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ENERGISING RESEARCH IN INDIAN HIGHER EDUCATION INSTITUTIONS

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He played a very significant role in conceptualizing and setting up the Homi Bhabha National Institute and concurrent with other responsibilities, he led it for eleven years (2005-2016). He was Principal Adviser in the Department of Atomic Energy during 2010-13 and was Homi Bhabha Chair during 2013-18.

He was conferred with the Lifetime Achievement Award–2011 by the Department of Atomic Energy, and the Padma Shri by the President of India in 2014.

ENERGISING RESEARCH IN INDIAN HIGHER EDUCATION INSTITUTIONS

R B Grover

National Education Policy–2020 (NEP–2020) provides a clear direction to the Higher Education Institutions (HEIs) to nurture a culture of research in the institutions and to conduct research to solve national problems. The Policy also recommends the creation of a range of HEIs: Research-Intensive Universities, Teaching-Intensive Universities, Autonomous Degree-Granting Colleges and large Multidisciplinary Universities to facilitate Interdisciplinary Research. To create large multidisciplinary universities, the policy provides the option of setting up clusters of HEIs. This essay focusses on Research-Intensive Universities, and advocates the idea of cluster-based universities for nurturing research culture in HEIs. It proposes that the Cluster-based Universities can include laboratories established by the Government as well as industry associations and the ambience thus created will facilitate the employees of a research laboratory, faculty and research students to address problems of relevance to the nation. This will benefit the laboratories as well as HEIs; and the Nation as a whole. Success stories of national and international clusters of HEIs, particularly, Homi Bhabha National Institute (HBNI), have been discussed in detail in the essay to provide models for HEIs to emulate.

PRELUDE

The National Education Policy–2020 (NEP–2020), when examined from the point of view of higher education, has several excellent features including an emphasis on critical thinking, problem-solving, creativity, multidisciplinarity, innovation, adaptation; and life skills such as communication, cooperation, teamwork and resilience.

Resilience is very important as fast-expanding knowledge is opening new job opportunities, and education received should equip a student with enough resilience to reskill and make use of new opportunities as they open up.

NEP–2020 is exhorting Higher Education Institutions (HEIs) to develop a skilled nation that can find robust solutions to its own problems and implement the solutions (Para 9.1.3, NEP–2020)[1] Implication of the exhortation is that research in HEIs should be conducted in areas of relevance to national development. Considering that large multidisciplinary teams are needed for solving real-life problems, and in India many elite HEIs are single-discipline institutions, NEP is proposing a move towards establishing large multidisciplinary universities and clusters of HEIs (Para 10.2, NEP–2020).

NEP–2020 envisions the co-existence of a range of HEIs: Research-Intensive Universities, Teaching-Intensive Universities, and Autonomous Degree-Granting Colleges. This article will focus on Research-Intensive Universities. With regard to the classification of universities, Carnegie classification is the oldest system, and in India, the publication by Jalote et al. (2019) is the first attempt toward a classification. HEIs have been providing detailed information to the Ministry of Education(MoE), erstwhile Ministry of Human Resource Development, as input to the National Institutional Ranking Framework (NIRF) every year, which has been analysed by Jalote et al. (2019) for developing a classification for research universities. They conclude that very few HEIs are research-intensive and one of the reasons is the fact that most HEIs do not have a faculty that is large enough. Elaborating on the need to increase the strength of faculty, it must be noted that low faculty strength is an impediment for HEIs to take up teaching to meet requirements of - and research on problems facing defense, space, and nuclear sectors. As a result, these ministries and departments have established their own HEIs (Grover, 2020). This is further elaborated in the next section.

Regarding problems to be taken up for research, NEP–2020 states: "*The societal challenges that India needs to address today, such as access for*

all its citizens to clean drinking water and sanitation, quality education and healthcare, improved transportation, air quality, energy, and infrastructure, will require the implementation of approaches and solutions that are not only informed by top-notch science and technology but are also rooted in a deep understanding of the social sciences and humanities and the various socio-cultural and environmental dimensions of the nation," (NEP–2020, Para 17.4).

