On the State of Scientific Research in India

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The question of the quality of scientific research and accountability of scientists in India has been vigorously debated in news media as well as some leading science journals. A potentially good sign is the frequency of this debate and the variety of fora which have taken up this debate in recent years. Divergent viewpoints have been presented although it has been usually agreed that the quality of research as well as teaching in science is, in general, far below the desired levels. A variety of reasons have been ascribed to this sorry state of affairs. This article may repeat some of these but I feel that certain factors, which to me appear to be basic cause of the existing malady, have generally been ignored. I will attempt to bring these into focus. Before going into these, we should briefly consider the compulsions of undertaking research and the minimal conditions required for meaningful results of endeavours in this field.

What is Research?

To be curious about self and the surroundings is a basic human nature. One may be curious about a large variety of things or issues but only in some cases is the interest strong enough to drive one to make positive efforts to satisfy the curiosity.

In "SCIENCE IN INDIA: Excellence & Accountability"
(1994) P. N. Srivastava (ed.), Angkor Publ., New Delh

The act of research is one's response to an inner urge to seek answers to questions that arise in our mind. Thus research, in any field of enquiry, has two essential components: first, the questions or curiosities that originate from existing knowledge and second, the urge or desire to find answers to these questions. Research is a continuing or open ended learning process and researchers need to have a child-like curiosity. It is well known that childhood is the most active phase of learning the unknown but as we grow older, the urge to seek answers to the many diverse queries that consciously or sub-consciously arise in our mind gets less intense or is ignored due to a variety of other pre-occupations. Research requires training to focus one's thinking and to seek answers in specific chosen area. Just as one cannot be forced to be a poet or an artist, a research career cannot also be imposed on anyone. Researchers need a special bend of mind which makes them curious and creative. It is this that also differentiates a technician from a research scientist. In scientific research a set of approaches are planned on the basis of our existing knowledge and the nature of enquiry. A technician who merely carries out the pre-defined steps of certain specific techniques or methodologies does not become a researcher.

Requirements for ensuring quality in scientific research

The key element in scientific research is the researcher, who as discussed above must have the appropriate questions and the desire and capability to seek answers in a logical manner. Modern scientific research in most cases requires elaborate laboratory settings (or infrastructure) that include both the material facilities and appropriately trained manpower. The material and manpower components of the infrastructure facilities vary in relation to the nature of research activity. However, in general an ideal or a good setting for scientific

research demands that the core scientific personnel are able to devote all or most of their time and energies to creative scientific activity, rather than get distracted in more mundane activities.

A third important requirement for establishment and maintenance of quality in scientific research is the interactive and critical feed-back from fellow scientists or peers. This feed-back, generally termed "Peer-review" has two very significant functions — firstly, the interactive feed-back often allows a different perspective or point of view which the original investigators may have missed. The second and perhaps more important role of the peer-review process is to act as the watch-dog to keep the claims of scientists in check and to ensure that in their own enthusiasms (justified or otherwise), the scientists do not lose sight of objectivity. Although the peer-review process may occasionally have stifled a new or bold viewpoint, it has generally played a positive role in quality control.

Factors that affect science research in India

India claims to have a very large scientific manpower and viewed in relation to its overall economic conditions, a fair amount of money is spent on teaching of science and on science research. However, compared to investment (money and manpower), the impact of scientific research carried out in India is practically nil on world science. In order to understand the reasons for our poor performance in this field, we may examine the situation with respect to the above considered three requirements for good science.

