# Table of Contents

## Dialogue

**Research**

- For a Place at the 'High-Table': The Compelling Case of Indian Women in Science
  - SNEHA SUDHA KOMATH
  - Page 1

- A Framework to Address the Food, Energy and Water Nexus among Indian Megacities and Their Rapidly Expanding Peripheries
  - ADITYA BANDLA, GOURVENDU SAXENA, RAJAT MISHRA AND SANJAY SWARUP
  - Page 31

- Impact of Digital Revolution on the Practice of Science Communication
  - K. P. MADHU
  - Page 39

**Commentary**

- Management of Collegiate Education in the 21st Century: Some Insights
  - KAMBADUR MURALIDHAR
  - Page 53

- The Knowledge Systems Debate in India
  - LAWRENCE SURENDRRA
  - Page 61

**Perspective**

- Fake Science and the Knowledge Crisis: Ignorance can be Fatal
  - HENNING HOPE, ALAIN KRIEF, GOVERDHAN MEHTA AND STEPHEN A. MATLIN
  - Page 77

- A Report of the Workshop on ‘Advances in Earth System Science’ Organized by the Department of Geology, Banaras Hindu University (BHU) and Indian Academy of Sciences (31st October – 1st November, 2018 at Varanasi)
  - N. V. CHALAPATHI RAO
  - Page 85

- Observations on the Draft National Education Policy
  - INDIAN NATIONAL SCIENCE ACADEMY, INDIAN ACADEMY OF SCIENCES, NATIONAL ACADEMY OF SCIENCES, INDIA
  - Page 89
<table>
<thead>
<tr>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Educational Potential of Students’ Movements</td>
<td>147</td>
</tr>
<tr>
<td>GAUHAR RAZA</td>
<td></td>
</tr>
<tr>
<td>Perceptions of Science Built in the Science Classroom</td>
<td>151</td>
</tr>
<tr>
<td>R. RAMANUJAM</td>
<td></td>
</tr>
<tr>
<td>Green Movements and Public Perception of Science</td>
<td>159</td>
</tr>
<tr>
<td>T. V. VENKATESWARAN</td>
<td></td>
</tr>
<tr>
<td>The Draft NEP and the Question of Finances</td>
<td>171</td>
</tr>
<tr>
<td>SUKANYA BOSE AND ARVIND SARDANA</td>
<td></td>
</tr>
<tr>
<td>Technology in the DNEP and Science Education</td>
<td>177</td>
</tr>
<tr>
<td>R. RAMANUJAM</td>
<td></td>
</tr>
<tr>
<td>Capitalizing Genome: The Business of Direct-to-Consumer Genetic Testing in India</td>
<td>185</td>
</tr>
<tr>
<td>SHASHANK S. TIWARI</td>
<td></td>
</tr>
<tr>
<td>‘Plan-S’ Model of Research Publication – A Serious and Unwarranted Drain on Money Meant for Actual Research</td>
<td>189</td>
</tr>
<tr>
<td>SUBHASH C. LAKHOTIA</td>
<td></td>
</tr>
<tr>
<td>How can a Young Scientist Help to Counter the Wave of Pseudoscience?</td>
<td>193</td>
</tr>
<tr>
<td>ANINDITA BRAHMA</td>
<td></td>
</tr>
<tr>
<td>Have we Scientists Failed Our Society?</td>
<td>197</td>
</tr>
<tr>
<td>ANINDITA BHADRA</td>
<td></td>
</tr>
</tbody>
</table>
RESEARCH

For a Place at the ‘High-Table’: The Compelling Case of Indian Women in Science

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Corresponding editor: DHRVU RAINA

Abstract

Much of the existing literature on women in science in India tends to highlight the ‘absence’ of women, while that is no longer the case. Based on an extensive review of the available evidence, the paper reflects that the number of women in science has been steadily growing, though with significant variations across disciplines. Using Biological Sciences as a reference point, the paper highlights the fact that even when women grow in numbers and begin to knock at the doors of positions in the scientific establishment, they continue to find recalcitrant gatekeepers. Underlying gender frames thus persist and shape the structures of scientific organizations. The paper contends that introducing ‘pro-women’ affirmative policies without working to alter the existing organizational normative and mindscapes could, in fact, be counter-productive.

Keywords: Gender; Women in Science; Hiring in Science; affirmative action; Indian scientific research and education; Indian scientific research institutions
As per the World Economic Forum report of 2017, among the 144 countries surveyed, India ranked an abysmal 108 in the global gender gap, dropping from a not-so-impressive 87th rank in the previous year. India was also ranked at an unseemly 141 in health and survival rates and a poor 139 in economic opportunities. Even in terms of education, it was ranked only at 112. Not surprisingly, the gender gap for women in scientific research is also significantly wide. As per the UNESCO Institute for Statistics (2017), even as the number of personnel engaged in scientific research increased by a healthy 37.8%, the per cent of women researchers dropped marginally, from 14.3% in 2010 to 13.9% in 2015.

The Indian middle-class might wish to connect these numbers to the ‘other’ India, the marginal and the poor, living in rural hinterlands and urban slums. But, what do these numbers mean to the Indian science community, or the socio-economic middle class and the educated segments? Is the presence of women in Indian scientific research and education truly a cause for concern? If so, is this in any way linked to their access or lack of it to higher education or research training in the Sciences, or do they reflect attrition rates? Are there areas or disciplines where women have better representation and is there a reason for this? Are there structural issues that prevent women from equal participation in scientific research? Are the recognitions commensurate with the women’s presence in the science research community? Based on the available primary and secondary sources on the subject, this paper attempts to examine some of these questions.

A brief history and the present context

Soon after India’s independence, the Government of India set up a University Education Commission (1948) to examine among other things, ‘The aims and objects of university education and research in India.’ The emphasis on education as a means for social transformation for the newly formed nation was clear. The Commission in its Report submitted in 1950 had an entire section dedicated to Women’s Education. It identified “some fields of work peculiarly appropriate to women...(to) indicate directions which women’s education might well take in Indian colleges and universities” as part of its recommendations. These special fields identified were Home Economics, Nursing, Teaching and the Fine Arts. The report espouses more lofty ideals in the introduction to this section, such as:

*We have heard frequent suggestions that women’s education should run to pretty “accomplishments,” such as drawing, painting or the like-skills which will enable well-to-do*
women to pass the time harmlessly while their husbands do the really important work. This point of view should be obsolete. Women should share with men the life and thought and interests of the times. They are fitted to carry the same academic work as men, with no less thoroughness and quality. The distribution of general ability among women is approximately the same as among men.\footnote{(The Report of the University Education Commission, 1950, Chapter XII p. 343–344)}

However, the thrust during this period was clearly not towards generating competent women scientists. This was also reflected in the enrolments to various courses in those early years. It was only in 1961–62, with the recommendations of the Hansa Mehta Committee (appointed by the National Council for Women’s Education) on ‘differentiation of curricula for girls and boys,’ that the issue of ‘common curricula’ began to be seriously discussed. The Kothari Commission (1964–66)\footnote{\url{https://indianculturalforum.in/2018/07/27/dr-kamala-sohonie-entry-of-women-to-the-indian-institute-of-science/}} went a step further, urging that women too should be actively encouraged to study the Sciences.

This is not to suggest that women did not have any presence in higher education or science education in India until this point. A number of studies have examined the history of Indian women in modern scientific research in India starting right from the colonial period. Many of the studies have provided not only excellent biographies detailing the individual struggles of women scientists but have also provided the socio-political milieu of the times. Many of these women, such as Kamala Sohonie, Asima Chatterjee or Janaki Ammal were trailblazers, often breaking the double barrier of caste and gender to venture into laboratories and work under extremely restrictive or even harsh conditions (\cite{Sur2001}; \cite{Damodaran2017}). However, since the inclusion of women was not an explicit state policy until this point; those who did make it were fighting a much larger battle. For instance, Kamal Sohonie became the first woman to earn a PhD degree in Science (Biochemistry)\footnote{\url{https://archive.org/stream/ReportOfTheEducationCommission1964-66dS.KothariReport/48.Jp-ReportOfTheEducationCommission1964-66dS.Kothari_Djvu.txt}} \cite{Sur2001}. Despite having topped her batch in graduation, she was denied admission to the Indian Institute of Science in Bangalore by none other than the Nobel laureate, C. V. Raman. When Raman did finally relent, he set out stringent and humiliating conditions to her entry: That she would not be considered a regular student for the first year; that she would work whenever her guide asked her to, irrespective of the time of the day, and that she would make sure that her presence did not distract other students. Thus, those who did make it did so under very special circumstances. However, this paper is not about these early achievers, many of whom even refused to acknowledge their own marginalization or refused to see it as gender discrimination.\footnote{For a more detailed discussion on the caste-class location and gender politics of women scientists of this era see \cite{Sur2001}; \cite{Damodaran2017}} It is not a historical, biographical or even a semi-autobiographical narrative describing the challenges faced by individual women scientists during the course of their
journey (for biographical accounts of women scientists in the present day context, see Ramdorai 2017; Vaidya 2017; Dogra and Jayraj 2016; and the TLOS website).

With independence from colonial rule and the adoption of a new Constitution that guaranteed citizenship based on equality to all its citizens, the terms of the game had been fundamentally altered. The Hansa Mehta committee and the Kothari commissions’ reports, in this context, laid the grounds for levelling the playing field by recommending common curricula and proposing that women be actively encouraged to study modern Mathematics and the Sciences. How far have we travelled down this road and where does the horizon lie?

A lot has changed since the early days, as this paper attempts to show. Nevertheless, gaps between intentions and actions continue to exist even today. For instance, leading universities/colleges, continue to make the Arts and Humanities more ‘accessible’ to women than the Sciences at the undergraduate level. Let’s consider the example of Delhi University (DU). The university offers undergraduate programs in Sociology and Psychology almost exclusively in ‘women-only’ colleges affiliated to it, while offering undergraduate programs in Physics in only 5 of the 22 such colleges. In Mumbai, of the many women’s colleges available, few offer an undergraduate program in the basic Sciences. Several offer courses in Psychology as well as Sociology. In Chennai, several degree colleges for women offer courses with different combinations of the basic Sciences. Some colleges offer only Mathematics in the science stream (although, it must be said that this subject has somewhat of a double life, and a B. A. degree in Mathematics can be achieved as much as a B.Sc. in Mathematics) along with Psychology and Sociology. Delhi, Mumbai and Chennai have Home Science courses mostly in women’s colleges. Exclusive women’s colleges for Home Science exist too. This is also true for Nursing and Education, which have also traditionally been seen as ‘suitable’ for women.

Again, let us consider the issue of discriminatory college/hostel rules and timings that most women students routinely must abide by in colleges and universities across the country. These rules and practices, in the name of women’s safety, routinely trample on their rights of equal access to libraries, laboratories, lectures, public spaces and transport. The Jayoti Vidyapeeth Women’s University, established by the Government of Rajasthan as recently as 2008, has several strictures laid down for students into its ‘Hostel Life’ page on its website. This includes constant monitoring of students’ movements in and out of campus along with notifications to parents/guardians as well as punitive action if found using a mobile phone or other such devices that possess a SIM card or could connect to the internet. Banasthali Vidyapith, as a rule, does not permit married women to apply for any of its programs, except under ‘exceptional circumstances’ to its post-graduate programs.

Sri Padmavati
Mahila Viswavidyalayam at Tirupati, established by the Government of Andhra Pradesh in 1983, informs students that they are expected to wear ‘clean and decent dress approved by the Dean’. They are also debarred from organizing any ‘meetings for criticizing the policies and actions of the university or college authorities’. In fact, one such case, that of the Mahila Maha Vidyalaya at the Benaras Hindu University (BHU), has even reached the Supreme Court. As per the petition, the hostel regulations do not permit women/residents, to go out after 8 pm, even to attend a program or to use the library within the BHU campus. The hostel regulations also do not permit girls to make/receive telephone/mobile phone calls after 10 pm; free Wi-Fi and Internet in their hostel rooms are not provided either. None of these rules apply to the male students in the hostels in the BHU campus.

Table I: Enrolment of students in Masters programs of Physical Sciences and Biological Sciences in 2015–16. The list is only representative and not exhaustive. (Source: AISHE report 2015-16)\(^{16}\)

<table>
<thead>
<tr>
<th>SUBJECTS</th>
<th>M. Sc. 2015–16</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Physical Sciences</strong></td>
<td></td>
</tr>
<tr>
<td>Mathematics</td>
<td>Male</td>
</tr>
<tr>
<td></td>
<td>50081</td>
</tr>
<tr>
<td>Physics</td>
<td>25540</td>
</tr>
<tr>
<td>Chemistry</td>
<td>44651</td>
</tr>
<tr>
<td>Statistics</td>
<td>3691</td>
</tr>
<tr>
<td>Geo-Physics</td>
<td>633</td>
</tr>
<tr>
<td>Electronics</td>
<td>2640</td>
</tr>
<tr>
<td>Geology</td>
<td>3518</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Biological Sciences</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Zoology</td>
<td>Male</td>
</tr>
<tr>
<td></td>
<td>13811</td>
</tr>
<tr>
<td>Botany</td>
<td>12021</td>
</tr>
<tr>
<td>Biochemistry</td>
<td>2137</td>
</tr>
<tr>
<td>Biotechnology</td>
<td>4579</td>
</tr>
<tr>
<td>Microbiology</td>
<td>3457</td>
</tr>
<tr>
<td>Life Science</td>
<td>2460</td>
</tr>
<tr>
<td>Genetics</td>
<td>351</td>
</tr>
<tr>
<td>Bio-Science</td>
<td>1650</td>
</tr>
</tbody>
</table>

\(^{11}\) [http://www.spmvv.ac.in/international.html](http://www.spmvv.ac.in/international.html) as accessed on 05 Feb 2019

Given these circumstances, when we come across newspaper reports that say ‘Women outnumber men for PG, M.Phil. courses,’\textsuperscript{12} it is certainly worth sitting up and taking note. That this is not only the case in the Social Sciences and Humanities but also in the basic Sciences\textsuperscript{13} is worth appreciating. In fact, the number of women per 100 men in M.Sc. courses has risen steadily from 80.1 in 2000–2001 (Manpower profile yearbook 2000–2001) to 113 in 2011–12\textsuperscript{14} and further to 157 in 2015–16 (as per the online All India Survey on Higher Education (AISHE), Ministry of Human Resource Development, Government of India initiative; AISHE 2011–12; AISHE 2015–16).\textsuperscript{15} These trends persist even when we examine the data across disciplines. To comprehend the numbers involved, Table I shows the enrollment of students in Masters programs of the Physical Sciences in comparison to the Biological Sciences across disciplines for the academic year 2015–16. As per the table, women outnumbered men by a significant margin in several disciplines at the post-graduate level. This included not only disciplines related to the Biological Sciences (Zoology, Botany, Genetics, Bio-Science, Life Sciences, Biochemistry, Microbiology and Biotechnology), but also the Physical Sciences (Mathematics, Physics, Chemistry, Statistics, Electronics Geology and Geo-Physics) (Table I). Clearly, advanced level courses in the Physical Sciences are no longer considered out-of-bounds by women despite the many impediments that persist along the way.

Nevertheless, a more careful reading of the data shows that the fraction of women enrolling in the Biological Science disciplines is considerably higher than those enrolling in the Physical Sciences, lending credence to the general perception that women tend to prefer Biological Science related disciplines over the more mathematically oriented science subjects such as Physics or Chemistry.

