

National Knowledge Commission



सत्यमेव जयते

Government of India

More Quality Ph.Ds

© National Knowledge Commission, December 2008

Published by:

National Knowledge Commission

Government of India

Dharma Marg, Chanakyapuri, New Delhi-110 021

www.knowledgecommission.gov.in

Copyediting, design and printing:

New Concept Information Systems Pvt. Ltd., New Delhi-110 076

www.newconceptinfo.com

Foreword

Quality research in India is fundamental for generating intellectual capital necessary to survive and sustain economic growth and prosperity in the competitive global markets. It is widely recognized that there is a severe shortage of people engaged in the academic and industrial research in the country. As India moves towards a knowledge society, reviving research culture in all established institutions of higher learning is necessary. High quality research in different areas of science and technology is critical to Productivity, Efficiency, Quality, Costs and new Products and Services for achieving long term competitive advantage. In addition, domain expertise in all frontiers of knowledge is essential for the overall progress of society as a whole.

With this in mind, the National Knowledge Commission (NKC) conducted a wide-spread survey across India and abroad seeking inputs on improving the research ecosystem in the country. The NKC submitted the letter and the note on 'More Quality Ph.Ds' to the Prime Minister on 6 November 2008. The thrust of this is to call for massive investment in education and research at all levels, together with a renovation and reform of the university system, and the fostering of a global outlook in research. We have also recommended a National Research Mission to be spearheaded by the proposed NSERB, which will undertake all the activities required to bring about long-term sustainable changes in the research culture, thus targeting a continuous increase in the amount and quality of research undertaken in the country.

In sharing our recommendations on More Quality Ph.Ds with diverse stakeholders through this document, we envisage generating discussions and debates that will catalyze implementation plans for a much needed change.

Several of these recommendations have linkages with our recommendations in the areas of education, entrepreneurship, intellectual property rights, knowledge network and attracting talented students to Maths and Science, submitted earlier to the PM. We have included the relevant highlights of the other recommendations. These suggestions should therefore be seen as part of a systematic set of knowledge initiatives for the future.

Sam Pitroda

Chairman

National Knowledge Commission

Acknowledgements

I am grateful to everyone who was generous with their time and energy to participate in our endeavour.

In particular, I would like to thank all the people who took time out of their busy schedules to answer our surveys and shared their ideas on how we could effectively tackle the challenge of augmenting quality research activities in the country. In addition, I am grateful to all the participants of the workshop held at Delhi.

It is a pleasure to thank the other Members of the NKC and Sunil Bahri, Executive Director, NKC, for valuable comments and suggestions. Thanks are also due to the support of the NKC staff. Finally, Pratibha Bajaj, Namita Dalmia and Vikas Bagri, Research Associates with the NKC did a tremendous job with the background research and coordination. I warmly thank them for their efforts and help.

Dr. Sujatha Ramdorai

Member, National Knowledge Commission

Contents

Methodology	3
NKC Snapshot	4
Letter to the Prime Minister	5
Note on More Quality Ph.Ds	11
Part A: Attracting potential doctoral students	12
Part B: Quality	21
Part C: Nurturing a research environment	25
Part D: Fostering a global outlook in research	37
Annexures	
Consultations	42
Highlights of Other Recommendations	43

Methodology

- Identification of key focus areas
- Identification of diverse stakeholders and understanding major issues
- Constitution of Working Groups and organizing of workshops/seminars, extensive consultations with concerned experts and stakeholders
- Consultation with administrative Ministries & the Planning Commission
- Discussion in NKC to finalize recommendations in the form of letter to the PM from the Chairman
- Letter to PM containing key recommendations, first steps, financial implications etc. supported by the relevant explanatory documents by NKC
- Dissemination of recommendations to state governments, civil society and other stakeholders
- Initiating the implementation of the recommendations under the aegis of the Prime Minister's Office
- Coordinating and following up implementation of proposals

Working Groups

Libraries, Language, Agriculture, Health Information Network, Undergraduate Education, Medical Education, Legal Education, Management Education, Engineering Education, Traditional Health Systems, More Students in Maths and Science, Open and Distance Education, Using Knowledge for Enhancing Quality of Life

Workshops/Seminars

Literacy, Translation, Networks, School Education, Muslim Education, Vocational Education, Open and Distance Education, Intellectual Property Rights, Science and Technology, Agriculture, Open Education Resources, Portals, Quality of Life, More Quality Ph.Ds

Surveys

Innovation, Health Information Network, Traditional Health Systems Entrepreneurship, More Quality Ph.Ds

NKC Snapshot

Recommendations submitted in 2006

- Libraries
- Translation
- English Language Teaching
- National Knowledge Network
- Right to Education
- Vocational Education & Training
- Higher Education
- National Science and Social Science Foundation
- E-governance

Recommendations submitted in 2007

- Health Information Network
- Portals
- Open Educational Resources
- Legal Education
- Medical Education
- Management Education
- Open and Distance Education
- Intellectual Property Rights
- Innovation
- Traditional Health Systems
- Legal Framework for Public Funded Research

Recommendations submitted in 2008

- School Education
- Engineering Education
- More Students in Maths and Science
- Entrepreneurship
- More Quality Ph.Ds

Portals Launched

- Energy
- Water
- Environment
- Teachers

Works in Process

- Portals (Biodiversity, Health)
- Knowledge Applications in Agriculture
- Enhancing Quality of Life

Letter to the Prime Minister

06 Nov, 2008

Dear Mr. Prime Minister,

It is widely recognized that a nation's transformation to a Knowledge and Skills Economy is critically dependent on the original research and development taking place within the country. If India is to make the transition to a Knowledge economy, it is therefore vital that research and development within the country be dramatically improved. There is ample evidence that India is not well-placed for this future transformation. For example, in many disciplines, there is already a severe shortage of well-trained young doctorates to fill in existing posts in research institutes and universities. This problem is likely to be even more acute in the envisaged elite new universities. The growth in the number of doctorates has only been 20% in India in the period 1991-2001 compared to 85% in China. Not more than 1% of those completing undergraduate degrees currently opt for doctoral studies in India, and a substantial number of students prefer to go abroad. To address these problems, there is a pressing need for urgent government policy interventions, including high priority initiatives to attract, nurture, and retain the country's best young minds in academia and research.

With this objective, the NKC conducted a wide-spread investigative survey across the country and abroad. Workshops and consultations were also held with other stakeholders from industry, research institutes and universities. The attached note on 'More Quality Ph.Ds', identifies the critical issues and discusses the remedial steps in detail. We recommend the following to improve the quality and quantity of Ph.D students in the country.

1. Launch a national publicity campaign to attract the best young minds for careers in teaching at all levels, and also academic research

One of the casualties of the expanding market economy has been the devaluation of the academic profession as a whole, and this is now seriously affecting the desirability of this profession. Specific measures for addressing this problem include:-

- Enhancing the prestige, social-standing and remuneration of people in the academic profession
- Systematic and targeted initiatives to unleash the potential of gifted students outside the urban population centres
- Utilisation of current technology to provide greater access to quality learning at all levels, and bridging the language gap
- Increased coverage in the media of different facets of teaching, research and academic achievements, both nationally and internationally

2. Initiate major academic reforms in universities

Throughout the world, universities are the natural home for the interface between teaching and research. But this is far from reality in the vast majority of Indian universities. In fact, the overall current situation in Indian universities is dismal largely due to the lack of quality infrastructure and the inability to recruit good young faculty and gifted students. Some concrete interventions for improving the situation include:-

- Urgent Regulatory reforms in Higher Education, reducing regulation while improving governance; the details have been articulated by NKC in its earlier recommendations on Higher Education
- Greater autonomy for departments within universities to introduce new relevant courses, along with encouragement and rewards for innovation in teaching and research
- Identifying and supporting university departments as Centres of Excellence
- Greater flexibility and increased funding for university departments to recruit and retain good faculty from across the world
- Periodic peer reviews of departments in the universities
- Encouraging recruitment of capable and talented younger faculty

3. Implement administrative reforms in universities

It is equally important that reforms in the administration of universities accompany academic reforms. This will ensure professional administration of universities, and help in attracting students and good faculty. These reforms should include the following:-

- Ensuring a capable administration headed by an able Vice Chancellor and Registrar; these appointments should be based on academic and administrative credentials

- Increasing efficiency and transparency in university administration at all levels
- De-politicisation of appointments and more administrative autonomy
- Better systems for monitoring and maintaining the physical infrastructure, especially buildings
- Sensitizing the administration towards academic freedom and the academic needs for a good research environment

