Declining Trend in Science Education and Research in Indian Universities

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Abstract

Universities are knowledge based organizations whose functions are largely confined to teaching and research. They are designed to operate to discover and disseminate knowledge by possessing significant and relevant expertise in all disciplines. India has a very vast structure of education and its higher education sector is now highly advanced, compared to its neighboring countries. The vast network of state funded Indian universities appears to be sinking into a state, where academic performance both in teaching and research become partially marginalized. Erudition and scholarship are no longer pre-requisites for advancement through academic ranks. Research both in science and the humanities, gets back the backseat and mediocrity has become glorified. A regressive trend has been observed in the past few years in science education in universities. Science seems to be losing out to other disciplines, particularly the professional courses in attracting students. The recent trend observed in secondary and tertiary education sectors is toward non science courses. Inadequacies in the policies of the government, negligence of its importance by political parties and social organizations, etc., have accelerated the decline. The widespread impression among students is that unlike professional courses, a career in basic science is not lucrative.

Universities have long abandoned the accent on research and have become mere teaching centers. Research aptitude in students is not properly developed during their course of study. Their curriculum is neither research oriented nor updated. For many reasons majority of teachers with doctoral degrees in science are unwilling to undertake research projects or collaborative research. The academic ambience persisting in many universities do not encourage the research pursuits of faculties. Research management in universities is another very serious problem faced by many Indian universities.

Careful analysis of the situation is necessary for elucidation of this trend and finding effective strategies for strengthening science education. An extensive study was made to establish the nature of science education of the Indian universities and the current trend. The study focused on the following topics.

- Policies and practices existing in the higher education sector
- Analysis of the pattern of enrolment in science degree programmes in Indian universities
- Centrally and state funded universities and their academic performance
- Quality assessment mechanism
- The central funding schemes in research and their distribution among universities and research institutions

A model survey was conducted in this context to explore the mindset of the students and teachers about the issue. Students from selected colleges who study science as major was given a questionnaire for extracting their opinion towards the present system of education, the course, their aptitude towards research and similar issues. Teacher survey reflected their attitude towards teaching and research. The sample survey indicates many inadequacies at the level of teaching and learning. Remedial measures are necessary for rejuvenating the interest in science and for ensuring productivity. The conclusions made here suggest immediate action on the following areas.

- Teachers must be equipped to design the curriculum with interactive teaching component giving emphasis to research.
- Competency of the students should be measured at a collective level
- The career in science must be made attractive
- Support must be given to application driven research in basic science
- Research management strategy must be strengthened.
- Teaching work and research work must be separately counted
- Research productivity must be rewarded
- Identification and exploitation of intellectual property right

Long term planning and flawless polices are required to sustain the existing talent and induct new aspirants to meet the challenges of a competitive world.

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1. Introduction

Universities are knowledge based organizations whose functions are largely confined to teaching and research. They are designed to operate to discover and disseminate knowledge by possessing significant and relevant expertise in all disciplines. Over the past few years the education system has been experiencing a radical and unprecedented process of reform. The reform on higher education is increased pressure for more accountability, changes in structure, increased student numbers and intense exposure to market forces (UNESCO, 2004). The expansion of knowledge based society beyond the confines of universities, have precipitated conflict between quality and quantity. Quality may be judged by the outcome of performance indicators. The vast network of state funded Indian universities appears to be sinking into a state, where academic performance both in teaching and research become partially marginalized. Erudition and scholarship are no longer pre-requisites for advancement through academic ranks. Research both in science and the humanities, gets back the backseat and mediocrity has become glorified. A regressive trend has been observed in the past few years in science education in universities. Science seems to be losing out to other disciplines, particularly the professional courses in attracting students. The declining trend is a global phenomenon. But it is much felt in India. A few universities and colleges have closed down their science departments. Major research establishments have vanquished their efforts to locate eminent scholars. The recent trend observed in secondary and tertiary education sectors is toward non science courses. Inadequacies in the policies of the government, negligence of its importance by political parties and social organizations, etc., have accelerated the decline.