Let’s look at more data to understand the issue further. Enrollment data, as well as pass-out data against each gender for 2015–16 in Physical Sciences disciplines as a whole was collated and compared with that for the Biological Sciences as a group at the post-graduate and higher levels (Table II). Once again, women outnumbered men by a significant margin at the Masters level. When it comes to enrollment for research programs, however, the gender gap persists in the Physical Sciences (Table II). It must be noted that the numbers enrolling

\textsuperscript{12} The Indian Express, December 28, 2015
\textsuperscript{13} Science here refers to both basic and applied science courses with the exclusion of courses in Engineering and Technology as well as Medicine.
\textsuperscript{14} Although these reports are available from 2010-11 onwards, the year 2011-12 has been chosen to compare with 2015-16 since the percentage of responses from higher education institutions in these two years is comparable.
\textsuperscript{15} http://aishe.nic.in/aishe/reports
for research programs are a very small fraction (one-twentieth to one-tenth) of those who pass out of Masters programs. Thus, theoretically, the available pool of trained candidates is 10–20 times the number of seats being offered. Nevertheless, in M.Phil. and PhD programs as per the AISHE data for 2015–16, there were only ~37% female students to 63% male students in the Physical Sciences disciplines.

In 2011–12, while specific disciplines saw greater gender gaps, on an average approximately 41% of the total students enrolled for an M.Phil. and 33% of those enrolled for a PhD in the Physical Sciences were women. In Biological Sciences disciplines, on the other hand, the gender gap in enrolments has already been reversed: roughly 53% of female students to 47% male students enrolled in M Phil programs and 54% female to 43% male students enrolled in PhD programs in 2015–16. This was also the case in 2011–12 when approximately 60% of those enrolled for M Phil or PhD programs in the Biological Sciences were women.

Table II Enrolment and pass-out of female students per 100 students in Physical Sciences and Biological Sciences in 2011–12 and 2015–16. Physical Sciences include Mathematics, Physics, Chemistry, Statistics, Electronics, Geology and Geo-Physics while Biological Sciences include Botany, Zoology, Genetics, Bio-Science, Life Science, Biochemistry, Microbiology and Biotechnology. (Source: AISHE reports)

<table>
<thead>
<tr>
<th></th>
<th>M. Sc.</th>
<th></th>
<th>M. Phil.</th>
<th></th>
<th>Ph. D.</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Enrol. (%)</td>
<td>Pass-out (%)</td>
<td>Enrol. (%)</td>
<td>Pass-out (%)</td>
<td>Enrol. (%)</td>
<td>Pass-out (%)</td>
<td>Enrol. (%)</td>
</tr>
<tr>
<td>Phys. Sci.</td>
<td>50.5</td>
<td>47.4</td>
<td>57.8</td>
<td>56.6</td>
<td>41</td>
<td>54.9</td>
</tr>
<tr>
<td>Bio. Sci.</td>
<td>61.3</td>
<td>62.2</td>
<td>67.2</td>
<td>66.7</td>
<td>60</td>
<td>63.6</td>
</tr>
</tbody>
</table>

The greater enrolment numbers also result in more women receiving doctoral degrees as compared to earlier. While data for specific batches of students are not available at the AISHE websites, there is pass-out data available for different years, starting from 2010–11 onwards. In the Biological Sciences, roughly 41% of all the doctorate degrees awarded in 2011–12 went to women (Table II). In 2015–16, roughly 46% of all doctorates awarded in the Biological Sciences went to women (Table II). Not surprisingly, the gender gaps were much larger in the Physical Sciences. In 2011–12, 67% of the doctorates conferred in the Physical Sciences were to men and only 33% were to women on an average. In 2015–16, 70% of those with doctorates in the Physical Sciences were male and 30% were female on an average.
Women employed in research and teaching

Given the narrowing gender gap in doctorates in Biological Sciences, it seemed worth examining how they fared in employment. Statistics regarding faculty recruitment in the Biological Sciences departments across the Indian central universities and research institutes were examined. The choice of the three central universities here was deliberate since they are ‘research universities’ where a significant proportion of faculty are actively involved in scientific research. These universities also have externally-funded research projects, and participate almost exclusively in teaching at the Masters or M.Phil./PhD levels. In fact, PhD programs are a major focus of these universities. Research institutes offer either integrated Masters/PhD programs or PhD programs alone but are mandated to provide classroom lectures/courses within these programs. Nevertheless, those familiar with the scientific research funding scene in India would be quick to see that here too lies a clear hierarchy, with the research institutes having significantly better infrastructure and being considerably better funded (Poonacha 2005). Thus, the two categories of institutions could provide us with an interesting set of comparisons. The gender ratios in the Biological Sciences-related departments until early 2018 in following institutions were estimated using the available data from their respective websites:

- In JNU, School of Life Sciences (SLS), School of Biotechnology (SBT), Special Centre of Molecular Medicine (SCMM) were included; in HCU, the School of Life Sciences includes Departments of Biochemistry (Biochem.), Plant Sciences (Plant Sci.), Animal Biology (Animal Bio.), Biotechnology and Bioinformatics (Biotech.); in DU, Departments of Biochemistry (Biochem.), Biophysics (Biophys.), Microbiology (Microbiol.), Genetics (Gen.) and Plant Molecular Biology (PMB) were included.
- Indian Institute of Science Education and Research (IISERs) at Pune, Kolkata, Trivandrum and Mohali (School/Department of Biology). Each IISER is autonomous and can award its own degrees as per the NIT Act of 2010, passed by the Indian Parliament.
- Indian Institute of Science (IISc) (Department of Biochemistry (Biochem.), Molecular Biophysics Unit (MBU), Molecular Reproduction, Development and Genetics (MRDG), Department of Microbiology and Cell Biology (MCB) at Bengaluru. IISc is a deemed university as per the UGC Act.

[17] https://www.jnu.ac.in/node#school_center; and the specific webpages of Schools/Centres thereafter; accessed February 2018
[21] http://biochem.iisc.ernet.in/group_leaders.php and webpages of individual faculty; accessed February 2018
[23] http://www.mrdg.iisc.ernet.in/people/faculty/; and linked webpages of individual faculty; accessed February 2018
The Council for Scientific and Industrial Research (CSIR) was the very first of its kind institution, created as an autonomous body for the sole purpose of accelerating research and development in the country. CSIR institutes were at one time expected to be affiliated to universities to award PhD degrees to their students. They are now affiliated to the Academy for Scientific and Innovative Research (AcSIR), created in 2010 by the legislation in the Indian Parliament to award degrees. Research institutes funded by CSIR considered for this study were Indian Institute of Chemical Biology (IICB) at Kolkata, Indian Institute of Microbial Technology (IMTech) at Chandigarh, Centre for Cellular and Molecular Biology (CCMB) at Hyderabad, National Botanical Research Institute (NBRI) at Lucknow and Institute of Genomics and Integrative Biology (IGIB) at Delhi.

Research institutes funded by DBT considered for this study are National Institute of Immunology (NII) located in Delhi, National Brain Research Institute (NBRC) at Manesar, Haryana. NII is affiliated to JNU for the purpose of awarding degrees, while NBRC is a deemed university.

Department of Biological Sciences, Tata Institute of Fundamental Research (TIFR) located in Mumbai, and National Centre for Biological Sciences (NCBS), a part of TIFR located in Bengaluru (inStem and CCAMP faculty are not included in this analysis), whose parent body is the Department of Atomic Energy (DAE). TIFR is also considered a deemed university and can award its own degrees.

As can be seen from Table III and Fig. 1 below, apart from TIFR and NCBS, the fraction of women in these institutions did not exceed 30%. There are roughly 27% women and 73% men at scientist/faculty level positions in these institutions.

Table III Faculty hiring in Biological Sciences departments/institutes in India. The data collated was taken from individual websites.  

<table>
<thead>
<tr>
<th>Institution</th>
<th>Male</th>
<th>Female</th>
<th>% Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>IISc (Biochem. + MCB + MRDG + MBU)</td>
<td>51</td>
<td>12</td>
<td>19.4</td>
</tr>
<tr>
<td>IISERs (Biological Sciences)</td>
<td>67</td>
<td>21</td>
<td>23.9</td>
</tr>
</tbody>
</table>


[26] https://www.imtech.res.in/research/scientists; and the linked webpages of the individual scientists; accessed February 2018.


[29] https://www.igib.res.in/?q=node/22; and the linked webpages of individual scientists; accessed February 2018.


It was important to understand whether there were specific positions at the employment level where the skew varied. Accordingly, an analysis vis-à-vis institutions/departments at different levels of the hierarchy was also done. Given that the enrolments and outcomes have improved over the years, it is expected to be reflected at least at the entry level hiring, even if greater gender gaps appear at senior positions. In the case of CSIR institutes, this implies that we should see less of a skew at Senior Scientist (Sr. Sci.) and Scientist (Sci.) positions as compared to that at the Senior Principal Scientist (Sr. Princi. Sci.) or Chief Scientist (Chief Sci.) positions. J. C. Bose Fellows are generally senior scientists too and may include retired scientists. Since this is a fellowship, not all institutes have them. Emeritus
Professors are also retired senior faculty and they are not present in every institute. The DBT-Wellcome Early Career Fellowships (ECF), DST-Inspire, etc. are also fellowships with a fixed tenure and do not represent regular employment. I will return to these fellowships later in this paper.

As can be seen from Fig 2 and Table IV, the presence of women is uniformly low at all levels of the hierarchy in CSIR institutes. Even at the entry-level positions of Scientist or Senior Scientist, their representation remains below 30%.

Table IV  Gender-wise data of scientists in CSIR labs. M: Male; F: Female

<table>
<thead>
<tr>
<th>POSTS</th>
<th>CSIR Institutes</th>
<th>Total</th>
<th>F (%) of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>IICB</td>
<td>IMTech</td>
<td>CCMB</td>
</tr>
<tr>
<td>Chief Sci.</td>
<td>2</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>S. Prin. Sci.</td>
<td>3</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Prin. Sci.</td>
<td>13</td>
<td>5</td>
<td>11</td>
</tr>
<tr>
<td>Sr. Sci.</td>
<td>13</td>
<td>0</td>
<td>14</td>
</tr>
<tr>
<td>Sci.</td>
<td>2</td>
<td>0</td>
<td>10</td>
</tr>
</tbody>
</table>
Was this any different for DST/DBT funded institutions? A similar analysis for two of these institutes, NII and NBRC, are shown in Fig 3 and Table V. Again, not surprisingly, senior levels positions (Scientists VI-VII) had more male than female scientists. But Scientist IV-V levels too had a large skew in favour of men.

![Fig 3 Post-wise hiring of scientists in NBRC and NII combined and segregated based on their gender.](image)

Table V The gender-wise data of scientists in DST/DBT funded institutes.

<table>
<thead>
<tr>
<th>POSTS</th>
<th>NBRC</th>
<th>NII</th>
<th>Total</th>
<th>F (% of Total)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scientist-VII</td>
<td>M 2</td>
<td>F 0</td>
<td>M 10</td>
<td>F 3</td>
</tr>
<tr>
<td>Scientist-VI</td>
<td>M 5</td>
<td>F 3</td>
<td>M 5</td>
<td>F 2</td>
</tr>
<tr>
<td>Scientist-V</td>
<td>M 2*</td>
<td>F 0</td>
<td>M 6</td>
<td>F 1</td>
</tr>
<tr>
<td>Scientist-IV</td>
<td>M 3</td>
<td>F 0</td>
<td>M 2</td>
<td>F 1</td>
</tr>
<tr>
<td>Staff Scientist-III</td>
<td>M -</td>
<td>F -</td>
<td>M 2</td>
<td>F 1</td>
</tr>
</tbody>
</table>

Note: *One is on deputation from UNESCO-MGIEP, New Delhi
As also noted earlier, the DAE sponsored TIFR and NCBS were different. They showed a clear trend of improved hiring rates for women at the entry/middle level positions (Fig 4: Table VI).

Table VI  Gender-wise data of scientists in Biological Sciences at TIFR and NCBS

<table>
<thead>
<tr>
<th>POSTS</th>
<th>TIFR M</th>
<th>TIFR F</th>
<th>NCBS M</th>
<th>NCBS F</th>
<th>Total M</th>
<th>Total F</th>
<th>F (%) of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Professor</td>
<td>1</td>
<td>2</td>
<td>8</td>
<td>3</td>
<td>9</td>
<td>5</td>
<td>35.7</td>
</tr>
<tr>
<td>Associate Prof</td>
<td>1</td>
<td>2</td>
<td>5</td>
<td>1</td>
<td>6</td>
<td>3</td>
<td>33.3</td>
</tr>
<tr>
<td>Reader</td>
<td>2</td>
<td>2</td>
<td>9</td>
<td>6</td>
<td>11</td>
<td>8</td>
<td>42.1</td>
</tr>
<tr>
<td>Fellow E</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>50.0</td>
</tr>
</tbody>
</table>

Among institutions that offer Masters as well as PhD programs and, are therefore teaching/research departments, is the skew any different? This is also interesting to look at, given that teaching was one of the areas initially identified as being ‘suitable’ for women. The following analysis includes not only the older institutes/departments like the Department of Biochemistry at IISc or the Central Universities of DU, JNU and HCU but also newer ones...
like IISERs. The recruitments in the new institutes, even if at the senior positions, would give us an idea of the current trends in hiring. The fact that the self-image of IISc and IISERs are those of research institutes and not that of universities is to be noted before we proceed further. Their salary structures, faculty autonomy and work ambience are very different from that of the central universities.

In IISc, women were less than 20% of the total faculty strength in departments related to Biological Sciences. As expected, the gender gap is large at the Professor and Associate Professor levels. But this is even more so at the entry-level, Assistant Professor, positions (Fig 5; Table VII).

![Bar chart showing post-wise hiring of faculty in Biological Science departments at IISc segregated on the basis of gender.](image1)

In the more recently setup IISERs the number of Professors is small. IISER Kolkata had only one female Professor and no men were hired at this position (Fig 6; Table VII). The other three IISERs had only men at this level and no women. Men also dominated the Associate Professor positions in all the IISERs. The gender skew was also evident at the Assistant Professor positions across the three IISERs, except for the one at Kolkata that seemed to have a reasonable gender balance at the entry-level position.
Fig 6  Post-wise data of faculty in Biological Sciences at four of the IISERs combined segregated on the basis of gender.

Table VII  Gender-wise data of faculty members in Biological Sciences at four of the IISERs.

<table>
<thead>
<tr>
<th>IISER</th>
<th>Mohali</th>
<th>Pune</th>
<th>Trivandrum</th>
<th>Kolkata</th>
<th>Total</th>
<th>F (% of Total)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>F</td>
<td>M</td>
<td>F</td>
<td>M</td>
<td>F</td>
</tr>
<tr>
<td>Professor</td>
<td>2</td>
<td>0</td>
<td>4</td>
<td>0</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Associate Professor</td>
<td>3</td>
<td>0</td>
<td>13</td>
<td>2</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>Assistant Professor</td>
<td>10</td>
<td>6</td>
<td>7</td>
<td>3</td>
<td>7</td>
<td>1</td>
</tr>
</tbody>
</table>

Among the Central Universities, Professor positions in JNU were overwhelmingly skewed in favour of men (Fig 7; Table VIII). A slight skew was also evident in the Assistant Professor positions but this is much less so.
For a Place at the ‘High-Table’: The Compelling Case of Indian Women in Science

![Graph showing percentage of total faculty members by gender and post]

Table VIII Gender-wise data of faculty members in Biological Science-related Schools/Centres of JNU.