Manpower

As stated earlier research activity is essentially for satisfaction of one's curiosities. We may ask if the large number of persons joining this field in India do so on their own volition? The answer is "generally no"! Indeed a large number of scientists and teachers of our country are in the field because in spite of their best efforts they could not be elsewhere. Validity of this apparently harsh statement will be evident when we consider the compulsions imposed on a school-leaving child regarding the choice of career. In nearly every case, the school-leaving students of science stream who are in the upper bracket of intelligence and enthusiasm are persuaded to join professional courses (e.g., engineering, medical etc). This preference is nearly universally encouraged by parents and teachers alike. To the student and his/her parents or teachers the prospects of joining a University/College to go through B.Sc., M.Sc. and Ph.D. does not look very attractive. Actually it is often looked down upon. Our social structure regards professional courses with esteem while a Ph.D. is the poor cousin. With limited employment opportunities, the prospects of finding remunerative and "Prestigious" jobs are much better for professionals than for Ph.Ds. A greater premium is put on professionals in the marriage market as well! The net result, therefore, is that a career in teaching and research is taken up mostly by those who failed to enter a professional career. Even among those who are left in this stream, many better ones try to join administrative services etc. Thus the pool of manpower that joins academic and scientific community is already impoverished.

The existing syllabi, the methods of teaching, the laboratory and library facilities available at most colleges and universities do not help to generate any excitement about science or scientific methods in the young minds who by

choice or otherwise find themselves in this stream. The shockingly poor state of laboratories and libraries that exist in the Science departments of most colleges or universities (including those recognized by the UGC as "Centres of Advanced Studies" or "Centres of Excellence") is to be seen to be believed. This is really unfortunate since all university departments or colleges have received development grants from UGC during every 5-year plan period - however, it is sad to remark that in most cases these "development" grants have been siphoned off to "develop" so-called research facilities. The needs of the laboratories where the students have to be trained in methods of science have been glaringly ignored. The result is that laboratories for B.Sc. and M.Sc. students have in most cases remained as ill-equipped as they were several decades ago. Likewise, more reference books (supposedly essential for researchers but rarely used by them) have been purchased out of these "development" grants in most of our libraries while the young students keep on waiting for basic text-books to be available for their studies.

Science can be properly learnt only when backed by appropriate laboratory exercises which give the students a feel for experimentation. However, what is carried out in the name of laboratory exercises in most cases is a monotonous set of "practicals" which many students find more convenient to just copy from their seniors' records rather than do it themselves. The inflexibility of the courses of our degrees inhibits any inter-disciplinary approach although every available platform is used by academic and political leaders to extoll the virtues of inter-disciplinary research ! All this certainly does not prepare a student for a serious research career. Since our academic system, instead of encouraging questions, actually suppresses curiosity, even those who join a B.Sc/M.Sc. course with some enthusiasm, are likely to graduate with a degree but minus their enthusiasm. Thus a young person who is compelled to join research for Ph.D. is

generally very ill-equipped for this career. Most of them have never even thought of a question that they may want to pursue for research. It is common experience that the young persons who approach a teacher for supervising their research, leading to Ph.D., also look upon the teacher to define their "problem". It may be admitted that a fresh M.Sc. may not be fully equipped to define one's research problem, but he or she should at least have thought of some questions in the relevant area which he or she finds interesting to pursue. In most cases, they have not done so either because they are incapable of doing so or in the existing system a need for this was never felt. Thus the very basic requirement for quality research that the scientist should be driven from "within" to undertake the arduous task of research is not fulfilled by these would-be "scientists". Obviously, the result in most cases is churning out of Ph.Ds who are not worthy of the degree that is so easily given by the system.

The quality of young researchers cannot be viewed in isolation of the quality of teachers. The teachers or investigators who guide or conduct research also frequently lack an honest motivation. More often than not, "research activity", instead of being fuelled by an inner desire to seek knowledge, is undertaken as a compulsion for reasons of promotion and/or to somehow maintain their "status" in the scientific community. Although on paper all promotions, time-bound or competitive, are through an elaborate system of assessments and so on, when put in actual practice, the objectivity behind these assessments is more often a casualty than a guiding principle. Withdrawal of the merit-promotion scheme in Universities or Colleges is a telling example of the gross misuse of an otherwise effective promotional avenue. The system of promotions in Universities or other academic institutions relies heavily on the quantity of Ph.Ds and papers "produced" rather than on their quality. It is a fact that a candidate aspiring for appointment or promotion in a teaching

job is rarely asked about his/her teaching interest or capabilities. Everyone in the system appears to believe that a person "producing" many papers/doctorates is also teaching well. In this rush for quantity, not only the quality of science suffers but it also leads to a more harmful snow-balling effect of producing poorly-taught and ill-trained degree-holders who would be future scientists or teachers.