4. Enable research environments in universities

Academic reforms and better infrastructure should go hand in hand with nurturing and sustaining a research environment. Some key enablers for this are:-

- Mechanisms for greater academic cooperation between universities and research institutions; in particular embedding research institutes (granting sufficient autonomy) within university campuses
- Providing access to digital media in universities, in parallel with funds for better libraries and laboratories
- Focused engagement towards making universities a natural home for research as well as teaching

5. Set up more quality undergraduate teaching institutions across disciplines

Dedicated researchers involved in direct training of the students at the undergraduate level create a greater impact. Most of the universities or elite institutions in the country are currently involved in training for the Masters or Ph.D degrees. However, it is now widely recognized that the students emerging from the undergraduate programmes are ill-prepared for a research career. The following steps are proposed to address this:-

- Introduction of well-planned four-year courses to enable direct entry into Ph.D programmes
- Encouragement of various measures to ensure multiple sources of input of talented people into the academic profession
- Credit portability across a network of institutions

6. Increase funding for education at all levels and for R&D

Even in the developed countries, it is fully accepted that long-term investment in education and increased spending on R&D is necessary to maintain the lead in cutting-edge research. This is even more relevant in India today. We propose the following measures:-

- Strengthening of education at the school level, with particular focus on teacher training
- Creation of effective monitoring and assessment mechanisms, nimble enough to measure outcomes and adopt new strategies
- Consulting stakeholders in making policy decisions

7. Rejuvenate doctoral programmes across disciplines

While the above recommendations are aimed at attracting potential doctoral students and enabling a research environment, it is vital that prospective doctoral students are chosen with sufficient care. The following measures are proposed with this objective in mind:-

- A review of the whole selection procedure and monitoring process for graduate students
- Multiple pathways for entry to a Ph.D programme while maintaining entry standards
- Support for quality research in Arts, Humanities and other areas
- Support and promotion of cross-disciplinary teaching and research programmes
- Greater exposure of undergraduate and postgraduate students to cutting edge research

8. Ensure quality of doctoral work and academic research in institutions

At the same time as striving for greater influx of people towards research careers, institutions must ensure that the research undertaken matches global quality in the relevant field. In addition, the graduate programmes should be continually reviewed so as to make them vibrant, challenging and internationally relevant. Here are some steps to be taken in this regard:-

- A preliminary vetting of the synopses of the theses followed by rigorous external examination of doctoral theses
- Broad funding for the organization of and participation in workshops, seminars and symposia, in India and overseas
- Encouraging doctoral students to teach, with remuneration provided via Teaching Assistantships
- Wider dissemination of research work, especially through current digital media in universities and research institutions

9. Enable vigorous Industry-Academia interaction

In the modern context, there is a crying need for a healthy and enlightened cooperation between private industry and academia, which replaces the existing feelings of doubt and mistrust. While industry should recognize that support for education is beneficial, universities should take cognizance of the changing needs of private enterprise in planning new courses. This could be achieved by the following measures:-

- A policy framework for meaningful Public Private Partnership in universities, and concerted efforts to nurture Industry-Academia interactions
- Encouraging private investment in education, research and innovation, backed by appropriate taxation measures
- Promoting collaboration between research and development units within industry and universities

10. Foster a global outlook in research

Research is increasingly becoming a collective global endeavour. It is thus necessary to harness global talent and expertise to develop capacity within the country. This is also essential if the nation is to remain a participant in global cutting edge research. With this in view, the NKC recommends the following:-

- Encouraging NRI/PIO Scientists to establish meaningful links with Indian institutions, and participate in the academic development of the nation

- Creating joint Ph.D programs between universities both within and outside of the country
- Financial and administrative support for international research collaborations
- Identifying important areas of research where national expertise needs to be developed and initiating steps for funding and capacity building by way of collaborations, guest faculty, pro-active hiring, etc.

In conclusion, it must be recognized that investment in education and research produces a broad range of dividends, both tangible and intangible. Our existing base in research needs to be urgently strengthened to arrest any further erosion. While the NKC welcomes the augmented allocation for education in the Eleventh-Five Year Plan, it is important that these funds are effectively utilized to make a visible difference in our academic landscape. As a first step, we urge the government to set itself a target of tripling the existing research base within the next dozen years, and meaningfully work towards it. We strongly feel that a mission oriented approach is necessary for creating the required research ecosystem in the country. Hence, we recommend a National Research Mission which can be spearheaded by National Science and Engineering Research Board, proposed in the current Five Year Plan. We reiterate that implementing these recommendations can invigorate the nation's intellectual and academic environment, and the NKC hopes that the Government will immediately begin work on these vital national issues.

Thank you and Warm Personal Regards,
Yours sincerely,

Sam Pitroda

Dr. Manmohan Singh,
Hon'ble Prime Minister of India

CC: Dr. Montek Singh Ahluwalia, Deputy Chairman, Planning Commission
Sh. Arjun Singh, Minister, Human Resource Development
Sh. Kapil Sibal, Minister, Science and Technology

Note on More Quality Ph.Ds

Research is an activity based on intellectual investigation and has the purpose of discovering, interpreting, and revising human knowledge and experience on various aspects of life. It is crucial for the overall development of human society. As the economic paradigm undergoes a change in the globalized world, future economic progress will increasingly be a function of the intellectual capital that a nation can create. This in turn depends crucially on the quality of academic research that is done in the nation. Thus, if India is to play a key role in the envisaged Knowledge Economy of the world, a significant investment in research, accompanied by sustained vision and policy is vital to achieve a long term competitive advantage. While the importance of research and development in science and technology is increasingly recognized, basic research in many other areas like economics, management, social sciences, arts, etc play an equally important role in the overall development and well-being of a nation.

Historically, India has had an enviable standing in the world of research. However, the current situation is unsatisfactory across multiple dimensions, and the reasons for this are manifold. An important factor which impacts the quality and quantum of research is the scarcity of talented and dedicated manpower engaged in research. We need qualified doctorates for our research laboratories, to teach and engage in research in our universities and to work for research and development in all sectors of the industry. The number of researchers in India was 112 per million inhabitants compared to 633 in China and 4374 in USA in 2002. The growth in the number of doctorates has been only a modest 20% in India from 1991-2001 compared to 85% in China during the same period.¹ The current state of affairs thus requires urgent policy intervention.

Research in any area requires continuous intellectual engagement along with a passion for ideas and creative thinking. We thus need to create a system where these qualities are nurtured and encouraged, thereby providing a pool of students wishing to pursue doctoral studies. Simultaneously, it must be ensured that once they acquire a Ph.D,

¹ "Measures of Progress of Science in India", Report by NISTADS 2006

further employment opportunities are attractive. This is essential to justify the amount of time and effort invested in doctoral research, even more so in today's modern world where there are many other seemingly easier and more lucrative career options. While achieving a critical mass of researchers in the country is important, it is necessary to ensure that quality standards are maintained at the same time.

With this objective, NKC initially conducted a wide spread survey across the country and abroad. A detailed questionnaire was sent to all the universities, academic and research institutions, government agencies, and other stakeholders. More than 250 people responded to the survey. A one day workshop was also held where prominent members from diverse industries, academic and research institutions and universities deliberated on these issues. A list of participants is attached in the annexure. This note captures the main suggestions that evolved from these consultations. Some of the recommendations below have systemic linkages to the previous NKC recommendations in the areas of education, entrepreneurship, intellectual property rights, knowledge network and attracting talented students to Maths and Science.

Part A: Attracting potential doctoral students

In order to sustain research in the long term and for it to flourish, creating a critical mass of researchers and academics is of the foremost importance. Serious policy interventions are required to ensure that this is achieved within a specified time frame in the country.

Recommendation 1: Create greater awareness and acceptance towards pursuing teaching and research as a career, by communicating the opportunities and excitement at a broader level

Issues: The Indian society at large, especially the younger generation is not well-informed of the career opportunities, excitement and freedom that a research career offers. Consequently, the acceptance level for embarking on such careers is rather low.

Societal pressure affects career choices significantly. A multi pronged approach needs to be adopted to bring about a change in the national mindset towards recognition and

acceptance of a career in research. For long term wealth creation, it is important that the nation trains academics, scientists and teachers, rather than bankers.

Awareness

Media: The media has an important role to play in bringing about a fundamental change in attitude and in the nation's consciousness on this issue.

- Short and engaging television or radio programmes related to research can be aired at prime time.
- News channels should highlight and publicize various achievements of academics and other scientists.
- Print and electronic media should be encouraged and incentivized towards promotion and engagement of the intellect.