From a policy perspective, NEP is providing a clear direction: direct research to solve national problems by establishing large multi-disciplinary universities. To create large multidisciplinary universities, it provides the option of setting up clusters of HEIs. In India, doctoral programmes are being conducted in national laboratories in affiliation with various universities which give degrees, and while formulating implementing strategies, one can form clusters of HEIs and national laboratories. Before looking at strategies for implementation, let us have a look at some important issues related to the conduct of research in India.

SOME OBSERVATIONS ON CONDUCTING RESEARCH IN INDIA

At the outset, let us recall an important observation from the report of the Kothari Commission issued in the mid-1960s: "*At present, the 'centre of gravity' of Indian academic life is largely outside India. That is to say, our scholars and scientists working in fields which are internationally cultivated still tend to look outside India for judgment of their work, for intellectual models of the problems which they study, for the books they read, and for their forum of appreciation and approval……. Indian problems are not seen in their concreteness and particularity and as a result, techniques and theories are not adopted to Indian situation*," (Kothari, 1966: 280).

Though Kothari wrote this in 1966, the situation has not improved as may be seen from the following observation by Elkana and Klöpper (2016:184): *"The fact that hundreds of new universities in China and India copy the curricula from the United States or Europe, and send many of their doctoral students to study there, results in a serious neglect of their own scholarly traditions as well as local and regional problems. ….. Since*

working on such problems seldom receives proper recognition, a focus on them usually does not help in building a scholar's reputation nor is it the stepping stone for a successful career. …Hence,…reorienting the system of incentives is the key to real change."

On analysing the structure of research establishment in India and various policy statements (Grover, 2019) it was noted that while the Ministry of Education (MoE) is tasked with the mandate of nurturing higher education, other Ministries and Departments are supplementing the efforts of MoE. Various ministries and departments of the Government of India are tasked with implementing programmes falling under their mandate. To conduct research on topics of direct interest as per the mandate assigned to them, and to meet their requirements of qualified manpower, many ministries and departments have established their own institutions and are managing them rather than relying only on HEIs established and managed by MoE. The list of such HEIs prepared by the author earlier (Grover, 2019) has been updated and presented in Table-1.

Many of these HEIs could have been a part of large universities, but the concerned Ministries or Departments found it necessary to have separate institutes that were required to focus on research and education related to their mandate. This is due to several reasons including the small size of HEIs in India, the prevailing reward system forcing scholars to look outside India for appreciation of their work and inspiration for ideas rather than the society around them, and denial of opportunities to Indian citizens to work in strategic areas in universities abroad which is valued for recruitment as faculty in elite institutions. Additionally, there are instances, where the motivation for setting up universities by ministries and departments other than the MoE is to run academic programmes efficiently, as the decision-making process in conventional universities managed by MoE or state governments proceeds at a glacial speed. The author has discussed the motivation for establishing Homi Bhabha National Institute (HBNI), which is a cluster of HEIs including national laboratories in his earlier publication (Grover, 2019). In the light of the inclusion of the concept of a cluster of HEIs, this idea needs further exploration.

Table 1: HEIs Administered by Departments and Ministries other than Ministry of Education