<table>
<thead>
<tr>
<th>POSTS</th>
<th>SLS</th>
<th>SBT</th>
<th>SCMM</th>
<th>Total</th>
<th>F (%) of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Professor</td>
<td>16</td>
<td>4</td>
<td>6</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Associate Professor</td>
<td>2</td>
<td>2</td>
<td>6</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Assistant Professor</td>
<td>3</td>
<td>3</td>
<td>5</td>
<td>3</td>
<td>1</td>
</tr>
</tbody>
</table>
A similar trend is seen in the Life Sciences related departments at DU in both Professor and Associate Professor positions, with the gender skew towards men being clearly evident (Fig. 8: Table IX). However, at the Assistant Professor level, a much better representation of women is seen. One notable exception is the Department of Genetics, where the number of women in Assistant Professor positions outnumbers men.

Table IX Gender-wise data of faculty members in Biological Science departments of DU.

<table>
<thead>
<tr>
<th>DU</th>
<th>POSTS</th>
<th>Biochem.</th>
<th>Biophys.</th>
<th>Genetics</th>
<th>Microbiol.</th>
<th>PMB</th>
<th>Total</th>
<th>F (% of Total)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Professor</td>
<td>M 6</td>
<td>F 0</td>
<td>M 1</td>
<td>F 0</td>
<td>M 2</td>
<td>F 1</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>Associate Professor</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Assistant Professor</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>0</td>
</tr>
</tbody>
</table>
In HCU, again, Professor and Associate Professor positions are dominated by men (Fig 9: Table X). With the exception of the Department of Biotechnology and Bioinformatics where Assistant Professor positions are overwhelmingly occupied by men, the other departments show a better gender balance in appointments at the Assistant Professor positions.

Table X  Gender-wise data of faculty members in the School of Life Sciences, HCU.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Professor</td>
<td>M 4 F 2</td>
<td>M 10 F 2</td>
<td>M 4 F 3</td>
<td>M 5 F 1</td>
<td>23 F 8</td>
<td>25.8</td>
</tr>
<tr>
<td>Associate Professor</td>
<td>M 2 F 1</td>
<td>M 1 F 0</td>
<td>M 2 F 0</td>
<td>M 0 F 0</td>
<td>5 F 1</td>
<td>16.7</td>
</tr>
<tr>
<td>Assistant Professor</td>
<td>M 3 F 1</td>
<td>M 2 F 1</td>
<td>M 2 F 3</td>
<td>M 7 F 1</td>
<td>14 F 6</td>
<td>30.0</td>
</tr>
</tbody>
</table>

Admittedly, if one were to include the Physical Sciences into this analysis, the gender gap would increase further. Just to provide an estimate of this, such an analysis is provided below for all the Science Departments of HCU (Fig 10).
Fig 10 shows that the number of women occupying any of the three levels of faculty positions is low within the Science Schools. In addition, the relative ratio of men to women is significantly higher in the Physical Science disciplines (Computer Science, Mathematics, Physics and Chemistry).

There are several points to be noted from the data presented above for the Biological Sciences faculty in different institutions.

- All research institutes show a marked gender skew at senior positions in their faculty profiles. TIFR and NCBS are notable exceptions.
- The gender skew persists at entry/middle-level positions in the faculty profiles of the research institutes. TIFR and NCBS are again the exceptions here.
- IISc and IISERs show significant gender skew at both senior and entry-level positions. This is true for Biological Sciences departments in an older institution such as the IISc but is also true for those in newer institutions such as the IISERs. As mentioned before, despite being known as organizations with a significant teaching component, the self-image and funding/faculty autonomy of these institutions are similar to that of research institutes. Is it possible that the hiring patterns in these places, therefore, mimic what is seen in most research institutes?

The Central Universities, in general, showed a much smaller skew at the entry-level positions, although the senior levels were expectedly skewed quite significantly in favour of men. While these are places with a clear mandate to combine research with teaching, their Master’s programs are generally very popular and gaining entry to these programs is highly competitive. Hence, teaching remains a major focus in these institutions.

What explains this skew in hiring? Is this really a result of gender bias in the larger society, particularly in the Indian family where the parents do not allow or encourage their daughters to enrol in career-oriented science programmes? Is it that women are just not ‘good enough’ or are ‘less ambitious?’ Do they prefer positions that emphasize teaching over positions that mandatorily prioritize research? Or do they encounter gatekeepers and selection processes that tend to favour men for research positions but consider women with less of a bias in teaching positions? Or is it a combination of all of these processes?

The available data may seem complicated but is not difficult to understand. To put this in perspective, the gender profiles of those who receive, arguably, two of the most competitive early career research fellowships, the DST-INSPIRE Faculty Scheme and the India Alliance DBT-Wellcome Early Career Fellowships (ECF) over a period of the last 7 years were examined. These post-doctoral research awards are given for a fixed term of 5 years to begin with. As can be seen from Table XI, from 2013 onwards women awardees begin to perform as well and often better than the men. One possible explanation is that these fellowships do not provide for a regular position and are therefore likely to be less attractive to men. However, this seems like an unlikely explanation, given that receiving these awards adds value to an individual’s career profile and enhances their chances of finding regular positions. The other more plausible explanation is that the current generation of women entering the Biological Sciences are actually competent enough and ambitious enough to make it to the top.

Table XI Gender profile of awardees of DST-INSPIRE Faculty Award and DBT-Wellcome Early Career Fellowships in Basic Biomedical Research

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>F</td>
<td>M</td>
<td>F</td>
<td>M</td>
<td>F</td>
<td>M</td>
</tr>
<tr>
<td>DST INSPIRE</td>
<td>8</td>
<td>3</td>
<td>28</td>
<td>16</td>
<td>14</td>
<td>10</td>
<td>12</td>
</tr>
<tr>
<td>DBT-Wellcome ECF</td>
<td>0</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>0</td>
<td>4</td>
<td>2</td>
</tr>
</tbody>
</table>

[35] [http://www.inspire-dst.gov.in/faculty_scheme.html](http://www.inspire-dst.gov.in/faculty_scheme.html); accessed August 2018
[36] [https://www.indiaalliance.org/fellowships/early-career-fellowships](https://www.indiaalliance.org/fellowships/early-career-fellowships); since this is the Fellows page, it may only represent those who accepted the fellowship offers and not the total number of fellowships offered.
Peer recognition and awards

How do women scientists fare when it comes to recognition and awards? This is particularly pertinent to ask given that since the early 2000s, several of the Indian science academies have sponsored studies, held high profile workshops and organized brainstorming sessions on gender inclusivity. How well did women fare in being elected to the science academies, the Indian National Science Academy (INSA), for example? Given below in Table XII are the numbers of women Fellows elected in different disciplines to the INSA.

Table XII Numbers of Women Fellows of INSA in different disciplines. The data for Biological Sciences are provided for a few years from 1990 onwards to show the trends in women getting elected as Fellows to INSA as available at the INSA website. The last two columns provide the data for total numbers of Fellows in the disciplines mentioned in the Table, along with the numbers of women and their percentages with reference to the total.

<table>
<thead>
<tr>
<th>Subject Areas</th>
<th>Elected in 1990</th>
<th>Elected in 2000</th>
<th>Elected in 2010</th>
<th>Elected in 2016</th>
<th>Elected in 2017</th>
<th>Total Fellows in INSA</th>
<th>Total women Fellows in INSA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>F</td>
<td>M</td>
<td>F</td>
<td>M</td>
<td>F</td>
<td>M</td>
</tr>
<tr>
<td>Plant Sciences</td>
<td>1</td>
<td>0</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Animal Sciences</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Microbiology and Immunology</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Cell and Biomolecular Sciences</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Health Sciences</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Agriculture Sciences</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>8</td>
<td>3</td>
<td>6</td>
<td>0</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Mathematics</td>
<td>76</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physics</td>
<td>134</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chemistry</td>
<td>127</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

For a Place at the ‘High-Table’: The Compelling Case of Indian Women in Science

As is evident from the trends and data shown in Table XII, in most disciplines, not only is gender parity a distant dream, it is highly unlikely to be ever achieved without active intervention in this direction. Although on a comparative scale, women in the Biological Sciences do seem to be slightly better off than their counterparts in other disciplines. A similar disturbing trend is observed in the conferring of prestigious awards such as the Shanti Swarup Bhatnagar Award (instituted in 1958) awarded in 7 scientific disciplines or the more recently instituted Infosys Award that is awarded in 4 disciplines of science and engineering. Until 2016, of the 525 awardees, only 16 were women (3.04%). This became 16 out of 535 awardees in 2017 (2.99%). Of the 8 awardees who received the Infosys Awards in Engineering and Computer Sciences until 2017, only 1 was a woman; 2 out of the 9 awardees in the Life Sciences were women and 1 of the 9 awardees in the Physical Sciences was a woman.

Worldwide trends in peer recognition suggest that the problem is, unfortunately, global. In a paper published in Nature Astronomy, Caplar and others (2017) examined the citations received by papers authored by women versus those authored by men. For this, they analyzed 150,000 articles that were published in 5 major Astronomy journals between 1950 and 2015 using a computational algorithm to control for the non-gender-specific properties of the papers. The authors concluded that papers authored by women, in general, receive 10.4 ± 0.9% fewer citations than would be expected if the papers with the same non-gender-specific properties were written by men. In another study published recently in Plos Biology by Holman and others (2018), the authors examined the authorship of scientific papers and the gender of the senior/communicating authors of the papers as evidence of women heading scientific research teams. For this, they looked at 35.5 million authors from 9.15 million articles (2002–present) in PubMed and 1.1 million authors from 0.5 million arXiv preprints (1991–present) using an algorithm that was trained to specifically identify the gender of the authors. The authors concluded that in Physics, parity would not be achieved for another 258 years and even in Biology this would require over 75 years. Women were also less frequently ‘invited’ to write a paper as compared to men. Liftstream, a specialist life sciences executive search recruitment company (also reviewed by Elie Dolgin in Nature Biotechnology (Dolgin 2012)) conducted a study and showed that women were underrepresented in biotech management boards simply because of the old-boy networks that kept them out and if they continued to be inducted into these boards at the current rate, gender parity would not be achieved until 2056.
Gender frames, bias and prejudice in science

Gender (as also caste) functions at both the micro and the macro level to influence interpersonal relations as well as organizational structures. Gender frames also bring cultural biases into play in how we respond to or expect others to respond in a given situation (Ridgeway 2009). Institutionalized cultural rules are then also used to penalize or disincentivize what is perceived as violating the gender code of behavior.

In a very interesting double-blind study published in the Proceedings of the National Academy of Sciences (PNAS), by Moss-Racusin and others from Yale in 2012, the ‘objectivity’ of scientists to gender identity during hiring was tested. The final 127 science faculty (both male and female) who were respondents in this study, received one or the other of two identical applications for the position of a lab manager. The only difference between the two applications was their gender (John vs Jennifer). The scientists were asked to rate the applicants on their competence, hire-ability, salary conferral and mentor-ability. Not only was the male applicant rated higher in all terms of competence, hire-ability and mentor-ability, but the salary offered to the applicant was also significantly higher with $30,238.10 versus $26,507.94 for the female applicant. The gender of the scientists did not affect their choice; female scientists were as likely to rate the male applicant higher than the female applicant as the male scientist. The problem of stereotyping and unintentional implicit gender biases has come to be widely accepted among the students of different genders in science. However, its various modes of working are still being explored. A study, also published in the PNAS, explores how men and women evaluate evidences of gender bias in science differently (Handley et al 2015). This group carried out three randomized double-blind studies using two settings from the general public and one from university faculty of both STEM and non-STEM backgrounds. For the purpose of this paper, it would suffice to examine how the 205 STEM and non-STEM faculty responded when asked to evaluate the abstract of the Moss-Racusin et al 2012 study. On an average, no significant difference was observed in the responses between male and female non-STEM faculty in how they evaluated the abstract. However, male STEM faculty were significantly less likely to favourably evaluate the same abstract as compared to the female STEM faculty. The female STEM faculty were not significantly different in their evaluation of the abstract as compared to the non-STEM faculty. This lead the authors to conclude that the results were not a result of overvaluation by female STEM faculty but were actually due to male STEM faculty less likely to accept the likelihood of gender bias in the fields of their own work, and whose acceptance would likely bring into question/challenge their own privileged locations.

Some startling findings were revealed in a survey of trained scientific women power carried out in 2010 by Anitha Kurup and others for the Indian Academy of Sciences in collaboration with the National Institute of Advanced Studies. Of the 794 individuals with PhDs who were registered in this study, roughly 40% were male. The researchers divided them into four categories, women in research (WIR), women not in research (WNR), women not

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[38] https://www.ias.ac.in/public/ Resources/ Initiatives/ Women_in_Science/ surveyreport_web.pdf
working (WNW) and men not in research (MIR). The study reported that as many as 87% of women with PhDs continued to work in science, with roughly 63% of these being WIR. Not getting jobs was the most prominent reason for WNR not pursuing a career in research. Not finding regular positions or finding only temporary positions were the most prominent reasons for WNW opting out of an active career in science. This was particularly the case for women who also had spouses with PhDs in similar/competing scientific areas or were themselves in scientific research. The temporary nature of the job that these women found then often acted as a further push factor when family emergencies such as caretaking of the elderly or children came up. Interestingly, roughly 14% of WIR were never married as compared to only 2.5% MIR. Significantly greater numbers of WIR reported spending 40–60 hours a week in the lab as compared to men. And significantly larger numbers of men spent fewer than 40 hours a week in research when their children were growing up. Yet, stereotypes of women not being committed to research or having competing interests of family versus career abound.

**Initiatives of Indian science academies and funding agencies**

As mentioned earlier, by the turn of the century, several academies of science in India had already flagged the issue of the absence of women in science, their lack of visibility when present and what could be done to change the *status quo*. How effective have these interventions been? Following the Indian National Science Academy’s (INSA) report in 2004, the National Academy of Sciences (NASI) and the Indian Academy of Sciences (IAS) conducted workshops and started multiple initiatives on women in science. The Department of Science and Technology (DST) set up a National Task Force for Women in Science in 2005. These concerted efforts brought the issues of Women in Science to the fore, and helped identify gaps between enrollments and hiring, the so-called ‘leaky pipe syndrome’. They also highlighted problems in recruitment procedures, the double burden of women in traditional household arrangements and their absence at senior levels or in decision-making positions. They also made recommendations on improving service conditions (flexi-timings, crèches, safe transport, campus accommodation, fellowships, awareness programs) to make a career in science more attractive for women.

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[41] https://www.ias.ac.in/Initiatives/Women_in_Science/
The easiest to implement were, of course, the fellowship schemes that did not in any way challenge the \textit{status quo}. Take for instance DST’s Women Scientist scheme.\footnote{http://www.dst.gov.in/scientific-programmes/scientific-engineering-research/women-scientists-programs} This well-intentioned program was meant to help women PhD degree holders return to scientific research after a career break. But without a long-term plan to provide regular employment avenues to beneficiaries, most such schemes merely became post-doctoral fellowships with uncertain futures. Several years earlier, in 1984, UGC had started a Research Scientist Scheme to attract and retain technically trained individuals. Many returned from positions abroad to grab the initiative. By 1999, UGC was reluctant to continue funding the scheme and often the affiliating host institutions were unwilling to absorb these Research Scientists. Many UGC-Research Scientists were able to continue in their positions until retirement with the help of legal interventions, and most faced hostility in the host departments.\footnote{https://indiankanoon.org/doc/170748679/} This is increasingly being seen as the likely fate of the DST-INSPIRE Faculty program (initiated in 2008)\footnote{https://www.inspire-dst.gov.in/faculty_scheme.html} or the UGC Faculty Recharge Program (initiated in 2013)\footnote{https://www.ugc.ac.in/} too, unless the host institutions find a way to retain the faculty, hired in such a scheme, after the funding ends.