Related to the poor calibre of many of those engaged in "scientific research" in this country is the lack of original questions in their minds. As a result, majority of labs in University departments and research institutions around the country remain busy with trivial issues which cannot make any impact on world science. Unfortunately, even in many cases of research in the so-called "front-areas", the research being pursued is not based on original questions but happens to be a mere extension of the work that the given scientist was carrying out while in a western laboratory. The work being done in the Indian lab, therefore, remains peripheral although the concerned scientists may get good certification/acclaim because of their association with an established western lab. The Ph.Ds of these labs are also "tailor-made" for the western labs. This is reflected in the misplaced pride that many of us take in having more of our Ph.D.s working as postdocs in a western country rather than encourage the brighter of them to settle in the country itself. Almost all the leading scientific institutions in country suffer from this complex. These institutions attract the best students available and almost invariably "export them after having trained them at a considerable cost to the country. How many of these better trained students have been encouraged by their mentors to accept the challenge of taking up positions in lesser institutions in the country so as to create new centres of "good-teaching and good-research"?

Infrastructure

The above dismal picture does not imply that all activity in the name of scientific research in our country is worthless. Fortunately, there are still some motivated and capable individuals or groups who are continuing to strive for excellence. However, can they attain the level of excellence that the country may expect of them? Unfortunately again the answer is in negative because the working conditions (poor administrative infrastructure, complex time-consuming bureaucratic procedures, poor library facilities, uncertain water and electricity supplies, poor communication systems, etc., prevailing at our Universities or Institutes leave much to be desired. Consequently, the sincere efforts put in by these dedicated individuals or groups result only in a limited achievement. In addition our nearly complete dependence on import of most equipments (sophisticated as well as not so sophisticated) and chemicals or reagents etc. that are vital for research in frontier areas also accounts for the slow progress. Poor maintenance and repair facilities that exist in most research establishments further aggravate the woes of motivated hard-working scientists. All these compel the devoted and capable Indian Scientist to take a back seat in competitive areas. Of course for those who are pursuing a so-called scientific career for other compulsions, these hurdles provide very "valid" excuses and alibi! Thanks to a greater input of money for science research, one may see very well equipped and "beautiful" laboratories at many places. However, these labs often remain showpieces only because the expensive, imported and "latest" equipment may have never been commissioned and may even be irrelevant to the lab which they decorate. This situation would not have arisen if the peer-review system was effectively implemented.

Peer-Review

Peer review (review by competent colleagues and fellow-scientists) is the most important watchdog for creation, promotion and maintenance of excellence in science as in any other field. Unfortunately, the peer review system has failed in India because of a general absence of appropriately qualified, honest and courageous peers or colleagues. Those who have to act as referees or reviewers either lack critical objectivity or the courage to be objectively critical of a colleague. Therefore, a constructive feed-back is rarely available. As a typical example of this lack of objective and critical feed-back in India, I may cite the case of a text-book written by a "leading" Indian scientist in the field – this book, now in its 3rd edition, has very serious flaws and does enormous harm to gullible teachers and students alike. Ironically, in the Preface the author thanks several colleagues (including two who happen to be FRS) for reviewing the book which was supported by UGC and was subsidized by the National Book Trust. These facts are a telling example of the sorry state of the peer-review process.