Ministry/Department	HEI (Year of establishment as an HEI)
Ministry of Home Affairs	National Forensic Sciences University*, Gandhinagar (2020) Rashtriya Raksha University*, Gandhinagar (2020)
Ministry of Railways	The National Rail and Transport Institute**, Vadodara (2018)
Ministry of Petroleum and Natural Gas (MOP&NG)	Indian Institute of Petroleum and Energy*, Visakhapatnam, (2018)
Department of Science and Technology (DST)	Indian Association for the Cultivation of Science** (2018)
Ministry of Food Processing Industries	National Institute of Food Technology Entrepreneurship and Management**, Sonipat (2012).
Ministry of Health & Family Welfare (MH&FW)	National Institute of Mental Health and Neurosciences*, Bengaluru (2012).
Department of Scientific & Industrial Research	Academy of Scientific and Innovative Research* (2011).
Ministry of Defence (MOD)	Indian National Defence University*, approved in 2010 and now coming up in Gurugram.
MOP&NG	Rajiv Gandhi Institute of Petroleum Technology*, Rae Bareli (2008).
MH&FW	Post-Graduate Institute of Medical Education and Research*, Chandigarh (2008).
Department of Space	Indian Institute of Space Science and Technology**, Trivandrum (2007)
Department of Atomic Energy (DAE)	Homi Bhabha National Institute**, Mumbai (2005).
DAE	Tata Institute of Fundamental Research**, Mumbai (2002).
Ministry of Commerce & Industry	Indian Institute of Foreign Trade** (2002).
MOD	Defence Institute of Advanced Technology**, Pune (2000).
Department of Pharmaceuticals	National Institute for Pharmaceutical Research*, Mohali (1998); and now at six more places.
Ministry of Environment, Forests & Climate Change	Forest Research Institute**, Dehradun (1991).

Ministry/Department	HEI (Year of establishment as an HEI)
Ministry of Agriculture & Farmer's Welfare: Indian Council of Agriculture Research (MA&FW–ICAR)	ICAR- National Dairy Research Institute**, Karnal (1989); ICAR- Central Institute of Fisheries Education**, Mumbai (1989). ICAR- Indian Veterinary Research Institute**, Izatnagar (1983).
DST	Sree Chitra Tirunal Institute for Medical Sciences and Technology*, Trivandrum (1980).
MH&FW	Jawaharlal Institute of Postgraduate Medical Education and Research*, Puducherry (1966).
Ministry of Statistics & Programme Implementation	Indian Statistical Institute*, Kolkata (1959)
MA&FW-ICAR	ICAR-Indian Agriculture Research Institute**, New Delhi (1958)
MH&FW	All India Institute of Medical Sciences*, New Delhi (1956) and now at six more places

* An Institute of National Importance;

** A Deemed to be University;

Notes: (a) HEIs are listed in reverse chronological order.

(b) In the case of multi-campus institutes, the city of location of headquarter is indicated in the table.

(c) The table doesn't list HEIs engaged in vocational education, or research in fields other than STEM. These include the following.

1. Ministry of Textiles established the National Institute of Fashion Technology having 15 campuses in 1986 and it became an INI in 2006.
2. Ministry of Shipping has set up Indian Maritime University under an Act passed in 2008.
3. Ministry of Civil Aviation established Rajiv Gandhi National Aviation University in 2013, and all flying schools are expected to get affiliated with it. At present, it offers only short-term diploma programmes.
4. Ministry of Commerce and Industry established Footwear Design and Development Institute having 12 campuses in 2006. It became an INI in 2017.
5. Ministry of Commerce & Industry has set up Indian Institute of Packaging as a non-formal institute and there is a proposal to convert it into an INI.
6. Department of Corporate Affairs has set up Indian Institute of Corporate Affairs (non-formal).
7. Ministry of Culture has three HEIs dealing with Buddhist Studies.

CLUSTER-BASED UNIVERSITIES IN OTHER COUNTRIES

Apart from HBNI, it is appropriate to recall examples from other countries. As stated on its website, Jet Propulsion Laboratory (JPL), Pasadena, California, USA is a federally funded research and development centre managed for NASA by California Institute of Technology (Caltech). JPL has evolved from the Guggenheim Aeronautical Laboratory established in 1936 at Caltech and was transferred to NASA in 1958. From the long history of leaders drawn from the university's faculty to joint programmes and appointments, JPL's intellectual environment and identity are profoundly shaped by its role as a part of Caltech. JPL is a large laboratory and has about 6000 full-time employees, and Caltech was placed 8th in Academic Ranking of World Universities (ARWU) by Shanghai Rankings in 2020.

SOKENDAI (The Graduate University for Advanced Studies) established in Japan in 1988 and running only doctoral programmes, brings together several research institutions and museums such as the National Museum of Japanese History.