There are various other means to increase the awareness of society at large:

- Annual R&D shows can be held, where leading research institutes and companies interact with the public, thereby providing a wider exposure.
- Museums, exhibitions and popular lectures are other avenues through which public attention can be engaged. These should be encouraged at as many places as possible. For this purpose, the resources and infrastructure of various educational institutions throughout the country should be used.
- Academic societies should be generously funded and members should be encouraged to participate in the outreach programmes.
- In schools and colleges, career awareness workshops and seminars highlighting research careers should be held regularly.
- Important academic events and visits of reputed academics to India should be publicized and shared with the entire educational community through the use of various channels. This will help create enthusiasm in teachers, students and also acquaint society with academia.
- Talent residing in rural areas remains completely untapped because of various reasons. Basic education and learning resource materials should be made available to all. At the same time, it is important that targeted initiatives be undertaken

to identify talented students and to provide them with opportunities for greater exposure, learning and bridging language gaps.

- Women and especially their parents must be made aware of the possibilities and flexibilities that a research career offers, and should be encouraged through targeted initiatives towards such a career path.

Acceptance

- Nobel Prize winners, reputed academics and other scientists should communicate and publicize the joy and opportunities in a research career.
- School teachers play a very important role in orienting students as well as their parents. Hence teachers should be trained and engaged in this endeavour. Parent-Teacher Associations provide a platform where role models can interact with both parents and teachers at the same time and increase their acceptance towards research.
- Open competitions and projects at different levels should be conceptualized, encouraged and widely publicized. Industry can be involved in such activities.
- Recognizing good research work is important for two reasons. It gives a sense of pride to the researcher as well as encourages others to do research. Hence, various means of recognition such as awards, felicitations, publicity etc should be taken up at all levels.
- Higher learning, along with research and innovation, plays an important role in development of knowledge areas. Its impact on society needs to be publicized widely.
- Both the monetary and non-monetary aspects of a research career, especially the accompanying academic freedom and the international nature of research, should be communicated to students.

Recommendation 2: Expose undergraduate and post graduate students to cutting edge research and engage them in serious research wherever possible

Issues: The major decision points where a student decides to pursue doctoral studies are towards the final year of either an undergraduate or a master's programme. These

students are often not well exposed to various research opportunities and hence remain untargeted.

2.1 Undergraduate Research: A good undergraduate teaching programme is vital for grooming prospective students towards research. Currently, our education system remains largely unimaginative and monotonous with a stress on rote learning and with problems handed down to students. Wide-ranging reforms that encompass pedagogy of teaching, curriculum and evaluation are a pre-requisite to nurture and encourage interested students towards a research path².

- Relevance and application play an important role in attracting applied researchers, while general abstraction and challenge attract theoretical researchers. Taking this into account, a judicious mix of projects and courses may be designed, of which one kind offers an exposure to real life problems from the industry, economy etc. and another imparts foundational training in theoretical aspects of the subject.
- Courses that orient students towards research need to be specifically designed and made part of the curriculum. An important component of these courses should impart knowledge on identifying and defining problems, various research methodologies, analytic methods and presentation. Team projects comprising of different disciplines can be introduced as an optional course for students. This could be combined with changes in syllabus that allow one research-based course even at undergraduate level.
- Summer internships, summer schools, workshops, competitions should all be encouraged. Exciting undergraduate research projects that can involve larger number of students should be rolled out. The vacation period should be utilized to provide undergraduate students with a comprehensive training comprising of exposure to problems in rural areas, industrial training, research project in academic or research institutions and an exposure to foreign universities through various means such as exchange programmes. DST, ICSSR and other organisations can fund a programme of small research projects to be undertaken at undergraduate level, which would introduce students to the actual practice of research.

² See National Knowledge Commission's recommendations on Higher Education, <http://www.knowledgecommission.gov.in/recommendations/higher.asp>

- Teachers need to be trained to promote research and should be incentivized to create innovative projects where undergrads can participate.
- Exposure to and acquaintance with frontier research should be facilitated.

Overall, undergraduate education needs to be strengthened in the country. Creativity should be encouraged at all levels. A continuum of quality institutions from the undergraduate level in all disciplines is required. Residential undergraduate programmes should be increased.

2.2 Post graduate research and training: To encourage research and innovation at post graduate level, several measures can be undertaken.

- Post graduate students should be given the opportunity of spending a semester at research labs or other Indian or foreign universities, outside their own university to broaden exposure. The home universities should facilitate such exposure by entering into alliances with other well established places of research. The BITS Pilani programme is an excellent example of such an initiative.
- Research projects which have the potential to be extended as doctoral projects need to be encouraged at the post graduate level. Projects should be offered in emerging areas to retain student interest. Faculty must regularly update themselves to be in a position to guide students. Group research projects among post graduate students will create more interest and add enthusiasm towards research.
- Reduction of course load with a corresponding increase in the research component for students who show deep interest and commitment to research would incite potential doctoral students.
- Post-graduate courses in Social Sciences and Humanities should have a component (perhaps a full course or paper) that requires either desk-based or field research, which could be an optional choice.
- All post-graduate departments should organize and hold regular research seminars, and students should be encouraged to attend these. Programmes that facilitate establishing links between interested post graduate students and their prospective guides should be encouraged.

2.3 Integrated doctoral programmes: There should be flexibility of moving from undergraduate degree to a Ph.D degree when substantial interest and aptitude for research has been shown at the undergraduate level by the student. S.N. Bose Centre for Basic Sciences runs such a programme.

An integrated programme covering bachelors, masters and doctorate degrees with various exit points has multiple advantages. It will establish a vital link between students at all levels. Networking among students at different levels will give rise to new ideas. It will bring much needed fresh energy into research by exposure and induction to research at an early stage.

However, many precautions need to be taken while designing the integrated course, for instance

- Curriculum must be planned well and subject to periodic reviews. It should have a provision for multiple exchange semesters which will enable wider exposure, interaction and exchange of ideas.
- Selection procedure should take research aptitude into consideration.
- The programme however should have multiple exit and placement opportunities. There should be enough flexibility provided to students so that while opting for an integrated course, a student should not feel that they are bonded by it for seven to eight years.

In view of all these requirements, it is suggested that a restricted pilot be launched at select institutions. This programme is especially directed towards science streams.

2.4 Linking researchers at all levels: Within an institution, relations among different levels of students (e.g. undergraduate, postgraduate and Ph.D) should be fostered. This could be achieved by judiciously mixing students in projects. Apart from facilitating peer learning, it provides a learning platform for potential doctoral students.

A comprehensive National Projects and Research portal is highly recommended. This is essential for connecting students and researchers at all levels, facilitating formation of

virtual peer groups, disseminating information related to various projects and schemes, and providing information of various positions for doctorates etc.

Recommendation 3: Restructure incentives for doctoral degree students to attract and retain them in research

Issues: The gamut of opportunities available to graduate and post graduate students today has made research in India an obvious secondary choice. Apart from financial unattractiveness and substantial investment of the prime years in their lives, there is a perceived lack of challenge as well as future career opportunities.

3.1 Remuneration: It is generally true that interested and talented people choose to pursue doctoral studies. They could have easily opted for better paying career options. Also, there are many more students whom the system fails to attract on account of remuneration issues. Thus it is important that while deciding remunerations, opportunity costs are factored in.

- There should be a regular upgradation of the amount of fellowships offered for Ph.Ds, and in general for the entire academic profession.
- Various forms of additional compensation should be explored.
- Teaching assistantship to bright Ph.D students should be provided to add to their earnings. This would also have the additional benefit of training and preparing them for a career in academics and teaching. This is vital considering the current serious shortage of competent faculty being faced by our institutions of learning.
- Other possible methods could include summer projects, summer internships in industry and involvement in organizational work as part of academics.
- Subsidized health insurance, home loans etc could be looked at.
- Generous travel grants should be ensured.

A good placement office for Ph.Ds should be given priority in all universities and institutions. They should have tie-ups with various universities, research institutions, industries at the regional, national and international level.

3.2 Entrepreneurship: More students can be attracted to doctoral studies by providing a platform where they can convert their ideas or research into reality. To foster such an environment,

- Incubation centres must be facilitated and promoted in academic institutions.
- Universities can offer courses on Entrepreneurship.
- Mechanisms should be framed to support start-ups.

While application-oriented research is important, care should however be taken to ensure that

- Traditional base of academic research is not eroded.
- Intellectual property of the university is well protected.
- Core values and requirements of research are not diluted.

3.3 Joint Ph.D programmes with industry: To address the needs of people from industry interested in doing a Ph.D, academic institutes should focus on networking with industry and work out joint programmes with interested companies. This will create a talent pool of researchers in industry. Consequently, research in private sector will get a boost, thereby creating attractive job opportunities for researchers which, in turn, might entice many students to enrol in a doctorate programme. Thus, a virtual circle can be created.