Unfortunately, funding schemes are often announced from the top. There is little cross-talk between organizations or frank assessments of previous initiatives. There is barely any honest discussion with the stakeholders in several of the postdoctoral research schemes that various funding agencies have initiated, and bureaucracy often takes over the control of these programs leaving the awardees themselves with very little say in how the programs are run.

Far more difficult to implement are programs or solutions that confront well-established power monopolies. In my many years as a student and then as a faculty at multiple institutions across the country, I am yet to come across a gender sensitization program that was carried out for the scientific staff, students or faculty either as a voluntary or mandatory requirement. While I have participated in several programs whose agenda was to attract more women to careers in science, I am yet to see one that seriously introspected on how to make a department or school of study more inclusive, more heterogeneous in composition. I have rarely, if at all, seen recommendations from any workshop adopted in an organization and followed up over the years to assess how successful such interventions have been. The consequence? Most organizations/departments even in the Biological Sciences, where the gender gap in PhD enrolments has been reversed for several years now, have only 25\% female faculty on an average even today, as discussed at the beginning of this
paper. Few organizations openly advocate policies to recruit women into faculty positions, or announce flexible timings or support preferential housing. Despite this, the survey by Anitha Kurup and others (2010) showed that this does not make women any less committed to their careers. A large majority of these women were married and lived with their families. Caregiving, whether for children or the elderly, continued to be largely their responsibility and very few science institutions had viable supporting structures like quality crèches or safe transport. Much of this remains true even today. Instead of offering flexible timings many organizations in recent times have introduced more market-oriented, profit-maximizing approaches that also quantify productivity by rigid attendance rules, including Aadhar-linked biometrics to further complicate the hostile working conditions that women scientists encounter.

Which also brings us to a larger question - does it matter who makes these policies? Do stakeholders matter? Or is 'location' entirely irrelevant? Let us take the example of a recent policy initiative of the UGC meant to apparently attract more women into scientific research. Clause 4.4 of the UGC Regulations 2016 explicitly states that, “The women candidates and Persons with Disability (more than 40% disability) may be allowed a relaxation of one year for M Phil and two years for PhD in the maximum duration. In addition, the women candidates may be provided Maternity Leave/Child Care Leave once in the entire duration of M Phil/PhD for up to 240 days.” At first sight, this could be seen as a very generous initiative aimed at ensuring that more women candidates successfully complete their PhD programs and hence we have a greater pool of trained individuals available for hiring. All women, irrespective of their marital status, are entitled to two additional years to finish their PhDs to begin with. If viewing women as equivalent to people with disabilities of about 40% is not sufficiently offensive, those who framed this policy went a step further and put the entire burden of childcare squarely on the women's shoulders. Worse, it puts the burden of marriage and adjustments on the women as well. Clause 6.6 of the UGC Regulations 2016 states that, “In case of relocation of an M Phil/PhD woman scholar due to marriage or otherwise, the research data shall be allowed to be transferred to the university to which the scholar intends to relocate provided all the other conditions in these regulations are followed in letter and spirit and the research work does not pertain to the project secured by the parent institution/supervisor from any funding agency. The scholar will, however, give due credit to the parent guide and the institution for the part of research already done.” Given these rules, is it difficult to guess what would be the likelihood that a research supervisor in science, male or female, would choose a female candidate in preference over a male candidate for a PhD program in their lab?

[47] For a discussion on gender as a narrative emerging in the biological sciences, see Vaidya 2017.
[49] For an extensive discussion on the gender politics of science policy making and education, see Poonacha 2005.
As already shown above, it is not the absence of trained individuals that prevent women from entering scientific research in large numbers. The hurdles often come later, where skewing of employment opportunities, the lack of infrastructural facilities and the absence of support from institutions come together to keep women out. Policies that do not include the groups for which they are meant often end up producing no real transformation in the lives or experiences of those for whom it is meant. But, as in the case of the UGC Regulations 2016, it would be catastrophic if they end up being detrimental to the interests of those it is meant to serve.

Also, introducing policies without the accompanying changes in the underlying organizational structures can be counter-productive and could result in further reinforcing stereotypes and biases. This is reflected in the apprehensions that many women voice on the idea of introducing gender-based reservations; or the anxiety that many women professionals demonstrate in using flexible work schedules or in working from home while being employed in highly competitive work environments where the workforce is overwhelmingly male. The underlying gender frames inform organizational structures (Ridgeway 2009). Thus, without actively reworking those structures, we run the risk of merely reproducing them. This perhaps explains why newer scientific institutions, such as the IISERs, appear to recreate the gender skew in just the same fashion as the older ones.

**In conclusion**

Much has changed in Indian science scene over the past seven decades. After independence from the colonial rule, the Indian state invested a good proportion of resources in expanding the reach of science education. Increasing gender parity in science has also been one of its concerns since the mid-sixties. Science has also changed otherwise, in response to a variety of forces, both global and national, as well as those processes internal to the scientific establishment. Perhaps the most important positive achievement in this context has been a steady increase in the number of women coming to study and research in the sciences. This is no longer confined merely to certain branches of science education or to a few pockets of the country. Women’s presence is growing in every field of higher education with their enrolment and pass out rates consistently exceeding that of men at the Masters and M Phil levels. Given their near complete absence from most disciplines of science up until the sixties, this is no mean feat. As has been widely pointed out, the Indian social reforms of the early twentieth century and the anti-colonial struggle came together to produce a moment in history where education of women took on a positive connotation (Chaudhuri 1999; Sur 2001). Granting though, that this move too was gendered and the purpose of their education was not to enable them to join public life as skilled professionals but to produce able
mothers for future generations of citizens, it nevertheless opened up spaces of modern formal education that had thus far remained largely out of bounds for women. This was particularly so for those sections that saw themselves as participating actively in the making of the new nation, its nascent middle classes. Seeing themselves as the custodians of the new nationhood, articulated in terms of its celebrated past and a civilization marked by great spiritual excellence while trying to infuse it with ‘modern values,’ many of these first and second generation educated Indian elite also equated education with spirituality and penance. Thus, in the Indian cultural context, education as a goal has acquired greater legitimacy over time.

However, women’s presence in adequate numbers in the scientific workforce, particularly within the scientific establishment and the higher positions in the professional hierarchy is still a long way off. Lesser still is their presence in the science academies and award lists. The way it is currently structured, this is a catch-up game that women cannot win. Quite like the corporate economy, scientific establishments continue to work within gendered frames of prejudice via ‘old-boy networks.’ It is well known that in the Indian context, hiring, elections, nominations, awards are all helped by such networks that most women do not have easy access to (also see Gupta 2016; Bal 2002; Ramdorai 2017).

More importantly, it is not merely a matter of mobility or recognition for deserving women scientists. Not having enough visible women as role-models for the young researchers entering the world of science, implies that stereotypes of the scientist as ‘male’ abound providing a negative feedback loop that is self-defeating for women in the sciences. The increased presence of women in the public sphere will make these places more accessible and safer for other women. It will also lead to the increased presence of women at all levels in the scientific establishment including the higher echelons of the profession to make younger women researchers more comfortable in scientific labs and classrooms and will enhance their motivation as well as scientific capability. However, tokenism should not be the answer. The token minority, whether in a race or a gender context, is often more likely to conform to the majority opinion and has the effect of lulling committees into a false sense of complacency that social biases have been adequately dealt with. Actively encouraging diversity is not merely an issue of social justice, as flagged by the Kothari committee report early on in our independent nation’s history, but also an imperative of science and its self-image as a harbinger of progress. Countries and institutions that have actively encouraged diversity have stood to gain from the variety of knowledge, experiences and ideas that come with it.

Why has it been so hard for the scientific establishment to recognize these rather obvious facts? Given the strong association of science with rationality, the scientific establishments perhaps find it hard to take on board the ‘gender question’ within its own functioning/working. How can scientists be challenged on the issue of ‘rationality?’ Scientists are supposedly trained to think and function in the realm of the rational, how could they ever be otherwise? Since most subjects that they research on have little to do with gender itself, introducing ‘gender’ as a subject in their curriculum/training process is often an even bigger
challenge. To put it provocatively, ‘gender blindness’ comes quite naturally to the scientists. Yet as ‘scientific evidence’ accumulates to the contrary, it is imperative that scientists sit up and examine their own implicit and explicit biases, discuss policy initiatives that are genuinely more inclusive, find better and more transparent ways of hiring more women into faculty positions including getting them into senior and decision-making positions. Enhancing their presence is likely to promote fairness as well as productivity and excellence in science. It is a win-win game!

References


RESEARCH

A Framework to Address the Food, Energy and Water Nexus among Indian Megacities and Their Rapidly Expanding Peripheries

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Abstract

India is growing fast, with its fast-expanding cities that are rapidly growing into megacities. This not only puts tremendous pressure on the existing resources of these cities but also poses a grand challenge to the urban planner on how to decongest the flow of resources to the continuously growing population. A major part of this challenge comes from the food, energy and water (FEW) nexus, which in part can be addressed by developing the peri-urban areas to provide the means of such resources. In this article, we have explained a generalized framework to develop the tools for sustainable resource management in the peri-urban areas of the Indian megacities and discussed the tripartite approach to implement it. The first part of the approach is to develop smart environmental surveillance, which will provide the first snapshot of environmental parameters in the region. The second part is to integrate the large datasets with the regional ecosystem characteristics to understand the interactions between the living organisms and the environment. Last in the approach is to extract simplified knowledge from the interactions about the ecosystem and translate them into activities. The outcome of this approach is a peri-urban ecosystem, which will be able to cater to the sustainable means of food and energy in return for the used/storm water from the cities. Such a framework can be extended to megacities in other developing countries and implemented to first understand the peri-urban ecosystem and then to implement the management tools.

Keywords: Peri-urban agriculture; environmental surveillance; AI, storm water; ecology; self-cleaning capacity; resilience agriculture; land-use; human impacts.

Introduction

Urbanization is unfolding at an unprecedented rate across the world, more so in India. Currently, India is home to 5 out of 31 global megacities and will be home to 7 megacities by 2030 (Habitat 2016), when cities will account for nearly 70% of India’s GDP (McKinsey Global 2010). Sustaining this growth requires that basic demands for water, food and energy are reliably met in a cost-effective and sustainable manner. Peri-urban agriculture is being advocated for meeting the heavy urban demands of fresh vegetables and fruits. However, the dependency of Indian cities on peri-urban freshwater resources means that water demands for peri-urban agriculture cannot be sustainably met for longer time periods. Peri-urban regions that lie in between cities and rural regions are most impacted by such resource flows, as transporting freshwater across large distances not only involves a substantial expenditure of energy but is also not eco-friendly. Hence, transboundary flows
of water, food and energy between urban and peri-urban areas will define the growth and livability of Indian cities in the coming decades.

The peri-urban agriculture is currently practiced using untreated or partially-treated wastewater channeled outwards from India’s urban centers (Leslie et al 2017). Such a practice poses grave health risks due to the spread of diseases and toxins. There is a pressing need to secure safe-to-use water for peri-urban agriculture, which in turn can contribute towards food supply for India’s urban population, while reducing the energy required to store and transport these perishables.

While cities, in general, depend on large-scale water imports to meet their demands, many are also experiencing urban flooding events, frequencies of which are projected to increase in the near future as a consequence of climate change (Grimm et al 2008, McDonald et al 2014). Urban storm water is a valuable source of freshwater that remains largely untapped. Quantifying water inventories across selected cities in the world has shown that volumes of storm water could fulfill a substantial proportion of a city’s water demand (Goonetilleke et al 2016). Indeed, such practices have contributed to Singapore’s transformation from a water-stressed country to a water-secure country. An Indian context would entail capturing urban storm water as a resource to meet urban water demand, with the excess being channeled to peri-urban areas for farming or utility purposes, depending on the quality of water.

Although storm water capture contributes to a diversified water portfolio, the conventional approach of using grey infrastructure has been found to be unsustainable (Palmer et al 2015). Supplementing networks with green components, using ecological principles, has been useful to capture storm water in a cost- and energy-efficient manner. Low-lying points in the urban landscape serve as collecting points for storm water sediments and microbes, which in turn underpin the integrity and quality of water (McLellan et al 2015). Here, we first describe how multi-functional urban surface water infrastructure networks are being used in Singapore to capture and treat urban storm water, and then present a research framework to understand microbial diversity and ecosystem service potential. Finally, we detail how smart-sensing approaches can be used to further inform and improve ecologically sound practices within an urban freshwater context.

A generalized framework to develop and manage a sustainable urban watershed

In order to develop an eco-friendly watershed and ecological-principles-based management action plans, the understanding of the waterway’s ecosystem, including microbial communities (Saxena et al 2015), higher life forms and their functions, which provide ecological services to the watershed is critical. Here we present a framework to develop an understanding of the watershed ecosystem and how they interact with the local
environmental factors of the watershed (Fig 1). The suggested framework has a tripartite workflow, which leads to the identification of important life forms and environmental parameters. It will help in developing sustainable water-resources management at catchment and peri-urban scale.

The first phase in this framework is to develop data-informed optimal sampling design and infrastructure for smart sampling, through environmental surveillance (I). The goal of this process is to measure the spatial and temporal variation in the levels of environmental parameters in response to different urbanization factors, such as land-use types, elevation and soil type. This can be achieved by installing a city-wide Wireless Sensor Network (WSN) to monitor environmental parameters of interest. In general, WSNs are comprised of multiple static nodes across the survey area (Jiang et al. 2009). However, in the recent years, hybrid WSNs are becoming more prominent where both static and actuated nodes are deployed for better spatial coverage (Dunbabin and Marques 2012). Another critical component for this phase is the sampling strategy based on elevation, land-use pattern (using digital elevation and land-use maps) and environmental parameters of interest. It encompasses the outlining of land-use type based regions such as commercial or residential, a broad range of environmental parameters that are of interest and the spatial and temporal resolution of the data collection process. However, in the cases where no prior information is available, deciding a sampling strategy can be difficult. In such cases, taking a top-down approach is advised where using hybrid WSNs becomes a necessity. With the help of hybrid WSNs, large spatial and temporal changes can be captured across various survey areas and later narrowed down to the specific questions to meet the overall objective.

Next is Environmental-Life Sciences Data Integration (II). The objective in this phase is to summarize the data from the first phase and produce a subset of important environmental
parameters and spatial regions that sufficiently describe the catchment, capturing the variability present in the ecosystem. The soil, sediment and water samples are then collected from the subset of spatial regions to analyse the physicochemical parameters, composition and functions of microbial communities and higher life forms. Soil from the catchment acts as a source of environmental chemicals and life forms that colonize waterways ecosystems (Cruz-Martinez et al. 2009, Fellman et al. 2009, Hullar et al. 2006). Within waterways ecosystems, while sediments are a sink for most chemicals and the favourable niche from microbial communities (Saxena et al. 2015), water acts as a medium of transport for chemicals and dispersal agent for both microbial communities (Saxena et al. 2015) and higher life forms. Therefore, soil, sediments and water samples should be analysed for environmental variables and life forms.