Scientific knowledge can be achieved by the cumulative experience of knowing how by doing it. In most case, it is achieved by participating in the practical research group. Research can therefore be seen as a way of learning. Universities have long abandoned the accent on research and have become mere teaching centers. Research aptitude in students is not properly developed during their course of study. Their curriculum is neither research oriented nor updated. For many reasons majority of teachers with doctoral degrees in science are unwilling to undertake research projects or collaborative research.

India has a long flourishing tradition of education in pure and applied sciences. The country has nearly 49 million graduates and about a quarter of these have a background in science. India has a very vast structure of education and its higher education sector is now highly advanced, compared to its neighboring countries. It consists of more than 338 universities like institutions and 17,625 colleges capable of producing the largest share of educated manpower in the world. Studies made at various levels (Garg and Gupta, 2000) have illustrated a paradigm shift away from science both at secondary and tertiary levels.

In the comprehensive report published by the National Council of Applied Economic Research (NCAER) reveals that less than three percent of school children want to pursue a carrier in science (Rajesh S., 2005). Students drift to other job-oriented courses after graduation in science is prevalent in India. The widespread impression among students is that unlike professional courses, a career in basic science is not lucrative.

In many campuses the teacher acts as information delivering agent who tends to promote memorization rather than conceptual understanding. The authoritarian nature of teaching-learning practice existing in universities turns students as respectable receptors of a pre-constituted knowledge package. The academic ambience persisting in many universities do not encourage the research pursuits of faculties. Research management in universities is another very serious problem faced by many Indian universities. Careful analysis is necessary for elucidating the reason for the decline and to find proper measures for strengthening science education and research. Addressing all the issues of these institutions in a country is a cumbersome task; however, there are many common problems that can be sorted out. A model survey was made in this context to analyze the issue. It reflects some of the major causes of this decline and possible measures for reversing the trend. The study was conducted among students and teachers. A two pronged approach-one at the university level to revamp the structure and another at national level may provide attractive opportunities on a par with other professions, for creating and sustaining the interest in science. A few remedies are suggested here as an out come of the analysis.

2. Back ground of the issue

Careful analysis of the situation is necessary for elucidation of this trend and finding effective strategies for strengthening science education. It is therefore relevant to examine the present system existing in India.

2.1. Science education in universities- the general trend

Considering the large population and the vastness of this area there seems to be an overwhelming demand for trained personnel, educators and research scientists in India. While the global development is linked directly to the developments in science and technology the attitude towards science education and in particular the sciences at universities is not encouraging. Statistical data complied from different agencies are given in Tables 1 - 3. The overall proportions of bachelors degree enrolment in all science subjects has varied from 27.95% to 29.5% during the period 1995-2005. The proportion was 34.65% in 2003-04. For the basic science subjects the proportion remained almost steady whereas for professional degree programs the trend was upward. It has improved from 6% to 8% in a decade. Nearly 0.3 million students appear for the screening test seeking admissions to various engineering courses in the seven prestigious Institutes of Technologies (IITs). So also the enrolments in medical subjects had shown an increase. In postgraduate degree courses the enrolments in natural science subjects had shown an absolutely declining trend.