An arrangement similar to that between JPL and Caltech has been recently established in France. According to information in Wikipedia, the Paris-Saclay University was established in 2015 as a "university system" and became a university in 2019. In the coming years, more universities will merge with it. The university shares 275 laboratories with several research organizations, including CEA (Atomic Energy and Alternate Energies Commission), INSERM (French Institute of Health and Medical Research), SOLEIL (National Synchrotron Facility) and others. Research Centres are expected to have a profile similar to JPL which is managed by Caltech. Though just established, Paris-Saclay university was placed 14th in ARWU by Shanghai Rankings in 2020. It is one of Europe's biggest research universities and was in the making for several years (Casassus, 2020).

HBNI was accredited as a deemed to be university in 2005. All countries have their unique legal framework for establishing universities, and therefore, while there are differences in the structure of HBNI, SOKENDAI, Paris-Saclay University, and JPL-Caltech, the

objective for all is to benefit from synergies. Benefits of the concept where the cluster includes national laboratories can be seen from the growth and success of HBNI (Grover, 2019). Figure 1 gives a year-wise output of students with a Ph.D. and Figure 2 gives a year-wise output of students with specialty and super-specialty medical degrees (M.D./D.M./M.Ch.) from HBNI. National Institutional Ranking Framework –2020 (NIRF-2020) ranked HBNI at 14th position among universities. Nature Index ranked HBNI at second position among all academic institutions in India based on publications during the period 1 October 2019 to 30 September 2020. Nature Index ranks universities based only on a single dimension and that is the share of articles published in 82 prestigious journals.

Fig 1: Year-wise Output of Students with a Ph.D. from Homi Bhabha National Institute

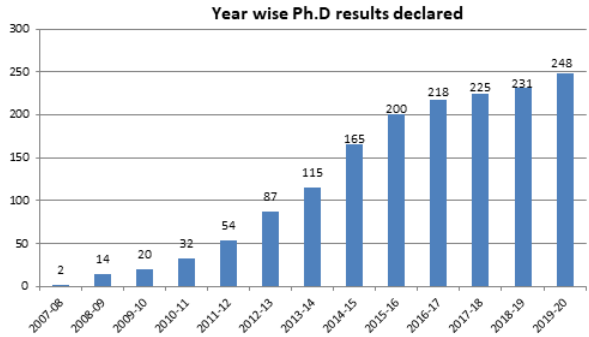
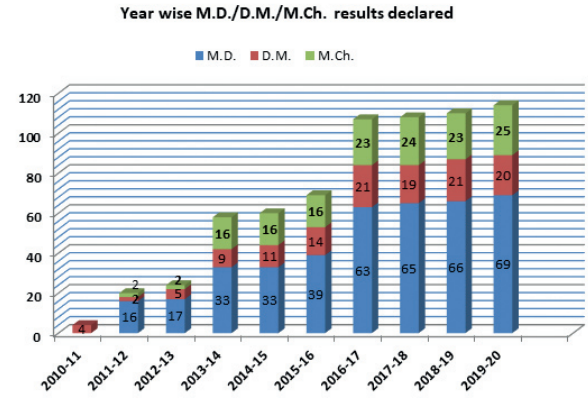


Fig 2: Year-wise Output of Students with M.D./D.M./M.Ch. from Homi Bhabha National Institute



Another example of a cluster-based university in India is the Academy of Scientific and Innovative Research (AcSIR) established as an Institute of National Importance in 2011. Nature Index has ranked AcSIR at eighth position in India.

There are more examples of collaborative arrangements between national laboratories and universities in other countries. In many cases, joint appointments are made between the collaborative entities. A notable example is the management of the Princeton Plasma Physics Laboratory by the Princeton University, and the arrangement between them provides for joint appointments.

