillusion him?

I, personally, am rather pessimistic of any short-term solution of this situation. A long-term answer may come from proper re-education. Public lectures about scientific matters, demonstrations of scientific experiments, books about science which can be understood by the layman can play an important part in this process. Exposure of fraudulent miracles will also go a long way towards teaching the precept known to every scientist: "You can't get something out of nothing."

It is wrong to assume that these problems will disappear in an ultra-modern technological society. The example of the Western countries like the U.S. shows that life in such a society brings in its own tensions and to escape from these the victim seeks a world of make-belief in which he thinks that shortcuts to success exist through miracles, astrology etc. It is worth noting in this connection that the world's great religions have never advocated such shortcuts. They have invariably laid stress on hard work, knowledge and determination. In this respect they share the ideals of science.

Story Telling

It is characteristic of all civilizations that they develop mythologies. The myths and folk-lore are handed down from generation to generation and are often deep-rooted among the masses. This is because story-telling is an effective means of teaching.

The great Sanskrit classic 'Panchatantra' is a collection of stories told by a scholar named Vishnu Sharma to the sons of a king. The king had been unsuccessful in educating his sons through formal channels as they were totally unreceptive. Vishnu Sharma, however, succeeded by telling them interesting stories with morals. Cannot science do the same today?

The coupling of science with story-telling immediately brings to the mind the concept of science fiction (SF). Today there is considerable SF-literature in the West although in Indian languages there is not much of it. It is, however, necessary to distinguish between good SF which seeks to educate and the bad which is merely a collection of horror stories in another garb.

The good SF will be useful not only for the re-education of the educated but also for the uneducated and the illiterate who occur in significant numbers in the developing countries. Perhaps this may turn out to be the only quick way of transporting them from the ancient folk-lore to the modern twentieth century. This is my unorthodox suggestion !

Conclusions

I have briefly outlined some ways of popularizing science at various levels. By science-popularization I also imply the popularization of the scientific outlook. As the first three quarters of the present century have shown, there will be an increasingly rapid growth of science in the foreseeable future. More and more frequently man will be confronted with the choice of whether or not to follow up any new invention of science. And the issues will be of such a nature that the progress and even the survival of the human species will depend on making the right decisions. It is therefore vitally important that the common man knows what science has to offer and has the ability to make the right decision.

The developing nations with more limited resources at their disposal must use them as efficiently as possible to improve the standard of living of their inhabitants. They cannot afford to make the wrong decisions.