Table 1. The trend in enrolment in India at university level

Subject	1995-96[1] (million)	2000-0[1] (million)	2003-04[2] (million)	2004-05[3] (million)
Science	1.91	2.62	3.29	2.95
Arts	3.18	3.88	4.65	4.37
Commerce	1.13	1.51	1.20	1.61
Others	0.43	0.44	0.36	1.08
Gross Enrolment	6.65	8.45	9.50	10.01

1University Development in India, Basic facts and Figures, University Grants Commission, Government of India

2 National Science Survey 2004, NCAER

3 Higher Education Statistics, Ministry of Higher Education, Government of India

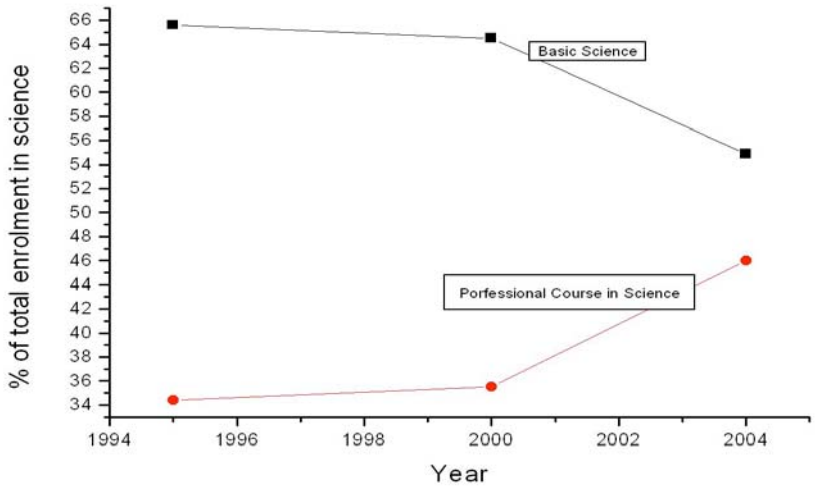
Table 2.. Stage wise enrolment in 2004-05

Type of Degree	Total Enrolments (million)
Bachelors' degree in Science	1.6141
Bachelors' degree in Arts and Humanities	5.4382
Bachelors degree in Eng. Technology	0.7729
Bachelors' degree in Medicine and related subjects	0.2232
Master degree in Science	0.2374
Master degree in Arts and Humanities	0.5692
PhD/ DSc/ D Phil etc	0.0655
Others	1.0886
Total	10.0091

Source: Ministry of Higher Education Statistics-2004-05

The NCAER study revealed that the total number of postgraduate students in the country was 1.73 million in 2003-04; almost double the number in 2000-01. Enrolments in postgraduate courses of natural science subjects were declined from 26.6% in 2000-01 to11.5% in 2003-04. For all other subjects there was an improvement is enrolments during the years. No separate subject wise analysis was available for enrolments in doctoral subjects. Generally, students from rural areas show more preference for arts subjects than in science. Variations and the general trend in basic science subjects and professional science subjects is depicted in fig 1. The statistics provided by the Ministry of Higher Education shows that there are 62,867 Ph D holders in Science and Technology in the country during 2002-03 which constitute 67% of the total. India had 10.01 million students in tertiary sector while China had 19 million students. It is surprising to note that this section is only 10% of the total population in the age group 18-24. The Indian university student population is projected to grow from 10.01 million to 11 million by 2008, according to the University Grants Commission, which funds and supports universities in India. There is also an increase in the number of Indian students seeking admissions in foreign countries. During the academic year 2003-04, 79,736 students from India were studying in the United States. The unemployment percentage among science

graduates is also increasing. Also many people who have science graduation are not made to pursue a science centered job. Among unemployed post graduates 63% are science degree holders and 14% are PhD holders in science!



Frig 1. Enrolment in basic science education and professional science education in India

Table 3. Growth rate in enrolments for various subjects in India

Subject	1995-2000(%)	2000-03(%)
Science	6.5	7.9
Natural Science	6.1	1.6
Engineering	8.2	21.9
Medicine	5.8	1.8
Agriculture/ Veterinary Science etc	4.7	7.9
Arts	4	6.2
Commerce	6	7.3
Others	0.5	6.5

Source: India Science Report, NCAER

2.2. Research in science and technology

Research in pure science in India is also on the decline. In major disciplines like physics and chemistry, the number of brilliant students opting for research appears to be sharply declining (Balram, 2002). For mathematics research, the number has fallen considerably low. With the recent developments in biotechnology and the popular notion created by the media that bio science is going to fuel the economy in the next century, research in biology has shown a relatively good trend. The developed nations are however, managing the problem by attracting brilliant scholars from other countries. If this trend continues, India will face a shortage in R & D personnel very soon!