The opportunity cost of pursuing a Ph.D is very significant for this target group. Hence, a favourable proposal needs to be designed which not only allows but also encourages employees to go for a Ph.D. There should be Memorandum of Understanding (MoU) between the partnering institution and the industry. The MoU could include the clause that the company pays their salary during the period of Ph.D. The Reliance Life Sciences (RLS) model is noteworthy in this aspect. RLS has a mechanism whereby its employees may pursue a doctorate degree at Mumbai University. BITS Pilani also runs a doctorate programme for professionals. The programme has inbuilt flexibilities which attracts people from industry and simultaneously has a very strong scrutiny system to ensure quality Ph.Ds.

One important factor that should be kept in mind is that academic freedom is maintained and an enabling environment is created wherein prospective guides and doctoral students from industry can interact.

This will also potentially attract those bright students who chose to work in industry because of attractive financial packages.

Recommendation 4: Create attractive post doctoral opportunities to provide fresh doctorates with a valuable cross disciplinary research and teaching experience

Issues: Postdoctoral opportunities in India and abroad are limited. The opportunities existing in India right now do not stand any appeal against post doctoral offers from abroad. The brightest go abroad and tend to prolong their stay as far as possible. Simultaneously, there is a lack of synergy between research and teaching experience.

This is an important stage where effective intervention should be made to broaden our academic and research base. Therefore, it is vital to create

- Dedicated central fund for Post Doctoral Fellows (PDFs) so that senior researchers can employ post docs for their research projects.
- More flexible positions for researchers with various institutions, centres of excellence, advanced research labs and industry.
- A large pool of post doctoral fellows. Projects of national importance, faculty for teaching institutions as well as private companies can choose new doctorates for temporary, yet financially very attractive positions from such a pool. Such centralization of resources will lead to better information dissemination and effective resource sharing.

Longer term offers could be made to PDFs by including teaching as a vital component. In many universities, a purely post doc research position is not recognized as teaching experience while making faculty appointments.

- Effective utilisation of the PDFs in universities should be facilitated by flexible and innovative appointment modes. This can provide a means of upgrading university departments in general, and also addressing the faculty shortage. Teaching experience will also increase opportunities of employment in universities after post doctoral work.
- Mobility across organizations should be facilitated during post-doc tenure. A group of five to six universities can be formed with an understanding that a Ph.D of one

university can do a post doc at another. International peer review mechanisms can be established for PDFs. Overall, this calls for greater coordination among universities and research institutes, better sharing of resources, and for convergence of teaching and research experience.

Part B: Quality

A quality degree which is universally recognized as such, and which is acquired after consistent hard work and application of mind both acts as a magnet to attract talented students and inspires awe in the minds of the general public. It is therefore essential that doctoral programmes in the country aspire to attain the highest standards of excellence. At present, the quality of research output in the country is completely uneven across institutions. While, it is necessary to maintain the high quality standards in elite institutions, it is simultaneously imperative to encourage the transition to cutting-edge research in others. It is also crucial that quality in the output of academic research is ensured by a variety of metrics like publications in peer-reviewed journals with good impact factor, academic activities like workshops and conferences, patents, technology transfer activities, etc.

Recommendation 5: Rejuvenate the Ph.D programme and adhere to quality standards to attract talented students

Issues: Other than the financial benefits, a key deciding factor in making a career choice in academics is the intellectual satisfaction that one expects. The quality of research undertaken at a majority of institutions in the country is however so low that it deters potential students.

5.1 Entry level screening: Usually, an entry level examination is conducted to ensure good quality of the intake of doctoral students. A prospective doctoral student's aptitude and attitude towards research should also be considered along with other qualifications. At all times, adherence to good standards at the entry level is essential.

- Multiple pathways should be used to fill research positions.
 - ◆ Flexibility should be given to universities for conducting their own entrance examinations.

- ◆ A demonstrated research potential should be given due consideration. If an applicant has published a good quality research paper, filed a patent etc, his/her application should be accordingly considered.
- ◆ For working professionals, who may find it difficult to pass an entry level test, other flexible methods of assessment should be put in place.
- ◆ Online testing of students should also be worked out. This is particularly important to attract potential students from abroad.
- Examinations
 - ◆ Testing aptitude for research should be made an integral part of the selection process. Apart from a written examination, a personal interview will be greatly useful.
 - ◆ Syllabus and quality of the current NET examination needs to be massively reformed.
 - ◆ Unlimited attempts should be allowed to pass the qualifying examination.
 - ◆ As the borders between disciplines are getting increasingly blurred, it is important to examine the entry requirements for lateral entry across disciplines.
- Adequate care should be taken to ensure that screening methods are transparent and objective.

5.2 Pre-Ph.D courses: It is important to identify and bridge the gaps between the present and the required knowledge of a doctoral student.

National Pre-Ph.D programme: In order to utilize the limited pool of talented faculty, a national Pre-Ph.D programme of suitable duration, run by major national institutions can be launched. The programme would help in broadening the perspective of a future doctoral student and also increase networking within the research community. The necessary infrastructure for such an initiative needs to be created.

- It should involve qualified researchers who should be sufficiently incentivized to teach in the training programmes. Other distinguished speakers can also be invited for delivering lectures.
- Qualified applicants with a Pre-Ph.D degree can return to their respective home institutions once their training is over.

- The programme should be tailored to cater to different disciplines and should include a study of latest trends in particular streams. It should also train students in analytical skills, research methodology, instrument use, dissertation writing, etc.

For students registering for a Ph.D directly after a bachelor's degree, the importance of a Pre-Ph.D programme increases. It would not only impart students with necessary background training but also examine their research aptitude. In an integrated doctorate programme, Pre-Ph.D can serve as one of the exit points. The Pre-Ph.D degree could be recognized as a qualification to teach undergraduate courses.

R&D laboratories can prepare teaching material for Pre-Ph.D courses. Lecture notes should be made available on the internet, thereby ensuring wider accessibility. This will also contribute towards greater access to quality educational material among students and faculty. At the individual level, the guides must give sufficient self-study coursework to students.

Recommendation 6: Create effective monitoring and assessment mechanisms during the course of doctoral research and encourage broader engagement with research

Issues: Research in India is carried out solely on the basis of internal motivation. Effective external mechanisms which ensure good quality of research largely do not exist. At the same time, there are no sufficient mechanisms to guarantee broader engagement with research.

To ensure effective monitoring and assessment mechanisms

- Students must be continuously monitored and mentored to ensure that the research output is of requisite quality. Regular seminars by students will ensure that the students adhere to their research work plan and show progress. Regular reporting in lab meetings could be used for informal feedback.
- Experimental projects should be monitored through a well maintained log book. The guide should insist and regularly check whether log books are maintained.
- Independent committees can also be set up before which the students make regular presentations. Any such committee should provide feedback and counsel the

doctoral students. External co-guides from industry/other institutes could facilitate a way to ensure better monitoring.

- Any mechanism used for monitoring should check for possibilities of plagiarism. Further, to enable an overall healthy research environment, Ph.D students should be taught ethics and standards of academic research as part of curriculum.

Before designing any new monitoring and assessment mechanisms, it is important to identify why the existing ones have failed and the lessons learnt should be taken into account.

To promote broader engagement with research,

- Regular interaction among the researchers should be facilitated through group meetings, research seminars etc. At some places, lab group meetings are held every week in which each student presents and discusses his/her work with the entire group.
- Wider exposure to research in the form of participation in international conferences, workshops, seminars etc will strengthen the student's research base and should be encouraged.
- Journal clubs where students discuss articles other than those in their own areas of research provide a means to broaden the academic horizon of students.
- Mentoring doctoral students for meaningful participation by means of poster presentations (individually or in groups), group discussions would provide further impetus in helping the students towards gaining confidence about their research. It will also lead to a larger networking among peers and established researchers from around the world.

Recommendation 7: Comprehensive assessment of doctoral thesis and wider dissemination of research work

Issues: Often there is no objective assessment of doctoral thesis, thus leading to theses of poor quality. The evaluation committee does not subject the thesis to a strict scrutiny. There is a huge problem of uneven quality across institutions, and this is particularly marked in the Social Sciences and Humanities, even to the point where Ph.Ds can be “purchased” on the basis of minimal work in some places.

One of the fundamental requirements for running a quality doctoral programme is to have a strong faculty involved in front-line exciting research. It is equally important that reputed examiners are appointed to validate the quality of output of research thesis.