Modern ecological approaches and data analytics, such as ecogenomics can be deployed to describe the microbial communities through high-throughput next generation sequencing (NGS) and environmental parameters through sensitive and broad-range technologies (Saxena et al. 2015, Saxena et al. 2018). In a project where a large number of samples are needed to be processed and analysed, the processing of samples should not be in batches (e.g., if multiple people are processing the samples in multiple days, same day samples or same location samples should not be processed in one batch by one person), rather it should be randomized to minimize batch effects (Leek et al. 2010). Therefore, a metadata file is created to capture any non-biological source of variations due to sample processing. This file records parameters, such as, the date, time of sample collection and each step-in sample processing, local environmental observations during the sampling, issues during sample transportation, details of sample processing (information viz., where, who did which step, reagents/kits) and any other information which might be useful to identify and remove the batch-effects in the analysis.

The samples are first analysed for the set of environmental parameters, which describe the watershed. These environmental parameters include, but are not limited to, pharmaceuticals, organics, emerging pollutants, persistent organic compounds, metals, nutrients and other physicochemical variables, such as pH, temperature, salinity, conductivity, oxidation-reduction potential, turbidity and total organic carbon (Saxena et al. 2015). Chemical parameters can be analysed by high-throughput, sensitive and broad range technologies, such as ion-exchange chromatography (ions), liquid/gas-chromatography for organics and pharmaceutical, inductively-coupled plasma mass spectrometry for metals and chemical sensors and probes from in-situ measurements of physicochemical parameters (Saxena et al. 2018).

Life forms are analysed from the same samples using next-generation sequencing (Pompanon and Samadi 2015). It provides deep-sequence data to classify the microbial taxonomic groups at the level of species and functional genes at the level of enzyme names with high precision (Saxena et al. 2018). Higher life forms can be qualified and characterized by sequencing variable region of the 18S ribosomal gene (Pompanon and Samadi 2015). This characterization can be complemented with transcriptomics and metabolomics analysis (Rocha-Martin et al. 2014) for
strategic locations and highly dynamic environmental hotspots and hot-moments. The transcriptomics and metabolomics data will provide the changes in microbial communities’ active taxonomic groups and their functions in response to the changes in the hotspot characteristics, including the higher life forms. The data on the microbial communities, higher life forms and environmental parameters obtained from the study can provide deep insights into the living and chemical landscape of the urban watershed. It provides the spatial distribution and temporal shifts of taxonomic groups, invertebrates and plants along with the changes in levels of major environmental descriptors.

This information is then processed using Environmental-Life Sciences Data Integration approaches to reduce the complexity of microbial communities from thousands of species and functional genes to a few important microbial species and functional genes. The reduced list of species and functions will sufficiently explain the microbiome variation (Saxena et al 2015). The number of environmental pressures influencing the microbial communities can also be reduced to a few key parameters that significantly explain the variation in the microbial communities (Saxena et al 2015). The variation in the important taxonomic groups and environmental variables can then be used to describe the variation in higher life forms. The most influenced life forms can be used as the first line of ecosystem health reports. These can later be used to develop management practices to enhance the ecosystem services provided by the microbial communities, in response to, for example, chronic pressures, such as land-use history, or pulse disturbances, such as rain.

Once the regulation of selected parameters is developed into management practices, the ecological health of watershed can be monitored by smart sensing and informed sampling. This is where the hybrid WSNs used in the first phase of this framework can be re-used for long-term monitoring. However, for this phase, the static and actuated nodes can be equipped with specific sensor payloads based on the knowledge from ecological models. This will facilitate real-time monitoring, with a strong emphasis on detection of any deviation from the developed ecological model. These deviations can be used as signs of early microbial outbreaks in water resources. Once such deviations are detected, these robots can be used to sample the survey area and help in developing an improved knowledge base for ecological modelling. Moreover, the large amounts of datasets that will be produced during this phase will potentially open the doors for big data analytics on environmental datasets (Hampton Stephanie et al 2013). Hence, it will be feasible to develop highly accurate ecological models using the smart sensing and machine learning techniques discussed in this phase and further improve the management of water resources.

Summing up

The first phase in our framework is to develop data-informed optimal sampling design through the use of hybrid WSNs, which are networks with both static and actuated sensor nodes. Such a systematic approach will help in narrowing down the research questions of
the overall objective. Based on the ecological model learned using the framework, the hybrid WSNs can be mounted with specific sensor payloads for monitoring anomalies. Moreover, the large amount of data collected during this phase will facilitate the use of big data analytics for environmental data, thereby developing more accurate ecological models.

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Impact of Digital Revolution on the Practice of Science Communication

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Abstract

The practice of science journalism/reporting/communication has changed completely in the last three decades. Though the number of specialised areas of scientific investigations and the number of scientific journals as well as the associated technical terminologies have increased many folds, for a science journalist, the task of reporting and popularising science has become simpler. This is primarily due to easy accessibility to sources, availability of digital resources and tools to deal with the knowledge explosion on the one hand, and mushrooming of digital platforms for communication, on the other. Though these developments had a disruptive impact on scientific publishing and media industries in general, for the individual journalist/reporter/communicator, the times have changed for the better; the digital world has empowered the individual content creator by providing better, cheaper, and often free, tools of production. In this paper, I will compare and contrast how a science journalist used to work, in earlier decades and how it is now. I will review the new digital tricks and tools that a science journalist can use today to keep updated about scientific advances, to deal with the complexities of ever-narrowing disciplines, to manage knowledge outside his or her mind, to double check and validate reports, while on tight deadlines. Easing the efforts required has led to an increase in science reporting in India, but at a slower rate than the increase in scientific activity in the country. Moreover, I argue that
an increase in the quantity of science reporting alone does not necessarily improve the scientific temper of citizens. That would call for improvement in the quality of reporting involved, making the process of doing science more transparent to the public.

Introduction

Early 1980s. I was a budding freelance science communicator, writing popular articles in English dailies and magazines in Delhi. I used to admire K S Jayaraman and the team at the PTI. They used to report science. Not popularise it. Later, I saw Prof. D Balasubramanian of the CCMB doing something in The Hindu that I would have liked to do. While reporting recent advances in science, he had relevant comments. It was not mere reporting; it was more like current affairs in science. Later still, I saw Prof. P Balaram doing such current affairs in science, quite often without the element of reporting, in his editorials in Current Science.

I mention these people because the content and style of writing, as well as their intent of writing, the channels of their output, and the people who read their writings, are all quite distinct, diverse. In this paper, I will focus only on the reporting of current advances in science, not popularisation, not communication campaigns in an effort to change the world we live in, not even acting as watchdogs of scientific institutions on behalf of society.

As per the Web of Science, India produces more than 80,000 scientific articles per year. If even a small percentage of this output is newsworthy, existing mainstream media journalists cannot deal with the sheer numbers. Moreover, the complexity of simplifying terminology-ridden scientific papers is a barrier in reporting scientific advances. This paper provides digital tools that have proved helpful for citizen journalists from among the scientific fraternity who are stepping in to fill this lacuna. Strategies to generate a generation of such scientist-journalists have been described earlier (Madhu 2019).

Science reporting in the pre-digital era

Consider the materials and methods available to a science communicator in the 1980s to work as a science reporter. The main primary sources of advances in science are scientific papers published in peer-reviewed journals. There were some 7000–8000 journals at that time. If you are a freelancer in Delhi, you may have access to a few hundred of them - if you take the trouble to visit some 50 odd good specialised, libraries related to science or its applications. But of course, recent issues are difficult to come by. You are lucky if you can get hold of even last month’s Science or Nature, Lancet or BMJ. The academic and
institutional hierarchy determines who gets to see the journal first, and who next. So you can only get journals that are three or four months old.

The fastest method to overcome the problem was to scan *Current Contents*, published weekly by the Institute of Scientific Information. Current Contents was published under different volumes:

1. Agriculture, Biology & Environmental Sciences
2. Arts & Humanities
3. Clinical Medicine
4. Engineering, Computing & Technology
5. Life Sciences
6. Physical, Chemical & Earth Sciences, and
7. Social & Behavioral Sciences

From these publications, you could get to see the contents pages of all the journals. From the titles of the papers, you have to guess which paper could be interesting for the public. You would note down the references on library cards.

If the library does not subscribe to the journal, you could use an inter-library loan system: you request your librarian; the librarian requests the library that has the journal to photocopy and send the paper...the process was tedious. It took a few months to get hold of a ‘recent’ paper.

**The beginnings**

Flash forward to the mid-1990s. I was producing Turning Point, a magazine format television series with the intention of popularising science. And I was still itching to try and report science.

The times had changed. The Indian National Scientific Documentation Centre (INSDOC, which is now part of NISCAIR) had started a service called CAPS: Contents Abstracts Paper Services. You subscribe to journals and they give you the contents pages from the ISI database in machine-readable form, on floppy discs.

You scan through, copy-paste the references into a list. You give them the list and they give you the abstracts of the papers that you have selected. You can then identify the papers that you really want to read, and they give you photocopies of the papers.

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[1] Similar services transformed by the digital revolution are still available from Current Contents Connect, accessible from Clarivate Analytics: [https://clarivate.libguides.com/webofscienceplatform/ccc](https://clarivate.libguides.com/webofscienceplatform/ccc)
All for a small payment, of course.\textsuperscript{2} I subscribed to the contents of 400 journals of my interest.

The materials and methods for reporting science had changed. But of course, I couldn’t make ’newsy’ stories. The process of getting the papers still took time. And producing a weekly television series does not allow time for research. The word ‘recent’ meant a month or more ago. It was still in the popularisation category – not reporting. We could not do news, but only features.

\textbf{The path forward}

Flash forward (again!) to the 2010s. I was working as the in-charge of the Science Media Centre in the IISER Pune. We initiated a 15-minute radio series on science for the Community Radio station, Vidya Vani, in Pune University. We oriented, facilitated and supported a team of student volunteers to put up the weekly serial called Science Radio.\textsuperscript{3}

I was still itching to try out science news. So to provoke the student volunteers, to give them tips on exciting new scientific advances, I started teasing them with my comments on recent research.

The materials and methods had changed. I could access the database initiated by the ISI, by then managed by Thomson and Reuters, directly, without any intermediary. I had access to the contents of journals as and when they are published online in the Web of Science.\textsuperscript{4} Recent could, at last, mean recent. Yesterday, if you will, as newspapers would report.

And there was an independent parallel method that became a viable, a decent alternative even for those who do not have subscription/access to the Web of Science. All you have to do is to subscribe to the contents of the journals. I have an email account which is devoted primarily to the subscriptions that do not cost me anything. And I get to know what those journals are publishing every week. I could then choose some interesting development. If the library subscribes to the journal, I can get a PDF copy very easily. And then I would write a teaser/trailer about the paper. Given that other community radio stations can also use the same tip to cover interesting scientific advances, I used a blog, sciencenewsforcr.blogspot.com.

\begin{footnotesize}
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\item[2] The services are still available from NISCAIR: http://www.niscair.res.in/Downloadables/caps.pdf
\item[3] The series is accessible from http://www.edaa.in/site/science-radio
\item[4] The database is now managed byClarivate Analytics and can be accessed by subscribers only from https://www.webofknowledge.com/
\end{itemize}
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But, of course, even the student volunteers at the IISER Pune did not pick up the story tips I provided. The science radio show remained a magazine, popularising the research of labs in Pune, with features on labs and interviews from scientists.

I realised the roadblock: BS-MS students, even in premier institutes such as IISERs have difficulties – reading and comprehending scientific papers to report in a manner that is understandable to the public takes too much effort.

I did not want to intervene in the production of the weekly science radio magazine since the ownership of the series had to vest in the student volunteers. The show stopped after one semester when the students got involved with their exams.

Meanwhile, in 2014, I started training PhD scholars, Post Docs, and scientists to write science. The availability of trained human resources capable of comprehending scientific papers allowed a series of successful experiments in science reporting (Madhu 2019).

In the next section, I will briefly describe the experimental results and focus more on the materials and methods that we use now.

**Moving to the present**

Besides temporal immediacy, newspapers are wont to go for spatial immediacy: what happens in your town is more ‘newsy’ than what is happening far away.

The filters in the Web of Science allow one to look at the papers from scientists in specific cities/towns. I leveraged on this facility, and the manpower base that I had trained, to start a weekly column in the *Sakaal Times*, a Pune based newspaper, in 2016.

The newspaper had no science column till then. The column covered science done by scientists in Pune exclusively, for five Sundays. Then for five issues, we covered science done in Maharashtra in the same column. Having tested the processes and procedures at city and state levels, we increased the scope to cover Indian science. From March 2016 we shifted the channel also and created a new column, Science Last Fortnight in *Current Science*.

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To achieve this, I had the backing of the PhDs that I had trained in two-week workshops held at the IISER Pune, 2014 and 2015. More such workshops supported by Vigyan Prasar, besides one-week workshops organised by the Current Science Association, increased the human power base to enable reporting more than 30 science news items per month.

Let me describe the materials and methods we use in a little more detail.

**Web of Science or Scopus?**

While Scopus,² the database managed by Elsevier, covers data from about 35000 journals, Web of Science covers a little more than 20,000 journals, even after ownership changed hands from Thomson and Reuters to Clarivate Analytics.

Web of Science has a tradition of taking peer review a little more seriously than Scopus does. For science reporting, it is important that the claims of scientists are vetted or supported by independent experts as genuine before they are published. Though a faulty system, peer review does reduce the chances of picking up papers that might have inherent faults or flaws. So, as science reporters, we use Web of Science as a starting point to get to newsworthy stories. (However, researchers, who are trained to read critically, are advised to use Scopus, since it has more extensive coverage of scientific literature).

Many journals today get more papers than they can publish per issue and, therefore, they schedule the papers for publication much in advance. And they provide the information to scientific databases. Thus, Web of Science (Scopus, ScienceDirect,² etc.) carries data related to papers that will be published. For example, on 20th November, in a search done with ‘India’ in address filter, I found that there were data related to 803 papers that will be published between 25th November and 10th December 2018.

Please note that this is a small subset of papers that will be actually published in a fortnight by Indian scientists. The actual number could be similar to about 4000 papers in two weeks. Web of Science (or any other scientific database) is still not complete as a crystal ball to comprehensively gaze into future publications.

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[7] [https://www.scopus.com/home.uri](https://www.scopus.com/home.uri)
[8] [https://www.sciencedirect.com/](https://www.sciencedirect.com/)
When I scanned through the data of papers that would be published for the fortnight, I found 108 publications that are relevant to the non-specialist citizens of India. Newsworthy science done by Indian scientists, as per my personal judgement.

I harvest the data into Excel sheets, categorising them as

1. Earth and Planetary Sciences,
2. Evolution, Ecology, Environment
3. Agriculture, Fisheries, Forestry, Animal Husbandry
4. Medical, Pharmaceutical and Health Sciences
5. Materials Science
6. Energy
7. Water
8. Technology
9. Theory

After minor editing and cleaning of the data, we share the Excel Document as Google Spreadsheets with the academics that we have trained and who have shown interest in writing about scientific advances. From different parts of the country - from universities, research labs, institutes - the members of a Google Group select the entry of their interest, cut it from Google Spreadsheets and paste it in a Google Doc specifically shared for the purpose.

The volunteer science writers have to access the PDF file of the paper. They may request the scientist concerned since the email ids are given in the data, they may request Indian Researchers Group on Facebook, they may request the scientist through ResearchGate or they may access the paper by searching in Digital repositories, using digital object identifier or DOI.