The absence of a strong peer review is glaringly apparent in the very poor quality of a majority of the science journals published in India. Many journals do not even pretend to have a review system for submitted articles; however those that have, also suffer due to subjective views of the reviewers or editors. With regard to refereeing, it is unfortunate that in spite of a very large number of "scientists" in the country, there are only a few in any given field who could perhaps be rated in upper category by world standards. Unfortunately, many of these "top scientists" are no more active "bench-workers"; they are more of administrators than scientists. They do not keep pace with recent developments in the subject and therefore, refereeing on their part becomes more dependent upon their personal view of the scientists

concerned. A paper is thus often liable to be accepted or rejected for publication on the basis of personalities involved rather than on the merits or demerits of its contents. The same applies to grant of funds for individual research projects or for bigger grants to university departments. Members of expert committees find it mutually convenient to refrain from making critical observations publicly.

Based on personal knowledge, I may give an example of the casual attitude to the reviewing process : a university department receiving support under COSIST programme of UGC (thus recognized as a center of excellence) was visited only once during a period of five years by an assessment committee; the visiting committee consisted of an official of UGC and an expert member. Interestingly, the "expert" did not belong to any of the specializations that were recognized by UGC as thrust areas for the department. The committee could hardly spend an hour in the department since the "expert" had to rush back by the same afternoon flight ! Thus a critical review of the performance of the departments that are receiving substantial grants from UGC and other bodies is practically non-existent. There is no pressure on the institutions to feel accountable or to undertake serious responsibilities of any kind. The officials of the funding bodies as well as the "experts" who constitute the visiting/assessment committees have to equally share the blame for their failure to insist upon proper implementation of the programmes and introduction of some basic corrective measures.

In this subjective environment, poorly planned and/or poorly executed and worse still, even unexecuted experiments are accepted and claimed to provide significant results. In the absence of proper training in research methodology and a self-imposed or institutional discipline, a detailed record of actual experiments conducted on day-to-day basis is rarely

maintained. We do not have any organized machinery to insist upon this basic laboratory discipline. Therefore, a verification of the claims made is often not possible.

With the over-abundance of mediocrity, the plethora of awards and "recognitions" instituted by the numerous organizations (governmental and others) with the stated objective of encouraging and promoting excellence in science in the country have become counter-productive. We have created our own brand of "bright young scientists" and "leading scientists" who may actually have little impact on science at the national or international level. Another unfortunate feature of our value system is that if one is rightly or wrongly recognized at some time point in one's career as having made a significant contribution, the person continues to be recognized as a "leading scientist" even when he/she may have actually ceased to be active in the given field: as a society, we are too polite to call a spade a spade ! With a critical appraisal generally missing, all types of claptraps are employed to bag as many different awards etc as may be available. Sycophancy and groupism are common in most institutions that are involved in making awards etc. Obviously the sincere and dedicated worker has to often suffer and feel demoralized. We have an overwhelming mass of mediocrity so that mediocrity maintains and promotes itself. It would not let excellence grow very easily.

Some suggestions for improvements in quality of scientific research

A basic cause for the poor state of scientific research is the general erosion of moral values in all walks of life in our country. In absence of critical feed-back, even the best-intentioned person tends to degenerate over a period of time. Thus attempts to improve the quality of scientific research

have to be linked with improvements in other sphere as well. However, since scientific research and related activities involve a selected sub-set of population, it may be hoped that certain measures if properly implemented may at least initiate qualitative improvements. Since the centre stage in scientific research is occupied by the scientists themselves, my suggestions relate mostly to improving the quality of manpower involved in scientific research. I believe that a "critical mass" of the right kind of people will initiate a cascade of change for the better.

The first and foremost requirement is to encourage and attract the right kind of persons to this field. This has to start at school level. The ill-conceived social values that regard only professional courses as of any consequence have to be rectified so that the young students are encouraged to take up a profession of their choice rather than be coerced by parents/teachers/friends to toggle between engineering or medical courses. This change not only requires that a teaching/research career be made economically more attractive, but also necessitates the availability of proper vocational guidance at the senior school level so that children at that stage can identify their likings more objectively.

The under-graduate and post-graduate courses in general science subjects should not be reduced to dumping grounds where all those who failed to be elsewhere could be sheltered. The intake for these general courses must also be highly competitive so that these courses are generally open to only those who really want to take a career in research and/or teaching. Social values of a "degree" must change so that every young person need not feel compelled to get a university degree for that purpose only since in most cases the degrees turn out to be totally irrelevant to the profession finally taken up.