- A combination of internal and external examiners should be used to make the system more robust. The names of members of the respective evaluation committee should be attached to each approved thesis. It is important to bring transparency in the system and attention to quality.
- Open defence of thesis could be mandated. If a student fails to defend his/her work suitably, a second defence can be planned after six months. Honourable exit options should be provided for doctoral students.
- Publications in quality research journals should be encouraged. Open peer review of publications should be aimed at.
- Ph.D thesis should be uploaded on the internet, preferably on the proposed National Research Portal. In any event, open and free access to research output in archives and other digital media resources should be made mandatory.

Alternative systems to grant a Ph.D can be explored. As practised these days in Germany, five published papers in peer reviewed journals should be deemed sufficient to acquire a Ph.D. This does not stipulate registration, time limit or supervision. Such students should publish in reputed and internationally recognized journals, and these papers may be reviewed collectively by a panel of examiners (at least two from developed countries and two from India). If a minimum of three pass the standards test, Ph.D degree may be awarded to the student and should be recognized in the existing system. Such innovative and alternative systems need to be explored and put into practice.

Part C: Nurturing a research environment

In order for research to flourish, it is vital that the entire academic system be made more conducive and vibrant. Universities are the natural homes for academic research the world over, and it is vital that research culture be brought back to our universities. Other stakeholders like industry and government can play an important role in this endeavour.

Recommendation 8: Enable university environment to produce quality Ph.Ds

Issues: Various compulsions in early policy making in the post-independent era led to a large number of stand-alone research institutes. It is now increasingly being recognized that separation of research and teaching has been at the cost of creating a good research environment in the universities. We have already lost a couple of generations of talent because of the resulting breakdown in the university system. The present academic environment in many universities remains largely unattractive for researchers.

8.1 Facilitating research opportunities in university environment: University reforms are urgently needed and an integral part of this should be aimed at enabling a research culture in universities. A vibrant research atmosphere in the universities will definitely attract more students towards research. The most essential enablers for such an environment include the presence of a facilitating administration, talented faculty and the availability of adequate research facilities.

Conducive administration: Often university administration itself militates against creating conditions conducive to research. This is largely because of the centralisation of decision-making, restrictions on faculty autonomy and imposition of rigid financial rules that makes “managing” projects very demanding. Administration should be sensitive to academic needs and should aim to encourage and help faculty to deliver better results. In order to enable a favourable administrative environment, it is essential to

- Ensure a capable administration headed by an able Vice Chancellor and Registrar.
- Grant autonomy in making recruitments to achieve higher standards.
- Undertake steps to completely eradicate politics and inbreeding in the system.
- Simplify bureaucratic procedures to make the system more responsive, transparent and efficient.
- Provide technical help or guidance to potential university researchers for writing grant applications.

Collaboration for sharing resources and expertise: It is vital to provide researchers with the required infrastructure to carry out their research work. Universities should

be given adequate funds for upgrading infrastructure. Often, the lack of funds acts as a hurdle in building and maintaining capital-intensive infrastructure. Hence, sharing of infrastructure with joint responsibility of maintenance among institutes should be greatly encouraged. For better, meaningful sharing of physical as well as intellectual infrastructure among institutions,

- Collaboration should be formalized by entering into alliances, signing MoUs etc.
- New research and academic institutions should be co-located as much as possible.
- Library facilities, access to journals electronically etc. should be provided freely. The upcoming National Knowledge Network should be leveraged for this purpose.
- Top down systemic linkages from elite institutions to universities and to colleges should be established and encouraged to ensure capacity building.
- Joint doctoral research where students are allowed to select guide and co-guides from across academic and research institutions should be undertaken.
- Research institutes can allocate sub-projects to universities to begin with.
- Inter-disciplinary projects involving multiple agencies should be explored.
- UGC should promote conferences with industry and research institutes to enable conversion of ideas into research to be implemented at universities.

Revamp of Laboratories: An inseparable part of research and teaching in Science and Technology is the laboratory. Laboratories play an important role in creating research attitudes, arousing interest and curiosity. They help in gaining experience in scientific methods and learning the process of scientific enquiry. Given the current state of affairs, there is an urgent need to begin an intervention aimed at addressing the quality issue in laboratory training. It is important that even schools are provided with good laboratories and specific attention should be paid to lab training at the undergraduate level.

A major problem with all laboratory experiments is that they do not attempt to challenge the student sufficiently and the whole exercise is conducted at a very rudimentary level. Vital aspects of experiments are not highlighted for the students. The student is typically not involved in important areas of the experiment such as designing or selecting the apparatus, deciding what measurements need to be taken, or what variables need to

be controlled. Students are given no opportunity to think for themselves. Laboratory courses thus need a complete revamp.

- There is a need to redefine the objectives with which experiments in a lab are performed, so as to make the laboratory training more concept based rather than 'result based'.
- It should lay emphasis on a student's contribution to planning, execution and analysis of the experiment.
- Error analysis, up to and including calculation of error bars should be essential requirement for each experiment.
- Training should include maintaining lab journals and technical communication skills.

This will help in guiding the talent towards hard-core experimental sciences.

8.2 Changes in the university system to encourage research and good teaching: Both teaching and research should be promoted by creating mechanisms which provide freedom, encourage innovation, and recognize and reward good work. Good teaching plays an important role in encouraging students to pursue an academic career and this aspect is often unrecognized.

- Faculty should have sufficient resources to carry out research as well as teaching activities. Teachers should be especially encouraged to create innovative teaching material and for providing wide-spread access.
- Good working conditions are absolutely essential in creating a vibrant academic environment.
- Free flow of researchers between industry and academia should be initiated. Sabbaticals to work in industry for academicians and vice versa for industry employees should be instituted. Sufficient provisions should be made for granting sabbaticals to faculty for undertaking research.
- Liberal rules should be looked into for providing faculty members with the flexibility to hold dual appointments between R&D institutions and universities.
- Flexibility in extramurally funded projects to university based investigators should be given so that they can travel and participate in international meetings/workshops.

- There should be provisions for mentoring of young faculty by established scientists which involves spending brief period at the mentor's laboratory/institute.
- To incentivize research, performance appraisal for promotions should give a higher weightage to research.
- A component of funding should be used for rewarding good teachers and researchers.
- Separate research wing in universities could be developed with as few bureaucratic hurdles as possible. Group recruitment with a specific mandate of developing frontier areas in research should be explored.

Flexibility should be accompanied with a component of accountability, the norms of which should be periodically reviewed.

8.3 Reduction of teaching load: There is a serious shortage of faculty across institutions. Further, with a large number of teaching posts in colleges and universities remaining vacant, there is severe stress on the existing faculty. Also, in the current system, the whole profession of teaching has been severely undermined with contract teaching in colleges becoming more and more acceptable. Teachers have no time or inclination to participate in anything innovative which has led to a lack of involvement and enthusiasm in the whole system, thereby leading to gradual decay and degradation. It is crucial that these issues are addressed and acted upon with the utmost sense of urgency.

Some steps that could be undertaken to reduce teaching load are:

- Duplication of courses should be avoided. This calls for greater interdepartmental collaboration at the level of individual institution. Inter-institutional collaboration to offer common courses can also be worked out by means of sharing credit.
- Lectures can be delivered to a large class combined with tutorial sessions in smaller batches of students.
- Positions of Adjunct Faculty must be created and strengthened. People from research institutes, industry, abroad etc should be invited to teach few courses every semester. Services of retired professors can also be used. This will also bring in much needed fresh inputs from outside into the university.

- PDFs and Ph.D students should be effectively utilized in teaching or teaching assistantships. Specially, bright students should be allowed as well as encouraged to teach junior classes.
- ICT should be used extensively for teaching wherever appropriate. This will give access to quality educational material to a larger section of the student community.
- Issues regarding new recruitment should be sorted out and new appointments should be made as soon as possible. Adequate facilities for research, seed money, housing and incentives for sponsored research should be offered to attract new faculty.

8.4 Data collection, organization and access: While there are numerous agencies involved in data collection related to different aspects of Higher Education and Research, the organization of, and access to these data remain largely nebulous and inaccessible. This should be rectified. It is important to recognize that such data can play a vital role in policy issues, funding, reforms, etc. Data collected should be cogently organized, analyzed and made accessible to a wide section of stakeholders. We also emphasize that there should be strong, vibrant and systematic linkages in place between institutions like NISTADS, NUEPA and the actual stakeholders in the system that these institutions are supposed to address. Just as the modern knowledge system necessitates continuous knowledge upgradation of the academic and scientific personnel, it also necessitates that the university administration be continually exposed to best management and administration practices in the university systems around the world. It is thus essential to create a vibrant and pro-active platform for the skill and human resource upgradation of the administration personnel.