Once they get the paper, the PDF file is dropped into a Folder in Google Drive, shared specifically for the purpose. This is useful because quite often, the stories written will have to be compared with the paper reported.

The reporters have to read the paper. And they have also to read around the paper. Using advanced search in Google, Google Scholar and Open Access Databases, they have to

[9] https://www.google.co.in/sheets/about/
[10] https://support.google.com/groups/hl=en#topic=9216
[11] https://www.google.co.in/docs/about/
[13] Sci-Hub, considered pirate site by some and a scientific necessity by others, has changed the way science is done; standing on giant shoulders to peep behind pay-wall is now a matter of clicks.
get a deeper and updated understanding of the contents of the paper, to create a psychosocial, economic, political, cultural and historical context in which the scientific problem is solved - components that are not usually reported in scientific papers.

Bookmarking and organising knowledge in digital form, outside the brain, reduces the cognitive load on the reporters. Webclipper tools such as Evernote\(^\text{15}\) take a load off from the need to memorise details. The mind is, therefore, free to reflect on the content, to make connections and to weave stories. (Besides Evernote, there are other web clippers. Some of them – e.g. ReadCube,\(^\text{17}\) F1000 – double up as bibliographic tool, collaboration tool etc. for researchers).

Our reporters must have an in-depth understanding of at least one field and a keen interest in other fields. For improvement in this direction, we usually suggest Researcher,\(^\text{18}\) an App that delivers data related to publications in journals of your choice, every day. Scanning through literature related to areas of interest can now be done on a smartphone while travelling, waiting for meetings, while having coffee in the morning. For many researchers, to keep up with what is new in their field has never been easier – in spite of the information explosion, because of the digital revolution.

In fact, scientific publishing is going through a phase of rapid evolution. Scientific journals will have to reinvent themselves to survive and grow. Even open source journals. Preprint publications such as ArXiv\(^\text{19}\) and bioRxiv\(^\text{20}\) are gaining traction among scientists. While we encourage our participants to use these for their personal research, for reporting, we still fall back upon traditional peer-reviewed journals. But as open, incisive, voluntary peer reviews start taking place on such preprint platforms, both science and science reporting will change further.

\(^\text{14}\) https://scholar.google.co.in/  
\(^\text{15}\) You can access quite a few open access databases from http://www.loadb.org/Control.do? brse  
\(^\text{16}\) The software is downloadable from https://evernote.com/  
\(^\text{17}\) https://www.readcube.com/  
\(^\text{18}\) https://www.researcher-app.com/  
\(^\text{19}\) https://arxiv.org/  
\(^\text{20}\) https://www.biorxiv.org/
Digital tools for research

PDF is the main digital form of scientific papers. As researchers download PDF files, managing them becomes more and more difficult. Mendeley, another digital tool, helps create a library out of your collection. It also doubles up as bibliographic tool. [21]

Zotero, [22] another bibliographic tool, is useful for writing papers. It helps to organise the references. Gone are the days when we used to spend more time putting together references than writing the paper. As you finish writing your paper, your references are also ready. You just have to decide which referencing standard you want – or the target journal wants.

SciNote [23] keeps the workflow in your lab streamlined, eases the burden of managing projects, keeping track of inventory, laboratory protocols, materials and methods…It also doubles up as an individual lab journal or even a collaborative one. The App claims that, ultimately, it reduces the burden of writing a paper: just have to collate the materials, methods and results... Many similar apps are being developed to help researchers. We will have to keep our minds and eyes open for digital tools that make our work easier.

We encourage the use of such digital tools among our group of science writers. Besides being useful for their research, these tools build their capacity as science reporters. By reducing time and effort for the researchers and by making their work more systematic, we wrest time from them for science writing. After all, this is unpaid work.

The digital resources and tools available for science journalists today allow the preparation of the news report before the paper is published. And that allows time for journalists to double check the veracity of the news reports with the scientists concerned, and reduces the

[21] https://www.mendeley.com/
[22] https://www.zotero.org/
[23] https://scinote.net/
possibility of faulty reporting – a phenomenon that estranged scientists and media professionals in the earlier decades.
Representative results and conclusion

Scientific activity in India has been doubling every decade in the recent past. Presently, the output from India is more than a lakh of papers, as per Scopus. Even by strict standards of selection, more than 10% of this output is directly useful for various target groups among Indian citizens and therefore report worthy in news channels - which means that we are missing out on more than 10,000 papers per year that are not reported in any Indian media.

Newspapers that allocate two or three pages for the coverage of sports do not have even a weekly science column. This is primarily because reporting scientific advances is not an easy task for a person trained as a journalist. However, training scientists to become citizen journalists – a task easier than converting a journalist into a citizen scientist – can overcome the problem.

To aid such researchers and scientists interested in writing science news, there are quite a few digital tools that have evolved in the recent past. Many more are, of course, expected. The digital resources and tools currently available are adequate to report science as it happens - or even before it happens. These resources and tools have led to an increase in science reporting in India during the last few years.

However, the regular output from the India Science News Wire of Vigyan Prasar, Research Matters and the periodic output from our group, along with occasional reporting of science in newspapers, cover only a minuscule part of Indian science. It is subcritical and inadequate to make an impact on the citizens’ way of thinking. To create scientific temper among media consumers, the present activities will have to be scaled up to ten thousand fold, given the fragmentation of media audiences.

Increase in the number of reports alone, of course, will also not lead to the desired outcomes. Indian news reporting quite often disregards the strategies and methods used by scientists and focuses primarily on the results. To improve scientific temper among the readers, however, it is important to spell out the way scientists solve their problems. Once the logic of scientific discovery – except the cases of accidental or serendipitous ones – is understood by the public, they too would start using it. So we must focus more on the materials and methods section of the scientific papers and use the results that are useful to the public only as a hook to fish for attention in the high pitched clamour of news.

Science News is distinct from other types of news where the journalists often do not provide the source. Science news, on the other hand, has to be transparent about its source. Providing the reference to the source papers is important in today’s context where the
number of citizen scientists is growing and scientific research is happening outside research institutes.

Representative results from such efforts intended to improve science writing in India can be seen in the column Science Last Fortnight in *Current Science*, in the column Lab to Land in *Kerala Karshakan*[^24] and in the website steamindiareports.com. As can be noticed in the column in *Current Science* and on the website, the reports are based on research done by Indian scientists. We may use some results from outside the country in Lab to Land since here the attempt is to take any useful science to farmers, fishers and foresters. But even in this column, the ultimate success would be measured by the provocation provided to the citizen scientists among readers.

The times have changed from the days of Jayaraman, Balu and Balaram whom I mentioned in the beginning. One doesn’t write with a pen and then revise it on typewriters. The digital revolution has changed the ways that science writers work – it has become more complex technologically, yet easier, in practice. The same is true for research. The time spent in ‘climbing on the shoulders of giants’ has become less tedious. Literature review that would take a year during PhD in the 1980s, can now be done within a few weeks.

The time taken for researching and writing has come down in the last few decades. And the number of PhDs, too, has multiplied many fold. The only other resource needed is money. But science reporting does not call for huge financial inputs too. It does, however, require committed and passionate people. Creating a core community of such people can, as Kerala Sasthra Sahithya Parishad and Ekalavya demonstrated in the 1980s, generate a more rational mindset among people by concerted efforts at science popularisation and communication. However, as history has demonstrated, the enthusiasm of such communities are transient and often, they do not survive – perhaps due to the lack of mentoring needed to evolve next-generation leadership within such organisations. Only time will tell whether our efforts will sustain the present rate of growth into the next decade.

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*This is a revised version of an article with the same title submitted to the Indian Social Science Congress organised in Bhubaneswar in December 2018.

[^24]: The column is accessible from [https://steamindiareports.com/archives-of-published-research-news/](https://steamindiareports.com/archives-of-published-research-news/)
Reference

COMMENTARY

Management of Collegiate Education in the 21st Century: Some Insights

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It is a popular perception in the minds of both educated laymen and distinguished academicians that the quality of higher education in our country is on a declining course since Independence. The ‘quality’ that everybody is referring to is not defined precisely. The global rankings published by a couple of international agencies in which no Indian university figures anywhere in the top hundred, added to the confusion. The opening statement also implies that Indian institutions of higher education (HEI) were better off before we attained political independence compared to the post-independent period, particularly in the sphere of science education and training. There was never any confusion about the University-Society interaction dynamics. Socio-economic-cultural milieu kept changing in the last one hundred years and accordingly what kept changing was the public understanding and expectation of what a University is and what it should be. The Government of India appointed many commissions and committees to assess the Indian education system from primary through secondary and tertiary stages to suggest appropriate reforms. Voluminous reports were also submitted and new organizations like University Grants Commission (UGC), National Assessment and Accreditation Council (NAAC), etc., were also floated to put into action some of the well-meaning suggestions. The growth of institutions of higher learning in terms of numbers, funding, administrative framework, infrastructure, etc., did not stop in the same period. Why then this common perception? We need a comprehensive study, and an analysis of the educational system to
 diagnose the problem. We also need tangible plans of action and clear recommendations on how to restore quality.

The book titled ‘Management of Collegiate Education in the 21st century: Some Insights’ edited by Srinivas Saidapur and published by Gyan Publishing House, New Delhi is a partial attempt at that goal. Aptly titled 'Management of Collegiate Education in the 21st century: Some Insights,' this collection of articles by highly distinguished academicians is timely, authoritative but provocative, comprehensive in coverage and also prescriptive on the management of higher education to meet 21st century demands. Srinivas Saidapur, an eminent Biologist, distinguished educationist and innovative administrator has done yeomen service to the academic community in editing and bringing out this wonderful and highly readable book. The cover page and the introductory Chapter 1 by Saidapur essentially summarize the contents of this book. A book review would appear redundant. Nevertheless, a review of the ideas/opinions expressed in this book in the form of a critique is still required and I have ventured to offer one.

The Preface by Srinivas Saidapur says it all. It bemoans the ‘declining quality of higher education’ in post-independent India. Indices to perceive this declining quality have been spelt out. They are varied like performances in National Eligibility Test, job interviews, etc. These are only symptoms. Unfortunately, some of these parameters do not correlate with research capabilities, and the least to the quality of higher education. The root cause is the lack of quality teachers in critical numbers to keep the institutions running. A distinction should be made between general education which includes humanities and social sciences, and science education. Moreover, the performance of educational institutions and that of research institutions should be assessed on different frames of reference. Policymakers add to the confusion by changing the goalpost in terms of the primary aim of higher education. If the goal post is changed, the problem becomes more acute. For example, raising questions about the relevance of university products to fourth industrial revolution or wishing for value education or for an innovative/creative ambience adds to the problem. Further, equity and excellence are mutually exclusive. Perception of a problem is always contextual. What is perceived as a problem or undesirable in one context is not a problem but a solution in another context. Goals of higher education have been made diverse and that makes the task of quality assessment challenging. Problems and solutions to problems are relevant only in the context of goals of higher education set by policymakers. Students are diverse, teachers are diverse and assessment parameters are diverse, and all these add complexity to defining quality and hence drawing conclusions or making corrective suggestions. While each of the parameters can be assessed quantitatively, what is to be made of the meaning of the numerical average is not clear to me. If uninspiring teachers grab the majority of teaching jobs, if politicians grab the academic leadership positions (principals and vice-chancellors) and if incompetent scientists crowd the laboratories and classrooms, the quality of higher education, especially that of science educations takes a beating. An ethical perspective of the whole education system is the only way to provide solutions. Given the complexity of our country, what India has done and achieved in higher education is not bad. Of course, there is a scope for vast improvement. What we can say emphatically is India has not been
able to realize its potential. Islands of excellence are getting submerged in a sea of mediocrity. We must first take a look at how Oxford and Harvard, as examples, function in every aspect of higher education. We must take cognizance of the social-cultural-economic diversity of the Indian student community. We must then design appropriate higher educational institutions. One must also remember what Aldous Huxley said i.e., “ends do not justify means!” A proper understanding of the ethics of higher education will set things right in our country. There are no short cuts to success or quality or excellence.

In our country, education is translated as vidya. In ancient India paraa vidya (roughly higher education) was distinguished from aparaa vidya (roughly lower education). The latter represented training in skills. Horse riding, fencing, metallurgy, astrology and other skills constituted the aparaa vidya. All of these are employable to make a living. Higher education referred to the education of the ‘mind’ to enable it to reach its highest level of consciousness. More important, the student sought the teacher or guru. Today it is the other way. It is mostly a commercial activity now and hence, business models are discussed to attain success. All the stakeholders are tense and quite often suffer depression. Students are most vulnerable. The biggest casualty is the joy of learning or discovery.

In Chapter 2, Saidapur traces the history of Indian education system over 5000 years. He has identified the ills that plague the present system. There is a lot of overlap between this chapter and that by S P Thyagarajan (Chapter 3). He aptly says that the collapse of quality education system leads to the collapse of the nation. What Lord Macaulay did to India is still being debated in the context of values of higher education. Chapter 3 traces the history of the growth of the British (colonial) education system in India in the nineteenth century to the present date. It is reported as a matter of fact but without any value judgement or even comparison with the contemporary western universities in terms of ‘quality.’ If even a comparison, in terms of quality, of Banaras Hindu University, Mysore and Osmania Universities which were established more or less in the same period (in the 1920s) were made, it would have given a case study and parameters of study for the present book. It looks like most of the universities established around those times were modelled after either London or Oxbridge Universities. Even here, a comparison of our universities with the parental model universities in a timeframe of the next hundred years of their respective lives would have provided the much required ‘insight’ in the theme of the present book. No such thing was attempted. In terms of guiding philosophy of higher education, there appears to be a little confusion between PG departments (especially humanities) and undergraduate colleges. The philosophy guiding the establishment of universities at Calcutta, Banaras, Andhra, Mysore, Madras, Santiniketan or Gujarat Vidyapeet appears to be different but no comment or analysis is offered with respect to quality attained. Indeed, what were the parameters of quality among these diverse universities? Were the parameters same between humanities and say natural sciences? No critical analysis has been provided. Radhakrishnan commission report has been discussed after tracing the history of UGC. Historically this appears odd. It is interesting to notice that over 20 commissions/committees were formed and asked to write reports on selected aspects of higher education
from 1947 to 2017. Nobody spoke about quality in globally recognizable terms. The focus was on growth targets in terms of a number of institutions, and social narratives like inclusive growth. Defining the quality of education, especially science education, is conspicuous by its absence. Parameters of the highest quality in science education/research are not the same as the parameters of the highest quality in say literature or history or even economics. There lies the problem. One, the focus was always on general education or on technical education. Fundamental natural science was not given that much attention as it deserves. Two, all the eminent educationists and the 20-odd commissions and committees did not compare Indian institutions with western institutions in terms of universally acceptable parameters of quality in any period of time. One such parameter is a number of students from far and wide, even foreign countries, attending a given institution in India. Universities at Nalanda, Takshasila in India and Anuradhapura in Sri Lanka in medieval times attracted more number of foreign students than any of the present universities in India or South Asia (the colonies so to say). Does the problem then lie in the parameters chosen? It is true that great teachers have come out of the Indian universities and great researchers have come out of Indian research institutions that lack educational context. All leaders of Indian science and academics appear to get confused between these two different ecosystems. They demand excellent research from universities and quality education from research institutions!