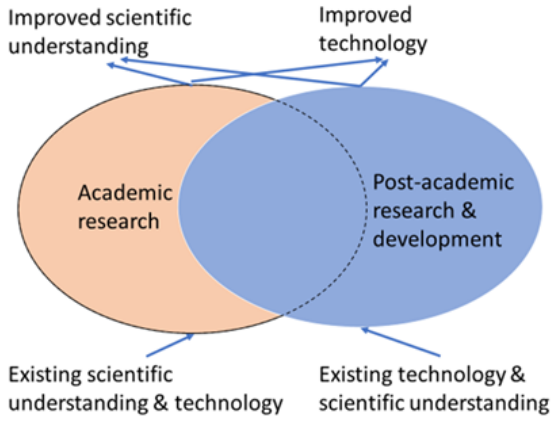
Looking at the success of cluster-based universities, India needs to pursue this model further.

IMPLEMENTING THE CONCEPT OF CLUSTER-BASED UNIVERSITIES

To contribute to national well-being, research must be followed by the development of technologies that is products and processes. This can also be expressed in terms of Academic Research (AR) and Post-Academic Research (PAR). AR and PAR are fully intertwined (Grover, 2019a). Both AR and PAR have epistemic and use objectives. The dominant objective in the case of AR is epistemic, while in the case of PAR, it is use. Using these arguments, Grover (2019a) proposed a representation of the relationship between science and technology as in Figure 3. It is best to carry out the two together in the same institution to get the maximum benefit from the research infrastructure and manpower, and to ensure translation of research to national development (Grover, 2020). Following up AR by PAR and translating it into state-of-the-art technologies was the idea behind setting up HBNI (Grover, 2019; Kakodkar and Gangotra, 2019:121). Managing an institution where both AR and PAR are pursued is a challenge[2], but it is necessary to have such institutions to contribute to industrial progress. In this regard, life scientists, by giving due importance to translational research, have done better than scientists pursuing other natural sciences. Considering increasing

funding and manpower required to set up mega facilities to make new discoveries, it is essential that AR is followed by PAR, and a significant fraction of researchers, after completing a Ph.D., find employment outside the academia. It should not happen that a teacher mentors a student to get a Ph.D. and become a teacher; if so the research becomes an epiphenomenon (Price, 1986:157).

Fig 3: A Representation of the Relationship between Science and Technology



Note: The words 'scientific understanding' used in the figure represents understanding in all branches of science including natural sciences, engineering sciences, health (or medical) sciences, agricultural sciences and social sciences.

As stated earlier, many laboratories also run doctoral programmes in affiliation with universities for students and their employees. For this purpose, senior researchers in laboratories are recognized as faculty or thesis supervisors by universities. One may call these programmes off-campus programmes. The Indian Institute of Science pioneered a variant of off-campus programmes called External Registration (ER) programme which enabled employees working in laboratories or industries to register for a doctoral programme under the supervision of its faculty and carry out a major part of research at their work-place. The topic of research taken up by students under the off-campus programmes is always of relevance to the work-place of the student. The ER programme[3] is being run by the Indian Institute of Science(IISc) since 1972. Subsequently, a few more HEIs adopted this programme. Considering this practice, one can go a step further

and make work-places pursuing knowledge-based work a part of a cluster-based university. In short, experience gained in the process of establishing HBNI needs to be replicated in the country.

The concept of the cluster need not be limited to Science, Technology, Engineering and Management (STEM) fields. It can be extended to social sciences as well, like by SOKENDAI.

Off-campus programmes are not unique to India; such programmes are running in other countries as well (Grover, 2019). Research centers of CEA, France host doctoral students. Students pursue their entire research in CEA laboratories and get a doctoral degree from the university in which they are enrolled. At any given time, there are more than 1000 doctoral students pursuing research in CEA laboratories.

Clustering of HEIs and work-places like laboratories and museums will result in *joint programmes and joint appointments* as is the case for JPL and Caltech. This will invigorate both research and education. Institutions for clustering in a university can be selected based on different concepts; some examples could be institutes managed by a department or a ministry or a trust, institutes located in close proximity, institutes pursuing similar objectives etc. A city like Chandigarh is a place where there are a large number of institutes and some of them could be selected for clustering into a university. For moving away from single-discipline institutions to multi-disciplinary universities, clustering is a cost-effective solution and can be implemented in a short time frame.