2.3. Policies and practices in science education and research

The science policy of the government of India (1958) clearly states that the country is committed to secure all the benefits that can acquire from the acquisition and application of scientific knowledge for the benefit of the people. During the last 59 years of independence, the country has developed a number of scientific and educational establishments and has considerable number of trained personnel in science and technology. Despite the remarkable progress the country has made in space technology, nuclear science, information technology and health, it remains backward on many counts. A brief summary of the Science and Technology progress is given in Table 4.

Table 4. Science and Technology of India-*highlights*

R& D Investment	0.8% GDP
Researchers in R&D (per million people)	7800
Women in R&D sector (% of total)	12.7
No of personnel employed in R & D sector (per million people)	276.12
PhD holders in Science & Technology (per million people)	58.64
Patents generated (per million people)	1.01
Tertiary students in Science Math's & Eng. subjects (% of all tertiary students)	2.95 million

Source: National Science and Technology Management Information System; Government of India, 2003-04

2.4. The higher education system and education policies

India has evolved a divergent system of higher education with a central monitoring and controlling system under the Ministry of the Human Resource Development. There are autonomous institutions, deemed universities, affiliated and non affiliated universities and national institutes for research and training in the country. Universities and Colleges are controlled by the University Grants Commission (UGC), constituted by and act of the parliament in 1956. All professional institutions are monitored by their corresponding National Councils constituted by the central government. Most universities are affiliating universities and have multi faculty campuses. Students who have successfully completed in the 10+2 pattern alone are admitted to the entry level courses of the universities. In the post independence period two National Policies on Education have been framed by the central government, one in 1968 and another in 1986. The later one was further modified in 1992 incorporating a plan of action assigned with special responsibilities. Until recently the public sector was the sole provider of tertiary education in India. During the last decade a considerable increase in the penetration of private institutions in the higher education sector was observed due to the liberalized polices taken by the government. The government is considering an open policy for foreign direct investment in the higher educations sector. The Prime Minister of India has recently given assurance to the

scientific community that the government is committed to building a strong science base in universities. Two new Institutes for Science Education and Research were started this year as part of this initiative. These institutes will be devoted to teaching of five year integrated masters and post masters and PhD program in science in an intellectually vibrant atmosphere. A chain of similar organizations are planned in the coming decade to promote advance teaching in science and research under a National Foundation similar to the NSF in USA.

2.5. Educational quality management

Quality plays crucial role today than ever before due to the impact of globalization on the higher education field. The central tenet of strategic implementation and planning of educational reforms in India has recognized the significance of quality teaching and learning. As an outcome of the national policy, the University Grants Commission has established the country's first autonomous agency for quality assessment (Antony, 2004). The National Assessment and Accreditation Council (NAAC), based on the careful evaluation report assess the universities and colleges and award accreditation status. The NAAC has evolved a three pronged strategy for quality assessment for awarding accreditation to institutions.

2.6. Research and development

The Science and Technology policy of the government envisages the promotion and strengthening of the technology base in newly emerging and frontier areas. It also encourages basic research and the building of centers of excellence. The country is spending about 0.8% of its GDP on research and development is minimal in comparison with expenditure in other sector. The UGC spends only 4% to promote research and development activities in universities. Government funding needs definite proposals with amazingly troublesome bureaucratic documents. The granting agencies usually demand periodic statements, refunds and returns. In contrast with the international situation, research management is not a basic priority on many universities and the staffs are unwilling to undertake research due to time constraints. Lacks of expertise, resources mobilization, dissemination of research output to the society are the other major problems encountered in the research field.