In Chapter 4, Shanbhag gives a comprehensive history of the growth of Indian educational institutions in post-independent India. Details of reports of Radhakrishnan commission, Kothari commission, and Yash Pal committee and of Sam Pitroda’s National Knowledge Commission are given. All the reports again talk of desirable structural organization and other features of HEI. The author neither analyses the impact of these reports, nor provides any data on the status of the colleges, centers and departments in different universities. There is no mention about the great personalities that came out of these institutions. Are there no quantitative and qualitative indices of excellence/quality in higher education especially science education? A few successful stories of growth like the Department of Chemical Technology, Mumbai University; the School of Biophysics of Madras University; the Departments of Botany, Natural Products Chemistry, Physics and Zoology of the University of Delhi; the schools of cytogenetics at Calcutta, Banaras, Mysore, Ahmedabad and Delhi Universities; the school of Entomology at Agra College and Madras Christian College; the schools of Marine Biology at Andhra and Annamalai Universities and many more could have been mentioned on a positive note to prove that Indian science education is not that bad and in fact very good by global standards.

In Chapter 5, Deshpande takes cudgels on behalf of education in social sciences but gives the impression of a sectarian battle. The author only talks of lack of focus on social science education in educational policies, the disintegration of social sciences into subdomains and the consequent absence of ‘holistic science of society.’ Déjà vu! I see a parallel in the growth of teaching biology at school and undergraduate levels. Instead of integrating other
disciplines in terms of unifying concepts, it has disintegrated into ten teaching departments for short-term gains. How will any of them get to understand biology as a single discipline!

The most interesting and inspiring article in the book comes from Sohan Modak in Chapter 6. Using anecdotal experience from his own professional career, he has with great insight, brought out what it means to be an inspiring teacher and what inspires the learner. All good teachers will resonate with these ideas. This is the only article that partially answers the question, what is hurting educational institutions most? Rightly implied by the author, it is the absence of inspiring teachers in sufficient numbers. Professor Modak speaks from his heart! The most important activity to ensure quality education is the selection of teachers. Quality will automatically follow. All other factors are needed but are not sufficient to guarantee excellence in education. Most of the articles are not explicit in stating what the problem is in higher education; instead, they focus on addressing the solutions they suggest. An opening statement at the beginning would make it easy for the reader to know what to look for in the article. Modak’s article is one of the exceptions. The title says it all.

In Chapter 7, Mulimani and Tanannavan take a look at the careers and sayings of many highly successful and visible scientists to illustrate what excellence means. One feels the absence of concrete suggestions to nurture excellence in the majority of colleges and universities as the title suggests. The content inside does not relate to this aspect of the title. Again, if a comparison were to be made between excellent institutions and average institutions using subjective and objective parameters, readers will get the message. A discerning reader, on the other hand, would notice that hero worship, characteristic of the Indian socio-cultural mindset and an irreverent attitude demanded great scientists are mutually exclusive. The correct solution is to develop ‘institutional arrogance’ and not individual ego or reverential attitude!

Chapter 8 is a very lucid article on the duties, responsibilities and leadership nature of college Principals. In minute detail, Saidapur has successfully enumerated all these. It is a textbook lesson for all in-service training programs for teachers aspiring to become principals.

Patagundi, in Chapter 9, has penned the most satisfying article on the implications of good governance in promoting and sustaining excellence in HEI. He has explained the six functions of governance as originally stated by Linda Bourne. He has hit the nail on the head. The goals of excellent institutions have to be very clear to all stakeholders i.e., teachers, students, administrators and funding agencies. If there is no conviction in those goals and only lip sympathy is given, institutions will only be architectural wonders where poor quality of education is transacted and actually, excellence/quality is buried.

Sivasubramanian, in Chapter 11, has tried to define quality higher education in abstract terms like good citizenry, ethics and values as desirable goals. He has suggested certain approaches/solutions to attain these. What is not conveyed explicitly is the correlation of these action programs to the terms defining quality higher education. Does quality
education in technical subjects like science, engineering and medicine also mean the same parameters? He leaves the readers dissatisfied.

In Chapter 12, Ranganath, a former Director of NAAC, has held the bull by its horns. He raises a pertinent question—why don’t our HEIs figure in the global rankings in the top 100? Our problem is in defining quality in quantifiable parameters. Further, this article, like many others, appears more relevant to humanities and social sciences. When it comes to natural sciences, the parameters of quality are not those that are enumerated here. In fact, we are not clear. Ranganath has discussed the dimensions of quality assessment in great detail. However what is missing is a discussion of the impact of HEI on general society in which it is not only embedded but is also being supported. Sundar Sarukkai, our philosopher of Science, has remarked somewhere that excellence in science education will be possible only in societies which exhibit excellence in culture and civilizational parameters like architecture, literature, performing arts and other creative pursuits. This essentially means excellent science institutions cannot afford to be ivory towers. Spreading scientific temper is an excellent activity but assessment bodies do not give much importance to this activity. Any institution is excellent only to that extent, limited by the state of an excellent mindset of the general society. Nobody has discussed the diversity of the student population and how it affects excellence in HEI. Chapters 12, 13 and 14 deal with quality assurance procedures both by NAAC and by host institutions. Ranganath writes eloquently about the NAAC philosophy and mechanisms it has put in for assessment and accreditation of HEI. Kasinath very lucidly explains the role of internal quality assurance cells in promoting, managing and sustaining quality education. Saidapur has written an advisory capacity about what colleges should do to be ‘ever ready’ for NAAC team visit. This is a training manual for all institutions hoping to become excellent. Once again, I wonder, if ‘best practices’ as good as those followed globally, are prescribed and followed in our country why do our HEIs not figure in global rankings? Does this mean assessments and examinations can only maintain procedures for quality but cannot assure quality in the global sense? Something is missing. Readers can recall the rankings of research journals suggested by the National Academy of Agriculture, which is relative and not absolute. Are our NAAC procedures also like that? I realize that all these procedures help in the management of quality institutions without producing quality. This is like in sports, where world-class sportspersons have come out in spite of the system but not due to the system. Venki Ramakrishnan, the Nobel Laureate and currently the President of the British Royal Society remarked somewhere that a nation should first produce breakthrough research and then only is it on the pathway to excellence at the global level. Like innovation or creativity, one can maintain conditions promoting creativity but cannot train people to become creative! How true!

The next three chapters i.e., 15, 16 and 17 deal with libraries as very important sources of learning for students and teachers. The importance of libraries (both conventional and digital) in enabling attainment of excellence for all stakeholders is realized by all. Three excellent articles by Sathyanarayana, Anupama Joshi and J S Bhat educate the readers about not just the need for a good library but also about how a good library should be and its role
in building a quality institution. In this age of information, researchers have to know what is being published elsewhere. It is not enough if libraries provide a means to seek information. Libraries should also be proactive in providing updates on different areas of research to the learner. I wish there was a chapter on Eugene Garfield and S Ranganathan and their contribution to information analysis and library movement respectively. The easiest and best way to attain quality is to ape, unabashedly, what the acknowledged leaders of quality do.

Chapters 18, 19 and 20 are grouped together. The first two are meant for the prospective employee and the already employed. These are not for learners but for the management teams that run institutions. There lies the dilemma. The continuing debate whether higher education is meant to generate employable skilled personnel or create excellent minds for future is inconclusive. Perhaps both the ends have to be realized. It is for the policymakers to give directions to achieve a balance. It is much easier to associate the goal of excellence to general education and the goal of employability or wealth creation to professional educational institutions. The only article written with compassion for the learner is Chapter 20 by Manika Ghosh. It is easy to talk about, assess and demand excellence. It is more difficult to produce excellence. In this game, the 'not-so-excellent' student coming from the socio-economic-culturally weaker sections of the society is the one who gets hurt. Student counselling is the most important activity of a truly excellent institution. Indeed the ethics of excellence demands that we carry everybody along. The bright, the not-so-bright, the indifferent and the downright insecure students, all should be taken along in this national journey. Nobody should be left behind or allowed to feel bitter. The fruits of development should reach everybody. The learning and the discovery of TRUTH is a journey of joy. Nobody should be denied this journey. The life and teachings of Shri Ramanujacharya, the 11th century philosopher who gave us Vishistadvaitha should be remembered always and should become a guideline for the management of HEI.

The most useful part of this book is the group of Chapters 21, 22 and 23. These chapters deal with resource (finance) mobilization, resource (energy, water, etc.) conservation, and resource generation with the help of the alumni. These three should form the core guidelines for how to plan and build quality institutions. The relevance of the term 21st century in the title of the book comes alive and draws our attention in Chapter 23.

The impatient reader will have to wait till Chapter 25 to get the 'take home' lesson. Saidapur poignantly brings out the ills plaguing the present HEIs and also what we should do to rectify these deficiencies. He calls for redesigning higher education system. He lucidly enumerates the important spheres like the appointment of faculty, women empowerment through access to higher education, nurturing reading habits, etc., where major action has to be taken. In essence, he wishes to have institutions not just compatible with Industrial revolution 4.0 but also future ready. In one line, the products of our HEIs should not have frozen minds (in technical content, attitude to learning and values) but dynamic and open-minded. Teachers must be flexible enough to absorb new knowledge and wisdom and competent enough to be critical of any irrelevant old practice and which is detrimental to
attaining excellence. The last section is an excellent curriculum for orientation courses in academic staff colleges. Each teacher should become an institute for *lifelong learning*.

At the risk of sounding repetitive, I once again raise the problem. The book discusses how to manage the educational institutions by focusing on the components of excellence like the library, sports, teaching-learning process, accreditation etc. It does not discuss how to select a good student, a good teacher and a good academic leader. The book explains what is expected in a good quality institution but does not spell out how to achieve those desired goals. It also does not discuss in detail about supportive administration in both civil and finance matters. It is time we change the audit rules for educational and research institutions. It should not be like gutter inspectors nor even an accreditation team for inspection and assessment. It should be sympathetic, understanding and suggestive. Excellence is not a destination but the journey. Management cannot demand this and that but should suggest ways to enable walking on the road of excellence. The last chapter in a way serves as an executive summary.

This book is a must read for all teachers, administrators and senior students. All public and private libraries should have it. The last chapter, in a pdf format, should be circulated to all stakeholders. The book, if read carefully and understood, will bring in the required changes in our educational system. It is no exaggeration to say this book is a mini-education commission report in a sense. All of us should be indebted to Professor Saidapur for planning, editing and bringing out this landmark book in the educational history of our country. It is an excellent reading material, thought-provoking yet implementable.
The Knowledge Systems Debate in India


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Abstract

This is the first part of a two-part review of the book titled Indian Knowledge Systems (Vol. 1 and Vol. 2) edited by Kapil Kapoor and Avadesh Kumar Singh, published by the Indian Institute of Advanced Study, Shimla. The review essays are an attempt to initiate a wider critical debate around the discourses, on Indian knowledge systems, especially among the scientific community in India. The essays are relevant and much needed today when questions are being raised about science and the claims made against the Indian knowledge systems by non-scientists, politicians and policymakers. The first part published here, looks at the different contributions contained in the two volumes that seek to expound on Indian knowledge systems, and also raise some preliminary critical questions, on the subjects covered under the rubric of Indian knowledge systems. The second part of the review essay would go deeper into the area of scholarship that is constructed around the term ‘knowledge systems’ and wider debates around it. The second part will also critically examine the domain that is being referred to as ‘Indian knowledge systems’ by attempting a more in-depth critique of the some of the papers in the two volumes being reviewed and their claims to be part of Indian knowledge systems.
Keywords: Indian knowledge systems; paradigms; philosophy and science

Introduction

‘Knowledge’ as a category embraces a large and wide spectrum of domains. Science is one of the domains of knowledge. Knowledge has evolved with the evolution of humankind and depending on their ecological contexts, knowledge and cultures have evolved. Attempting to separate a specific domain as a ‘knowledge system’ within any particular national or cultural context is fraught with problems. The task is complicated further when one examines works that use an all-embracing term like ‘Indian knowledge systems.’

With these cautionary introductory statements, let me venture forth into an examination of the contributions in the two volumes in a review in two parts. The contributions in the two volumes have emerged from a seminar organized in 2003 at the Indian Institute of Advanced Study (IIAS). The proceedings of the seminar were published in 2005 and for some reason, the content of the publication has come to the public notice only in the past year or two. The editors in their preface introduce the background to the seminar and state that “the disciplines/domains of knowledge proposed to be covered included Logic, Philosophy of Language, Technology and Crafts, Polity and Governance, Ethics and Sociological texts, Architecture – the Outer Sciences, Poetics, Aesthetics, Law and Justice, Mathematics and Astronomy, Agriculture, Trade and Commerce, and Medicine and Life Science.” They go on to add, “We strove to cover as many Indian knowledge systems as possible, but naturally could not cover all and quite a few systems, we are sure, would be undertaken for study later. We consistently focussed on Indian knowledge systems and their relevance in India and global situations. The present volumes do not lay claim any comprehensiveness of discussion on various issues pertaining to the Indian knowledge systems. What we claim is our ceaseless commitment to these Systems and their validity and values (emphasis added).”

The two volumes together comprise a little over 700 pages with contributions by 34 authors. At the outset, one must confess that in a review article it will not be possible to do justice to both the volumes and all the contributions, in spite of doing a very careful reading of all of them. We shall first review the articles that are part of the collection, before embarking on the second part on a broader discussion on the notion of ‘knowledge systems’; while also looking into some of the critical dimensions of the contributions in the two volumes under review, in order to attempt a critique of the collection as a whole.

Section I - Indian Knowledge Systems: (Ex) Positions

The opening chapter is by Kapil Kapoor (an eminent linguist and Sanskritist) on ‘Indian Knowledge Systems – Nature, Philosophy and Culture’. His contribution is organized into 6
sections. The first speaks about the importance of knowledge in Indian traditions. The second is on the richness and strength of oral traditions; how it is “constituted, stored and maintained” (emphasis added). The third section deals with how “knowledge of different domains over a period of time has been institutionalized as so many disciplines, vidya and crafts, kala.” The fourth section is on “philosophy, nature and character of knowledge”. The fifth attempts to characterize the Indian knowledge tradition. The sixth answers the question, “What are the assumptions, models and methods of Indian knowledge systems?”

Kapoor’s dense and packed contribution demonstrates his scholarship in Indian traditional texts and his understanding and interpretations of this rich resource. His paper, singly, needs a detailed review to do full justice to his contribution by placing it within the larger context of the discussions on the Indian knowledge systems, which will necessitate a discussion in Part II of this review essay. Kapoor opens his contribution with the statement “Indian civilization has always attached great value to knowledge” and goes on to refer to the large body of intellectual texts and to what remains as the world’s largest collection of manuscripts. However, he then proceeds to lay considerable emphasis on how in tradition, “knowledge has been constituted, stored and maintained (emphasis added) in the framework of oral culture”. He writes, “A different philosophy of knowledge and of cognitive processes informs this mode of orality. Knowledge in this mode is simultaneous, not sequential/linear – as the case in the scriptal traditions” (emphasis added) and adds, “In the oral culture, the scholar has a library in his mind and the speed of information processing is very high, much higher than in the scriptal mode where the information is first transferred to the mind through the senses. In this case, the mind-memory is loaded with large bodies of data – remember that the mind has a much larger capacity to store data than the hard disk of a modern computer – and there is direct visualization of data with the eyes shut (emphasis added). He subsequently talks about how large volumes of text could be held mnemonically than in “perishable mediums such as paper, floppy and CD” and cites the example of how the Rgveda has come down intact from over 5000 years while Shakespeare’s plays that were printed in their time have many textual problems in only 500 years. (Page 14, footnote 6).