Cluster-based universities can also include laboratories established by industry associations such as Electrical Research and Development Laboratories (ERDA)[4], Vadodara, or motivate industry associations to set up such laboratories in HEIs. Such clustering will benefit both the laboratories and the HEIs. The ambience created will facilitate employees of a research laboratory, faculty and research students to discuss problems and methods of solving them, through which all of them are benefitted. Research carried out by doctoral students in such laboratories will always have direct relevance to the needs of the industry. Students who have worked on contemporary problems are

likely to be in demand for employment by the industry. The concept of integrating research laboratories will be beneficial to research in all branches of engineering, and some branches of natural sciences particularly chemistry and life sciences. Such an arrangement will motivate the industry to hire post-doctoral researchers and induce young minds to start their research career by solving problems of the Indian industry. Universities can also set up incubation centers within their campus and use them to take up research as a relay race involving researchers, technologists, entrepreneurs and end-users. One can also consider extending the concept to include work-places associated with organizations like the Archeological Survey of India and various well-established museums.

Every institute has its unique culture and the initial period is almost always challenging for the management[5]. Culture evolves over a period of time and not overnight. First, challenges have to be overcome with dialogue and mutual respect. Second, one should provide maximum autonomy to the Constituent Institutions (CIs) consistent with the legal framework. Third, a crucial issue is the fact that the scope of PAR is more than AR, and the scope of innovation is much more than PAR. In a cluster-based university, having university schools and knowledge-based work-places as its CIs, the 'rewards system' has to be framed to recognize all aspects of talent and all knowledge-based output. One may recall the advice given by P B Medawar to young scientists that "technicians are colleagues in a collaborative research", and "despite their paper degrees", young scientists have a lot to learn about scientific research (Medawar, 1979: 39). This advice is more important today when experimental facilities are becoming more and more complex, and need not only competent technicians, but highly competent engineers, called scientific officers in national laboratories in India, for their design, construction, operation and maintenance. Examples of such facilities are research reactors, synchrotron sources, large telescopes, tokamaks etc. Such facilities also need a well-conceived and well-run organizational structure. Contribution of all is necessary for good research output and needs due acknowledgement in the reward system designed for the career progression of employees.

CONCLUSION

NEP–2020 is directing HEIs to conduct research to solve national problems and to achieve that objective India needs large multi-disciplinary universities. NEP provides the option of setting up clusters of HEIs. Considering the preponderance of single-discipline HEIs in India and the small size of HEIs, establishing cluster-based universities has to be an important part of the strategy to implement NEP with the objective of energising research. In India, doctoral programmes are being conducted in various research and development laboratories established by the Government of India, industries, or industry associations and therefore, while formulating implementing strategy, one can form clusters of HEIs that include knowledge-based work-places which will also ensure that research conducted has relevance to problems facing the Indian industry. The concept of cluster-based universities has already been implemented in India and two examples are HBNI and AcSIR. Noteworthy examples outside India are Paris-Saclay University, and Caltech with JPL as its part.

HBNI is a success story and has the potential of being counted amongst the top universities in the world. Based on the experience of establishing HBNI which conducts its academic programmes in eleven institutions, one could say that for success, it is necessary for the management of the cluster-based university to respect the existing culture of CIs, provide autonomy to all CIs, and devise a reward system that respects all aspects of talent and all knowledge-based output.

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Notes

1. Paras in brackets refer to paras of the National Education Policy – 2020.
2. The challenge arises in devising an award system as the metric to measure

the output of AR and PAR have to be different. Individuals pursuing AR seek to know, while individuals pursuing PAR seek to do, and there are many who pursue both simultaneously or during different phases of their career.

3. I have myself benefitted from this programme first as a student, and later as a guide jointly with faculty from the Institute, for junior colleagues in Bhabha Atomic Research Center.
4. This is cited as an example, and ERDA has not been consulted for this purpose.
5. On the basis of my experience of establishing and running HBNI for more than ten years, some cautionary notes are added here.

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