Recommendation 9: Foster inter-disciplinary research, translational research and basic research in social sciences, arts and Humanities

Issues: New interdisciplinary areas of research are emerging rapidly in the global context and these are not adequately represented in the country. Almost in all important professional streams like medicine, engineering, management, law etc, actual practice is divorced from research. Despite the tremendous diversity, rich history and cultural heritage, credible basic research in the social sciences is conspicuous by its absence in most universities.

The face of sciences, or for that matter, every discipline today, is changing rapidly. Conventional boundaries between different streams are fast disappearing. Interdisciplinary projects and doctoral programmes in interdisciplinary areas need to be encouraged to propel research in emerging areas. To facilitate this, interdisciplinary faculty options may be created. Interdisciplinary guide and co-guide combinations should be permitted for guidance towards a doctoral thesis. Generous funding should be provided to encourage research in new areas. Appropriate modification of entry barriers to such doctoral programmes should be looked into.

Translational research, especially in the area of medicine and engineering is largely absent in the academic landscape. As a specific example, Medical Education and Research lack in innovation due to the present lacunae in the education system. This field is largely service oriented with less or no emphasis on research, reasoning and rigour. In order to drive innovation, it is imperative that a medical education straddling programmes from diverse disciplines such as clinical, epidemiological, laboratory, pure sciences (physics, statistics, optics, medical chemistry, organic chemistry, cell biology, biochemistry) be rolled out in front-ranking institutions. An option of having a component of clinical research in Ph.D programmes in the natural sciences should be introduced. This will require co-mentoring of students by faculty drawn both from a surgical/clinical/para-clinical pool and basic biology/physical/engineering sciences. In general, translational research linking practice, field and lab work should be generously funded and encouraged. The existing regulatory structures make this highly difficult and this needs serious intervention.

The training in the humanities has to be reformulated so as to provide a sound, but preliminary, theoretical classical foundation which is in the end solidly geared towards training the student to understand social life as it actually is. It should equip him/her to tackle its vast range of problems in their full magnitude, reinforced by solid and practical training in the field. Integrated courses which allow for a creative and imaginative choice of subjects should be designed. There could also be a component of Management Education within the Humanities stream. Integrated Masters programmes in the Humanities that initiate a congruence of many components ranging from communication skills, traditional knowledge systems and practices, disaster management, community life, local government, international diplomacy, governance

and conflict, public administration and beyond should be designed. These courses could also be made open to international students, especially from the developing world. The courses should relentlessly focus on the centrality of human living, and represent a thorough amalgam of its constituents, with the first two years devoted to theoretical foundations, the next two years to applied aspects, and the final year to practical field work. Such programmes would also improve the quality of work at the doctoral level.

Industries probably do not have a tangible stake in funding basic research in social sciences. Hence public funding is vital to ensure research and progress in these areas. It should be recognized that knowledge in these areas contributes directly to the well-being of society and also in nurturing a sense of pride about our cultural heritage.

Overall, undergraduate and postgraduate courses should offer a wider bouquet of subjects within a credit and semester system.

Recommendation 10: Promote excellence at research institutes and universities

Issues: Research institutions have maintained a lead in research activities in the country. However, they need to play a larger role in academic activities by means of linkages with universities, etc.

10.1 Research Institutes: To promote better managed institutions, it is essential to groom leaders who can take the institutions forward. Governance of the institution should be based on democratic principles. Wider feedback from scientists at all levels should be taken. An independent Board of Governors with respectable members from academia and civil society should be constituted for each institution. Transparency in recruitment of faculty members is necessary and promotions based on appraisals should be encouraged. An efficient administration totally devoid of corruption should be put in place.

The research institute should be nimble and dynamic in developing new areas of research. Industrial consultancy group should be developed in application research based institutes. This will bring in funds, ideas and much needed efficiency in the

system. Better managed institutes should be encouraged to lead and mentor others. Research institutes should be encouraged to work with universities.

The interaction between research laboratories and universities should be institutionalized. It is important to work towards aggregating research institutes and universities rather than creating new stand-alone research institutes. Possible ways of doing this are to convert research institutes into small-sized research universities, aggregating various CSIR research labs under a common university system whose strengths are interdisciplinary teaching and research, co-location of teaching institutions and research institutions, as between IISER and NCL in Pune. Some research institutes which have outlived their utility can be absorbed in regular universities. This will also give much needed access to quality research personnel at universities.

10.2 Periodical reviews: A good periodical review system of departments to support centres of excellence can be undertaken through independent accreditation, out of turn rewards, and conditional grants. Advisory committee of Alumni can be constituted for internal review of the departments.

Ph.D thesis, publications, patents, commercialization of research and peer review can be included as measures of performance review. Quality of faculty should be strictly monitored.

Recommendation 11: Establish more centres of excellence for research and teaching from the undergraduate level for different disciplines across the country

Issues: There is a serious shortage of institutions which provide both good undergraduate training and research environment. Currently, in most of the existing centres of excellence where doctoral studies are undertaken, the focus is largely on the Ph.D and/or Masters programme.

Sound training at the undergraduate level is vital for students wishing to embark on an academic career. Often, students entering a doctoral programme at elite institutions are found to have an inadequate background for research even after having completed

a Master's degree. A high quality four year programme should be rolled out in select institutions³ which will enable direct entry to a Ph.D programme, thereby effectively reducing the total time spent on doctoral study. A new system of research based universities starting at the undergraduate level focusing both on teaching and research is essential to create the right environment needed to nurture research. Existing universities or research institutes may be transformed into a smaller research based universities. Smaller universities ease administrative hurdles. Universities without attached colleges have a higher chance of developing a good research culture. Excellent resources and infrastructure should be created. Also, adequate communication channels should be established with existing universities to provide holistic (broad based) education. The Government has taken a step in the right direction by starting Indian Institutions of Science Education and Research (IISERs) in the field of sciences. Corporate houses could be involved in starting some of these new universities. Research universities for thrust areas can be created in public-private partnership mode.

However, some caution needs to be observed while setting up new research universities.

- An able director is essential for developing a new institute.
- These universities should not become isolated islands of excellence.
- Faculty will remain the most serious issue in expansion and appropriate steps should be taken in this direction.
- Serious investigations into the existing system should be undertaken in order to identify the gaps and to ensure that mistakes are not repeated.

Simultaneously, a comprehensive process of repair and reforms within the existing system should be initiated. This can take the initial form of identifying select departments/colleges/universities with a potential for substantial improvement. Funds should be invested in upgrading and monitoring the progress of these. Vital components of this exercise are transparency, academic autonomy and establishment of systematic linkages.

³ See NKC's Publication on "Attracting More Talented Students to Maths and Science", Pages 9 and 22, http://www.knowledgecommission.gov.in/downloads/documents/nkc_maths.pdf

Colleges within universities which are engaged in quality teaching and research projects should be encouraged and supported with free access to funds, investment of infrastructure, more academic and administrative autonomy. A useful metric for evaluation of colleges could be the placement of its students at research and academic institutions within and outside of the country. On the whole, there should be an overall empowerment of colleges providing quality undergraduate education.

Recommendation 12: Augment available sources of funding, optimize allocation and provide greater flexibility towards utilization

Issues: Funding remains a key issue in facilitating quality research in most universities. The low quantum of funds, the cumbersome process of acquiring them and the lack of fund raising capabilities in the university/faculty members have severely hampered growth of research.

Concerted efforts are needed in funding research. Various sources of funding should thus be explored.

- Large scale public funding is necessary for nationally relevant research projects.
- Recruiting companies should contribute towards university research funds. Industries should be encouraged to sponsor and collaborate on research projects. Laboratories named after sponsoring companies can be established. Also, Sponsored Chairs by industry can increase the number of faculty and researchers without any additional cost to the university.
- Universities should formulate strategies to convert research findings into commercial applications, thus generating funds. Alternate means like consultancy, online courses, etc should be explored. Universities should also establish and leverage alumni network.
- Government funding agencies should proactively encourage and guide faculty members from universities to submit research proposals. A system of open competition for research grants should be developed.
- Collaborative funding between countries and universities should be encouraged.

To increase research funding in the longer term, alumni/corporate fellowships should be looked at. For instance, NASSCOM has developed a Public Private Partnership

framework under which fellowships could be provided to students. Collaboration with foreign universities in which students and co-guides get a chance to attend foreign universities has been worked out as part of the initiative. Academia should evolve strategies to increase such funding avenues substantially. Such initiatives also have the merit of wider industry academia interaction.