With a very large number of M.Scs and Ph.Ds being "produced" as of now, quality control becomes impossible. This situation breeds nepotism and kills a healthy competition. A beginning in this direction has been made with the introduction of national level tests (NET/GATE etc) for research fellowships. However, a drawback of these tests is that they may at best examine the knowledge and understanding of the candidate but whether the candidate is capable of independent thinking and has an aptitude for research remains largely untested. Therefore, additional ways and means need to be devised to test these essential qualifications for being a good research scientist.

In an attempt to build a strong base in Science, we have invested substantial amount of money and resource in research and teaching at graduate and post-graduate levels. While this is desirable, a basic fault in our national planning has been the neglect of school education. While in other countries the university education is much more expensive than the primary and secondary school education, we have a highly subsidized university education but generally very expensive schools. Added to this is the relatively poor salaries and social status of school teachers. This is very unfortunate since the job-requirements of school teachers are much more strenuous and also their responsibilities in building future citizens are greater. We must correct this imbalance so that dedicated and capable young persons are attracted to take teaching in schools as a career with preference rather than under compulsion of no choice. Good teachers help generate better students and good school teachers would do that on a larger scale since they handle many more students than the college and university teachers.

Almost every academic institution in our country suffers from a very high degree of "in-breeding". This has to stop. The advantages of "hybrid-vigor" is well documented in Biology.

Application of the same principle to our academic manpwoer will definitely have salutary effects.

To gradually generate the "critical mass" of good teachers and researchers, we must encourage our better students to take up positions in different academic institutions within the country instead of encouraging them to find better pastures abroad. This will require a change in attitude on part of the young persons, their mentors as well as of those appointing them. The young persons need to be prepared to accept the challenge of creating good facilities for teaching and research where these may not be existing. At the same time, those providing the jobs must also help in creation of appropriately conducive environment. The common argument that only when the working environment improves can we ask the younger generation to take up positions within the country is wrongly founded since the establishment itself will not change unless forced by those affected by it. Therefore, I believe that the initiative to accept the challenge to do good research work under Indian conditions has to come from the younger generation.

The vicious circle of mediocrity in peer review process has to be broken. This requires some amount of courage and dedication to the cause. This is not entirely missing among working scientists of India. The more dedicated among the senior as well as younger scientists must speak out more candidly against the prevailing mediocrity. Editors of scientific journals have a great responsibility in shaping the quality of research. A positively critical approach with a firm but helpful attitude on part of the editors and reviewers will help the scientists to take scientific research more seriously and honestly. Similarly the funding bodies need to feel that they themselves are accountable to the nation and then only can they compel the scientists and academics feel accountable for the financial support they receive.

To promote quality in research output, only a certain maximum number of research papers, depending upon the level of seniority, should be evaluated for appointments and promotions. Total number should not be the only criterion for assessment purpose, since one may be a prolific publisher but with little purpose. Limiting the number of papers to be considered for assessment would inhibit the tendency to publish anything just for the sake of numbers.

The present system of appointments of teaching staff in university departments and colleges involves a small selection committee which interviews the candidate and in a matter of a few minutes, candidate's fate is determined. This system does not test the teaching capabilities of the candidate who is being appointed primarily for teaching. This may be partly offset by asking the prospective candidate to deliver lectures to students and staff of the department or college where appointment is to be made and by involving all existing staff members in a collective decision. The system should keep pressure on teachers to take their responsibilities seriously and good teaching must be appropriately rewarded. For this purpose, the assessment system for promotions etc in the teaching institutions should include an evaluation of teaching capabilities. The UGC has periodically talked about this issue, but it has never been seriously introduced in most academic institutions. This must be done.

The level of degeneracy that we have attained does not now permit many soft options for retrieval. The situation requires some harsh, unpalatable "undemocratic" steps if we want the basic intelligence that Indians generally possess to be useful in nation building.

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