3. Methodology and sample study findings

The survey was conducted among students and teachers to analyse the trend towards science education and research in India. Students from selected colleges who study science as major was given a questionnaire for extracting their opinion towards the present system of education, the course, their aptitude towards research and similar issues. A total of 430 graduates and under graduates from rural and urban backgrounds participated. Over 32 % of the student's parents are non-specialists. A nominal cross section of teachers (around 50), from different colleges also participated in the teacher survey. A questionnaire was also adopted in the teacher survey. None of them have any administrative responsibilities in the campus.

Students have expressed clear but differing opinions and suggestions. Not all of them joined the science course with a taste or an aptitude towards the subject. For 40% of the students, the course was not their first option. Their choice was motivated by parental compulsion, peer suggestion, hope of job possibilities etc. Majority have dissatisfaction about the teaching learning process. Five to ten percent of the students indicated clearly that the infra structure facilities available in their campuses are poor and they have only limited or partial access to Information Technology. Only four percent expressed their satisfaction with the availability of information technology in their campuses. Nearly a quarter of the students were motivated by research career in future. But still they have strong apprehensions about the working conditions, salary and career promotion prospects of a scientist existing in the country. About 10 to 15 percent of the students from urban or semi urban areas preferred an administrative or business profession than for opting for careers related to science. The overall picture shows that a good number of students lose their interest while learning the course. Majority of students expressed their dissatisfaction about the present examination systems, as it measures only the memory capacity of the student at the end of the year or semester. The summary of the findings is provided in Table 5. The survey also reveals interest in teaching careers among the children of non specialist.

Table 5. Summary of the results observed in the Student Survey

Proportion of students	% of students in the category
External pressures felt in opting the present course	37
Students enrolled with a genuine interest in the science course	60
Motivation for a research carrier	26
Chances of shifting away from science stream in future	24
Losing interest in science	10
Dissatisfaction about the teaching learning process	59
Satisfied with ICT in learning process	04
Complaints about the University system	50
Fraction of students from urban areas opting for other courses	26
Fraction of students from rural areas opting for other courses	10
Fraction of students from urban areas interested in career as science teacher	35
Fraction of students from Rural areas interested in career as science teacher	50
Fraction of students whose parents are agriculturists interested in career as science teacher	60
Students who were aware of the openings in science	71

Teacher survey reflects their attitude towards teaching and research. Sixty eight percent of the teachers complain that it is difficult for them to manage research along with their heavy teaching schedule. About half of the teachers therefore abstain from any form of research along with their teaching. Teachers have very poor exposure to scientific

meetings and international conferences. Sharing ideas and information with others who are working in the same or related areas are minimal in the campuses. Teachers expressed their willingness to pursue research if adequate facilities and support for infrastructure are provided in the institution. However, contrary to their complaints on infrastructure facilities only 16% found that it is difficult to get adequate research support from public or private agencies. Teaching and research are not treated separately and no carrier advancements are provided to the faculty member who had proven track records in research. The summary is shown in the Table 6.

Table 6. Summary of the results observed in the Teacher survey

Findings	% of total
Not doing any kind of research together with teaching	52
Expressed difficulty to mange teaching and research	68
Having complaints about career advancements	44
Unable to get funding for research	16
Lack of administrative support	52
Having international collaboration	01
Research projects undertaken	28

4. Remedies and plan of action

It is evident that science education is declining in the country. A question arises here why is this happening when the country is facing a huge demand for scientists and engineers. Students interested in science while at school appear to give up their interest in pure science at higher levels. This is indeed worrisome.