Primarily however, professional financial management is needed at universities. There should be in-built flexibility and lenient guidelines for utilisation of funds. It is also important that faculty in research institutes and universities are trained in the utilization of funds.

Recommendation 13: Encourage private participation in research activities by fostering industry-academia interaction

Issues: The two worlds, academy and industry, are viewed as divergent, because of perceived vested interests, which often leads to mistrust.

It is important that there is a change in this mindset and that new ways of establishing and institutionalizing permanent linkages are explored. The value of domain knowledge expertise is bound to increase as the economy matures and knowledge gets integrated as an important component of the economy. Industry should take cognizance of this and should support doctoral programmes in both basic and applied research disciplines. Further, social sciences can contribute to innovation in business processes, and in the overall understanding and progress of the society. Industry can participate in academic research activities by -

- Investing in infrastructure building.
- Inviting students to spend a semester in industry.
- Allowing people from industry to take special lectures in universities.
- Getting involved in monitoring and updating curriculum.
- Offering research projects to people in academia either alone or by collaborating with other industries.
- Conducting or participating in science fairs, seminars, workshops and popularization programs etc.

- Sponsoring research in universities directly. As an example, TCS sponsors research projects in various colleges instead of giving one time infrastructure grant. This ensures more than just monetary support and leads to healthier interaction.

At the same time, academia should open its doors to industry. Lateral entry provision should be facilitated for those interested in academics with a background in industry. It should also facilitate continuing education of industry employees by designing and delivering short courses. Appropriate methodologies should be developed to carry out all collaborative efforts. It is essential to clarify issues such as sharing of intellectual property rights. Industry associations must facilitate interaction and collaborations between industry and academia.

A culture of research in the private sector is essential to develop more prospects for doctorates and increase efficiency and diversity in the system. To encourage Indian as well as foreign industries to carry out research activities in the country,

- Industry should be incentivized to use indigenous technology.
- New science and technology parks in the private sector should provide research and development facilities at subsidized rates for all companies.
- Knowledge hubs should be created in each state, which should provide space and other facilities like patent cell, entrepreneurship cell. Multinational companies which aim at creating large research centres in India can pilot launch their operations in the knowledge hubs. Knowledge hubs will facilitate market driven research and product development.

Part D: Fostering a global outlook in research

Research as an activity requires exchange of ideas and sharing of knowledge at a broader level. In today's globalizing world, there is a pressing need for India to provide its students and faculty with international and multi-cultural exposure.

Recommendation 14: Attract NRI/PIO Scientists by providing attractive opportunities in the country

Issues: Researchers often leave India for a better environment that offers variety of choices,

opportunities and intellectual freedom. Such researchers find it difficult to return back because of the absence of an enabling and nurturing system in the country.

Provide flexibility in the system: Currently, the rigidity of entry in the university system repels the scientists who might otherwise consider coming back to India.

- The system should be made more flexible to encourage talent at all levels. Respect for talent rather than "seniority" should be built into the system. To attract the best people, it becomes important to offer them positions that are professionally better than what they currently have in their country of residence.
- Positions of Research Professors with advancement capability based on research excellence and not age should be created. Young scientists should get equal independence as their senior counterparts.
- Adjunct positions in industry and research laboratories should be created for inviting NRIs.
- Institutional mechanisms should be created to allow scholars to go back and forth and to freely invite other researchers and collaborators. In case, the scientist returns back, he/she should be encouraged to continue to maintain contact with the researchers in the lab and guide them.
- The system should also enable appointment at the level of Director, Dean, Vice-Chancellors, and Technical/Scientific advisors to Union and/or State Government. At the same time, there should be effective monitoring mechanisms to ensure accountability and to prevent misuse of such positions.

Offer more resources and create nurturing environment: Creating a challenging and excellence-oriented environment with appropriate resources is vital.

- Substantial amounts of "start-up funds" for setting up labs and hiring post doctoral students should be made available to the researchers. The researchers should also be given freedom to generate their own funds.
- A congenial environment to foster independent thinking and working is a must. This requires providing facilitating administration as well as maintaining best standards in research.

Recommendation 15: Formalize collaboration with foreign institutions and researchers

Issues: Failure to attract foreign students and collaborate with foreign universities and researchers has led to an absence of multi-cultural and international exposure for both Indian students and faculty.

Collaborative programmes with foreign universities and research institutions will encourage faculty and students to learn and exchange ideas and practices on latest developments.

- Indian scientists should be given generous travel grants to attend international conferences. Further, they should be given adequate and comprehensive support to organize international meetings.
- Visa procedures for research exchanges should be simplified. Just as credible business travellers are granted multiple entry visas valid over a longer period, similar facilities for scientific visas can be looked into. The post of Academic Attachés in various consulates should be created and filled. They can play an important role in facilitating scientific exchanges between countries. In addition, this will also provide an alternative employment avenue for people with a research background. Multiple entry provision for foreign researchers would also benefit frequent collaboration by considerable reduction in the hassles of obtaining visas.
- Joint supervision of doctoral thesis is one area where cooperation should be promoted. Length and type of exchange programmes should be so designed that our faculty as well as research students gain adequate benefits.
- Other forms of collaboration which could be looked at are joint degree programmes with foreign universities.
- Initiatives should be taken to invite faculty from abroad to not only give special guest lectures but also teach partial or full courses.
- A public/private non-profit corporation like Carnegie, Ford and Rhodes Scholarships of high brand value can be created to pay for faculty exchanges from both industry and research institutes. Individuals who are capable of mobilizing funding for such corporations could be chosen to head such institutions.

- Indian Institutions should tap the benefits of multi-institution networks by participating in the good ones that already exist or by creating such platforms themselves. The McDonnell International Scholars Academy and McDonnell Academy Global Energy and Environmental Partnership at Washington University in St. Louis are examples of such networks. The two academies collaborate with select universities from across the world. They provide opportunities to the partners to interact, discuss, and learn from each other by working on collaborative projects.

Many funding agencies from the developed countries are conscious of the demographic advantage that India has and are keen to participate in joint initiatives in research, training, etc. Funding and collaborative opportunities for the younger people should be widely publicized and national funding agencies should play a pro-active role in directly linking up scientists and such diverse international funding agencies. Collaborations should be based on win-win models and should facilitate a need-based, two way flow of knowledge. One must also ensure the following:

- Intellectual property is well-protected.
- Collaborations are based on synergy and not brand name alone.
- Students are not just made to do repetitive work without any meaningful exchange of knowledge.
- Students spend considerable amount of time in the home institutions.

To conclude, excellent infrastructure, favourable research environment, reforms in Higher Education - especially university reforms - and increased funding with sustained investment are all needed to attract students to doctoral programmes. In this context, there is an urgent need to give special attention to the dire situation of the lack of qualified faculty, and to overall spark national interest and attention towards academics. Any initiative or investment in this direction may not produce tangible results in the short term. However, given the enormity of the problem, further procrastination will only lead to greater damage of the system which will render future repairs vastly more expensive, both financially and academically. Hence it is imperative that the Government acts with a sense of urgency and embarks on the remedial path immediately.

Annexures

Consultations

We did an extensive survey and received opinions from more than 250 diverse stakeholders (from academia, research institutions, industry etc) on the subject. Later, we organized a workshop inviting participants to delve on the issues of fostering industry academia relationships and improving the research environment in universities. Following is the list of experts who took part in the workshop:

1. Dr. K.V. Subramaniam, Director, Reliance Life Sciences
2. Mr. Venkatesh Vallury, Managing Director, Agilent Technologies
3. Dr. Shilpa Vora, Principal Research Scientist, HLRC
4. Ms. Valsa Williams, Intel Technology India Pvt Ltd
5. Dr. Sandhya Chintala, Director, Education Initiative, NASSCOM
6. Dr. Vidyasagar, Executive Vice President, TCS
7. Dr. Meenu Singh, Additional Professor of Pediatrics, PGIMER, Chandigarh
8. Dr. Bala Subramanian, Director, LVPEI
9. Dr. Y.S. Rajan, Principal Advisor, CII
10. Dr. R.B. Grover, Director, Knowledge Management Group, BARC
11. Dr. Gyan Arora, Tata Motors
12. Prof. G.D. Yadav, UICT
13. Dr. Sushma Gupta, Ranbaxy Laboratories
14. Prof. B.D. Singh, Dean Sciences, Banaras Hindu University
15. Prof. E. Haribabu, Dean Social Sciences, University of Hyderabad
16. Dr. A.N. Desai, The Bombay Textile Research Association
17. Prof. Balaji Parthasarthy, IIIT Bangalore
18. Prof. Pankaj Jalote, IIT Delhi
19. Prof. Shashiprabha, Jawahar Lal Nehru University
20. Dr. J.K. Bhasin, NEERI
21. Dr. Ajit Ranade, Chief Economist, Aditya Birla Group
22. Dr. Rajendra Singh, CMIR Dhanbad
23. Prof. Varyam Singh, Dean Languages, JNU
24. Dr. Ashok Ganguly, Member, National Knowledge Commission
25. Dr. Sujatha Ramdorai, Member, National Knowledge Commission

Highlights of Other Recommendations

School Education

- Substantially increase public spending for both elementary and secondary education.
- Explicitly incorporate the physical requirements for schooling, including provisions for play grounds and other school facilities in urban planning and local planning.
- Make flexible the norms for central government disbursement to states of Sarva Shiksha Abhiyan funds and other central schemes for school education.
- Provide greater flexibility in disbursing funds down to the school level and a greater degree of autonomy of local level management in the use of funds.
- Ensure transparent, norm-based and straightforward procedures for the recognition of private schools, as well as for the disbursement of aid from the government to self-financing schools and the ability of school management to raise resources from other sources.
- Create a complete database on schools and school-age children so as to track the actual coverage and quality of schooling at different levels, and make it widely available in a timely manner.
- Ensure greater co-ordination among different departments of government on school education policy, even while ensuring more autonomy to the local community in matters of day-to-day management of schools.
- Revamp the system of school inspection in most states, with a greater role for local stakeholders.
- Improve and regulate pre service training of teachers and expand in-service training.
- Move away from rote learning to understanding concepts, good comprehension and communication skills and learning how to access knowledge independently.
- Use new technologies, especially but not only ICT to reduce costs, enable more effective use of resources, and provide wider exposure to students and teachers.

Higher Education

- Create many more universities that would enable India to attain a GER of at least 15 percent by 2015.
- Change the system of regulation for higher education. Set up an Independent Regulatory Authority for Higher Education.
- Increase public spending and diversify sources of financing.
- Establish 50 national universities that can provide education of the highest standards.
- Reform existing universities to restructure curricula and examination system, make a transition to a course credit system, become the hub of research, attract and retain talented faculty etc.
- Restructure undergraduate colleges by providing them autonomy wherever appropriate.
- Promote enhanced quality by ensuring mechanisms for accountability.
- Ensure access for all deserving students by adopting a needs-blind admission policy and providing National Scholarship Scheme.
- Ensure access for economically and historically socially underprivileged children.

More Students in Maths and Science

- Invest in upgrading and expanding the existing infrastructure and promote sharing of available resources.
- Revitalize the teaching profession to attract and retain quality teachers.
- Revamp teacher training at all levels and promote development of teaching aids to retain student attention in classrooms.
- Restructure masters and graduate degrees to promote career flexibility after graduation.
- Reform the science curriculum content in line with the changing world and increase research component.

- Change the evaluation system to encourage scientific thinking and promote better understanding of basic science concepts.
- Promote access to quality science educational material.
- Re-brand and promote careers in basic sciences.
- Launch a massive science outreach programme aimed at students and their parents.
- Encourage industry participation in promoting sciences.

Open and Distance Education (ODE)

- Create a national ICT infrastructure for networking ODE institutions.
- Set up a National Education Foundation to develop web based common open resources.
- Establish a credit bank to effect transition to a course credit system.
- Establish a National Education Testing Service for assessing ODE students.
- Facilitate convergence with conventional universities.
- Set up a research foundation to support research activity in ODE.
- Overhaul training programmes for educators.
- Increase access for learners with special needs.
- Create a new standing committee for the regulation of ODE.
- Develop a system for quality assessment.

Open Educational Resources

Our success in the knowledge economy hinges to a large extent on upgrading quality and enhancing access to education. One of the cost effective ways of achieving this would be to stimulate the development and dissemination of quality Open Access (OA) materials and Open Educational Resources (OER) through broadband internet connectivity:

- Support the production of quality content by a select set of institutions by launching a 'National E-Content and Curriculum Initiative'.

- Develop a network enabled infrastructure to facilitate access to online multimedia educational resources through broadband internet connectivity.
- Undertake faculty development and teacher training programmes to develop pedagogic skills using new educational technologies.

National Knowledge Network

- Build a national knowledge network with gigabit capabilities to connect all universities, libraries, laboratories, hospitals and agricultural institutions to share data and resources across the country.
- This will ultimately require provision of connectivity to around 5,000 nodes covering all major institutions.

National Science and Social Science Foundation

- Set up a National Science and Social Science Foundation which will look at all knowledge as one seamless entity.
- The Foundation to suggest policy initiatives to make India a leader in the creation and use of knowledge, to ensure that science and technology are maximally used for the betterment of the lives of people, and to develop the scientific temper in the country.

Intellectual Property Rights (IPR)

- Scale up efforts to build a world class IPR infrastructure, including steps to modernize the patent offices with computerization, e-filing, process re-engineering, human resource development, transparency, documentation, accessibility and building global standards.
- Intensify IPR training in IP Offices as well as in educational institutions and develop IPR Cells.
- Establish new structures such as a separate IPR Tribunal, a national institution for cutting edge IPR policy and a Global Technology Acquisition Fund.
- Protect Traditional Knowledge (TK), create incentives for TK and also explore mechanisms for identification of key IPR issues in new technology areas.

Innovation

- NKC's Innovation Survey reveals that innovation is emerging as one of the key factors in India's economic growth, where both large firms and SMEs have increased innovation-related revenues. The strategic prioritization of innovation has also increased significantly since the start of economic liberalization.
- Crucial firm level structures and processes play a key role in innovation but skill shortage arising out of lack of emphasis on experimentation/problem solving in the curricula is a critical barrier. There is also need for more effective synergies between industry, government, the educational system, R&D environment and the consumer.
- A comprehensive campaign is needed across the entire economy from the grassroots to the large firm level to make India a global leader in innovation.

Entrepreneurship

- Develop a supportive business environment consisting of single window clearance, single composite application form for clearances, a single unique company number.
- Create new institutional mechanisms such as commercial courts to settle commercial disputes and limited liability partnerships.
- Provide access to financial, statutory, legal, and regulatory information for entrepreneurs through one stop shops, web-based portals and information handbooks.
- Develop measures to facilitate access to early stage finance, and provide incentives for seed capital funding.
- Develop and put in place a comprehensive policy on Business Incubation for Entrepreneurs.
- Enact a uniform legislation for publicly funded research and enable researchers to set up commercial entities.
- Make Entrepreneurship a core subject in business schools and explore possibilities of setting up specialized entrepreneurship schools.
- Develop an entrepreneurial culture by rewarding and recognizing successful entrepreneurs and entrepreneurial networks and associations.

Legislative framework for the Public-Funded Research

- Enact a legislation that would give universities and research institutions ownership and patent rights over inventions arising out of government-funded research thereby creating an enabling environment for commercialization of such inventions through licensing arrangements where inventors would also be allowed to receive a share of the royalty.
- The proposed enactment should incorporate important safeguards for exceptional circumstances where the government could be given 'march in rights' to protect public good.

Members, Advisers and Staff National Knowledge Commission

Shri Sam Pitroda
Chairperson
s.pitroda@nic.in

Dr. Ashok Ganguly
Member
a.ganguly@nic.in

Dr. P. Balaram
Member
p.balaram@nic.in

Dr. Deepak Nayyar
Member
d.nayyar@nic.in

Dr. Jayati Ghosh
Member
j.ghosh@nic.in

Shri Nandan Nilekani
Member
n.nilekani@nic.in

**Dr. Sujatha
Ramdorai**
Member
s.ramdorai@nic.in

Prof. Amitabh Mattoo
Member
a.mattoo@nic.in

Mr. S Regunathan
Adviser
s.regunathan@nic.in

Dr. Kiran Datar
Adviser
k.datar@nic.in

Dr. Kumud Bansal
Adviser
k.bansal@nic.in

Mr. C.N.S. Nair
Adviser

Mr. Amlan Goswami
Research Associate
a.goswami@nic.in

Ms. Namita Dalmia
Research Associate
n.dalmia@nic.in

**Ms. Sukhman
Randhawa**
Research Associate
s.randhawa@nic.in

Ms. Megha Pradhan
Research Associate
m.pradhan@nic.in

Mr. Vikas Bagri
Research Associate
v.bagri@nic.in

Ms. Deepti Ayyanki
Research Assistant
d.ayyanki@nic.in

Ms. Aashima Seth
Executive Assistant
a.chaney@nic.in

For further enquiries:
Email: n.dalmia@nic.in
Website: www.knowledgecommission.gov.in