4. 1. Redesign the curriculum with interactive teaching component

Creative ideas for reforming education may come from many sources, but only teachers can provide insights that emerge from direct experience in the classroom itself. Science instructors must focus more on what students learn and how well they can use their knowledge about a subject than on "covering" a pre-designed syllabus. Problem based and case based approaches are the two instructional approaches which create opportunities for applying the knowledge (Fabrizio 2005). The existing science courses must be improved by incorporating an active component of student engagement in the learning process. Choosing a subject of study is a very important matter in the life of an individual. The school education system must also be necessarily revamped to nurture the budding talents in science. It is necessary to decide what knowledge is to be managed by the teacher and administered to the students. Teachers should train students the way to handle the information flooded around them (Cameron, 2004). Most teachers who are reputed in their research are unaware of the effectiveness of teaching methods (Robert, 2005). Lack of trained teachers in rural areas may be a reason for the preference for other subjects. Teacher must be motivated to spend time and effort for developing new teaching methods or redesigning learner centered courses. The assessing mode existing in the universities needs immediate attention. Properly tested and effective evaluation

instruments must be used for assessment purpose. Competency of the students should be measured at a collective level throughout the entire course duration. Research must be made inevitable part of teaching in universities and colleges. Teaching work and research work must be separately counted. Research productivity of the faculty member must be rewarded with incentives and career advancements.

4 2. Application driven research in basic science.

The notion that basic research leads to applied research, and applied research to technology, and ultimately to prosperity, has been abandoned in the developed countries. They have shifted to application driven basic research. This method is more effective and is a socially responsive approach. Some oppose this idea by saying that a demarcation between pure and applied science is difficult. Research proposals must be reviewed by keeping emphasis on the intellectual merit of the topic and its broad impact on the society. Science will grow in an environment where unlimited freedom exists and have access to abundant resources. Research in basic science needs enormous funding, the profit of which are not immediate. Can a country like India or China afford to allocate too much of its GDP to the educational institutions for sustaining basic research? The question is more relevant in the Indian context today.

4.3 Research management

All the major problems in research management must be solved effectively for attaining global competency. A top-down approach prevails in Indian universities in delegating responsibilities for research. This risks delays or losses at various stages and dilutes the concern when it reaches the implementation level. There must be an efficient central mechanism in all universities for the management of research activities in science (John and Gerry, 2004). While keeping the prime responsibility of external collaboration with research collaborator, the university administration should assume an important role in promoting this activity. Identification and exploitation of intellectual property rights should be important in development of research in economically important areas. Issues like who should own and benefit form the research must be clearly sorted out in a professional manner. Research establishments, which make ties with the industry, must have clear mechanisms for sharing the revenues. Tenure policies, sabbaticals, awards, adjustments in teaching responsibilities and administration support should be used to reinforce the potential of the faculty in research activities.

4.4 The role of society

It is a welcome signal that most Indians have still keeping good faith in science. They feel that Science and Technology can contribute to education, agriculture, and defense, and in general to the economic growth of the country. The social organizations must take the lead role in elevating the morale of the researcher. The career in science must be made attractive by providing economic incentives and rewards. If we generate a culture of reflecting on the methods we use in the pursuit and development of science, we can overcome many a drawback.

5. Limitations of the study

Several modifications to the survey will improve the data collection process and authenticity of the findings. The findings reflected in the study are just a trend observed in a sample survey. More reliable and comprehensive data is required before making a policy change at national level. Long term planning and flawless polices are required to sustain the existing talent and induct new aspirants to meet the challenges of a competitive world.

6. Conclusions

Science teaching and research face a challenge in Indian universities. A major reason for this trend is that the career in science is not attractive like a profession in business administration or in politics. Teachers refuse to undertake research along with teaching and are resistant to major structural changes in the system unless it is beneficial to their career. Remedial measures are necessary for rejuvenating the interest in science and for ensuring productivity. If evaluative conclusions are made at this level we can reasonably describe the situation needs immediate attention of the policy makers and the society, in general. The sample survey indicates many inadequacies at the level of teaching and learning. Universities should not behave like consumer oriented organizations concerned with the production of trained technocrats but should focus on attending the pitfalls in pedagogy.

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