The second paper in the first section is that of M. D. Srinivas, Amara Bharati: Sanskrit and Resurgence of Indian Civilization (emphasis supplied). Its point of interpolation after Kapoor’s contribution remains unclear unless it is to signal indirectly to the readers of these two volumes that Sanskrit is central to the discussion on ‘Indian knowledge systems.’

It remains perplexing why the contribution by a physicist is seen to be so important as to succeed a very scholarly contribution by Kapoor. It is even more perplexing, given that the contribution of Srinivas to the volume is anecdotal and rambling. His paper is a classic case of what is often referred to as ‘anecdotal scholarship’ that is very common in India, especially in the social sciences. To the reviewer, it perhaps indicates a need for acolytes in constructing a domain called the ‘Indian knowledge system’ as is attempted in these two volumes. In the light of Srinivas’s contribution, one may ask why should we not call the subject under examination in the two volumes as ‘Sanskritic knowledge systems’. We are
The Knowledge Systems Debate in India

not contesting the organizing of a domain called the ‘Indian knowledge systems’ but the specific way in which the contributions in these two volumes are organized. It corroborates Thomas Kuhn’s (Kuhn 1970) exposition of how paradigms (in this case knowledge systems) acquire an institutional base in a manner that is comparable to establishing a new religious sect. According to Kuhn, “In putting together a new religious sect, four things are necessary: 1) a founder; 2) believers; 3) doctrine and scriptures; 4) a believers’ organization and physical facilities of some kind” (1). Possibly the role that people like Srinivas perform is to fulfil all, some, or one of the four roles at different points in time for a certain kind of ‘revivalism’ with regard to ‘Indian (Sanskritic?) knowledge systems.’ This is perhaps why the writing of the kind that Srinivas produces is included just like that of S. Kalyanaraman at the end of the two volumes. These contributions are however useful in this review essay, in relating our review to discussions that emerge from Thomas Kuhn and his contributions on the subject of ‘The Emergence of Paradigms.’ Kuhn’s perspectives relevantly and effectively address this discussion on ‘Indian knowledge systems,’ to which we will return in the second part of our review essay.

Indian Knowledge Systems and Science

Part II consists of five papers. The first reads ‘Educating Sciences of Life and Mind’ by Ananda Wood, the second, ‘India’s Scientific Mind: A Quest for Infinity’ by Michel Danino, the third, ‘Dividing the Thousand into Three’ by Wagish Shukla, the fourth, ‘Some Special features in Procedures of Ganesa Daivajna’s Grahalaghavam’ by S. Balachandra Rao, and the fifth, ‘Philosophy and Science in Indian Texts’ by Ravi Khanna.

Ananda Wood’s contribution tries to tease out the essence of Indian traditions and the manner in which they differ from ‘modern sciences’ like physics. Two statements, one in relation to nature, and the other a reference to ‘modern physics’ could illustrate the trajectory of thinking in this contribution by Wood. Talking of ‘prana’ he refers to it as “an energy of inspiration” and says, “In this conception, nature’s actions are all animated from within, by the inner inspiration of prana’s living energy. Nature does not function as a partial person, driven by limited and changeable desires for some partial objects of external perception. Instead, the functioning of nature is inspired only for the sake of expressing an inner consciousness: which in itself remains unmoved and unaffected through all of nature’s changing acts” (page 57). The second statement of his referring to modern physics and how it is different from ‘nature and consciousness’ in Indian traditions, relates to how Indian traditions appreciate the five elements. Referring to *air,* he says that it is appreciated “through *vijnanamaya-kosa* or the covering of discernment”. On the other hand for him, “In modern physics, the comparison is strictly quantitative, ascribing a mathematical value to each point of space and time and thus formally describing a mathematical value abstracted “field” (page 67).
The next paper by Michel Danino is an excellent paper. Danino discusses ‘the quest for infinity’ in Indian traditions and historically makes a parallel attempt to illustrate “the Indian approach to scientific knowledge systems” using the example of mathematics and astronomy, two disciplines, which he says were inseparable in ancient times. He also alludes to architecture. It is a very interesting contribution, which appreciatively looks at the development of Indian knowledge traditions, and their fascination with eternity and the exploration of the mind. He achieves this end without being parochial about these traditions while at the same time placing the Indian search for knowledge as part of the larger human thirst for knowledge.

Wagish Shukla’s paper, sequentially following Danino, sets out “to explore the concerns of Indian mathematics before the advent of modern times.” It is interspersed with polemics against those from what he calls the Judean and non-Judean Prophetism. By the latter, i.e., ‘Non-Judean Prophetism’ he refers to Christianity, Islam and Marxism as “the most famous and powerful examples”. Then follows a series of sweeping ahistorical statements on these traditions and how India has been, for more than a millennium, under attack from the forces of “these non-Judean Prophetisms.” If the chaff is taken away, it could have been a good paper on the history of Indian science and the development of Indian scientific knowledge in mathematics. Unfortunately it is not to be, given that polemics, in the cause of ideology, overtakes scholarship - a pitfall for those who write about his or her (culturally speaking) knowledge system, and those who are unable to stand at an objective distance from their own cultures and the injustices that have happened, and are perceived to have happened to them during the course of history. Is it a narrative of victimhood? One is not sure.

The next paper in this section, by S. Balachandra Rao on ‘Some Special features in Procedures of Ganesa Daivajna’s Grahalaghavam’ deals with the development of astronomy in Kerala after Bhaskara II (twelfth century). Ganesa was an astronomer from Kerala and the son of the famous astronomer Kesava Daivajna. Grahalaghavam is the most popular method for pancanga making and according to the author, “still in use today in Northern India, Maharashtra and north Karnataka.” This article is not surprisingly supported by the Indian National Science Academy (INSA) and could be a model paper on History and Methods in Studying Early Indian Sciences, a venture that this writer would say does not really exist; an area of study that needs to be cultivated and promoted, as we attempt to do in Part II of this Review.

The final paper in this section by Ravi Khanna, ‘Philosophy and Science in Indian Texts’, opens with these lines, “Our dependence on the Western systems that we inherited from the British has run its full course. This very West is tiring with its technologies and fragmented areas of specializations, and looking seriously towards the East for alternative holistic systems of knowledge. This is best summarised in the article, ‘How your Mind can Heal Your Body’ in Time Magazine special issue (20 January 2003)” and then has a long quote from the above-mentioned article. With such an opening the less said the better about this contribution. It is an odd paper containing a collage of thoughts that refers to Bohr, Pauli, Schrodinger, Heisenberg, Dirac, and De Broglie in one breath, with one line linking them to
The development of Quantum Mechanics. A miniature reproduction of Magritte’s ‘The Human Condition’; a quote from Frijtof Capra, Notes on the Sanskrit Alphabet plus an appendix with poems of R. W. Emerson on Brahma, A. C. Swinburne on Man, and Rabindranath Tagore with ‘I’. One is lost, asking in futility to what this melange points to. Certainly not ‘Philosophy and Science in Indian Texts.’ What then is it about? It could have been easily omitted in the process of assembling these two volumes, even if it was part of the seminar presentations. But it is likely that the organisers of this effort were also attempting something else in this exercise, a point to which we shall return later.

**Medicinal Science in India**

This part has three contributions. The first one on ‘Modern Medicine and Indian Wisdom’ by Dr. B. M. Hegde, a celebrated presence online, not the least for his talks on YouTube. He writes an excellent and knowledgeable piece, once more showing the difference between those who are also practitioners and those who are just hacks who pontificate on Indian knowledge, culture, and tradition with all the baggage that those terms contain. He, like all those who write of the differences between Western and Indian (non-Western) traditions in Science, in the realm of health sciences, refers to the “reductionism” of modern or western science. While his reference to “reductionism” with regard to health does have some validity, this cannot be a given in discussing ‘western science’ and need not be true in all cases of modern and ‘western’ science.

This recourse to ‘reductionism’ also features in the writings of Indian environmentalists like Vandana Shiva and social scientists like Ashis Nandy when they attempt to critique ‘Modern Science’ which they equate with ‘Western Science’. A feature of standard criticism of modern science and western knowledge traditions, mostly done in a sloganeering fashion, is akin to firing at random, hoping it will hit the target. Talking of using ‘reductionism’ as a catch-all term to criticise modern and western science, it will be useful to refer to the Nobel Laureate Jacques Monod’s (Monod 1972) timeless classic, ‘Chance and Necessity’, wherein he refers to the “old quarrel between reductionists and holists”(2). This is not to say we have any serious quarrel with Dr. Hegde and his contributions. He ends his piece in this collection by saying, “Long live humankind using the help of the best in all systems of medicine”. This is a salutary perspective often missing in the parochial perspectives of non-western knowledge systems and in arguments for such knowledge systems, especially ‘Indian knowledge systems’, which includes many of the contributions in these two volumes, thus, unfortunately, confining the universal aspect of such knowledge systems to a parochial domain. This position is often adopted, paradoxically, after correctly arguing that non-western knowledge systems have their own universalisms and the notion of “universal” is not confined to “western” knowledge systems alone.

The second paper in this section is on ‘Ayurveda as a Knowledge System’ by P. Ram Manohar. His contribution is very thought-provoking. Ram Manohar makes an important argument: “Attempts to understand *Ayurveda*, it seems, have been limited by an
overemphasis on external frameworks of reference, so much so that the traditional viewpoint has been eclipsed and neglected. Therefore, a fresh enquiry into the nature of Ayurveda is very much called for at this crucial juncture when it is getting all set to become a global phenomenon. *Classically, Ayurveda has sought to define itself as a knowledge system and not merely as a health care approach or medical system* (emphasis added). This paper is an attempt to critically examine the position assigned to *Ayurveda* by tradition, and in the process also to highlight its strengths and weaknesses as a knowledge system.

The third and last piece in this section is on “Social Organization of Knowledge in India-Folk and Classical Traditions’ by A. V. Balasubramaniam and is an overview of what appears to be taking place in ‘Sanskritic knowledge systems’ and other folk and tribal knowledge systems. Interestingly, scholars like Kapil Kapoor (who we have encountered earlier) and the editor of the two volumes under review lay emphasis on the oral nature of the classical Indian knowledge systems starting from the *Rg Veda* and also on the uniqueness and strength of such oral systems, as we have pointed out. The author of this chapter argues partially against the propositions of Kapil Kapoor about the strength of the ‘oral culture’ in Indian knowledge traditions. In the context of extensive research and documentation of folk and tribal traditions, especially with reference to the use of bio-resource in Asia, Africa and Latin America, he makes a point about the uniqueness of the Indian context. He says, “What makes the Indian situation quite strikingly impressive is that we have not merely extensive and deep folk traditions but also classical textual traditions that bear symbiotic relationship to the folk traditions. This offers outstanding opportunity and possibilities for the revival and strengthening of traditional knowledge since a weakened oral tradition (emphasis added) can also derive strength and vitality from its classical counterpart. *A linkage between the folk and classical can also infuse new life into theories of classical systems which may have got alienated or cut off to some extent from mainstream Indian society*” (emphasis added). The latter, in the view of the author, of course takes place “particularly in the last two centuries” who, as customarily, seeks to explain the phenomenon by attributing it to the “colonial period”. The contribution in this chapter and the entire quotation to which we have referred is riddled with very problematic statements. We shall approach such contradictions later. Most importantly, apart from a total lack of an ecological perspective, what need to be also pointed out are the claims to an exceptionalism of the Indian context with reference to knowledge and certain amnesias about how India as a society itself has evolved internally in terms of ‘knowledge and power relations’ across hierarchies. There is a tendency in such writings to present the history of India as a kind of ‘pure evolution’, untainted by any deep-rooted internal social causes or with no stagnation or deterioration, other than the travails experienced due to external forces such as ‘colonialism’. How have the internal social and other forces evolved (including in the playout of conflicts among social forces), as well as attempts by ‘textual traditions’ to parasitise, and even in an imperialistic manner, take control of folk traditions, needs examining with intellectual integrity. Only then can any proper evaluation and narration be conducted, on the evolution and survival of diverse systems of knowledge, which can then be organized under the rubric of ‘Indian knowledge systems’. This task will lamentably remain undone, as long as such projects as the one
undertaken in this two-volume collection that seeks to establish a certain 'hegemony in the
discussion on Indian knowledge systems', are supported at the governmental and
institutional levels.

**Psychology, Polity and Sociological texts**

This part has eight contributions. The first is titled ‘Psychology: Five Major Indian
Contributions’ by Mathijis Cornelissen, the second, ‘Indian Political Thought’ by Ashok S.
Chausalikar, which in turn is followed by ‘Governance According to Manu-Smriti’ by Bharat
Jhunjunwala. The fourth contribution takes for its name ‘Agriculture and Trade in India’ by
P. Shashi Rekha, while the fifth reads ‘Treatment of Women in Indian Sociological Texts:
With reference to Manu Smriti’ by Chandrakala Padia. The last three contributions in this
section are ‘The Indian Noetic Tradition: The Dharmasastras – Bharatiya Jnana Parampara’
by Santosh Kumar Shukla, ‘Vision of Disaster Management in Kautilya’s Arthasastra’ by
Niranjan Patel and finally, ‘Indian Psyche – A Note’ by V. Prakasam. We are not attempting
an in-depth examination of any of the contributions in Part IV. This being a review essay of
the two volumes *in toto*, it is not intended to be a critical examination of each and every
contribution in the two volumes. Notwithstanding what has been said, it is equally
important to point out that the contributions here are also good candidates for an extended
critique on the discourse on ‘Indian knowledge systems’ in India. Why are such discourses
so defensive? Why is it that these discourses always have to confront the ‘other’ even when
it is not needed? Is it a problem, as I see it, of self-imaging? We shall return to these themes
in Part II of our review.

**Volume II – Aesthetics and Poetics**

This part has five contributions. The first, ‘Alam Brahma’ is by Rewaprasad Dwevedi; the
second, ‘Salvation and Knowledge: Ananda Coomaraswamy and the tradition of Indian
Aesthetics’ by Chandrasekhar Jahagirdar; the third is ‘Krsna Dvaipayana’s Veda of Life’ by
Kavita A. Sharma; the fourth ‘Reading the First Adhyaya of Natya Sastra’ by Makarand
Paranjpe; and the last and the fifth paper in this section, ‘Neither Amnesia or Aphasia:
Knowledge, Continuity and Change in Indian Poetics’ by Avadesh Kumar Singh, also the co-
editor of these two volumes on Indian knowledge systems.

The first contribution is a very short piece regretting why such an important concept as
‘Alam’ from the Agni Purana has not been much noticed, discussed or examined by Indian
scholars working in the field of Indian aesthetics. In referring to the second paper in this
section, firstly, one must congratulate the editors including a paper on Coomaraswamy in
discussing Indian aesthetics. Coomaraswamy has written beautifully on the subject, and as a
true admirer from the outside of Indian culture, art and aesthetics, he himself has confessed
his bias for Indian culture as against the Western. The contribution in this volume, however,
does not do full justice to Coomaraswamy by selective quotations to justify some *a priori* positions on Indian knowledge systems. To be fair to the author of this paper on Coomaraswamy, he does express disagreements with Coomaraswamy in relation to his views on caste and *sati*, for instance. While I have appreciated the inclusion of Coomaraswamy, I am at the same time surprised that another great Indian writer, in my view a philosopher as well, is not only not included as the topic of a contributed article but hardly finds a mention even in passing in these two volumes. We will come to this ‘*missing person*’ later on in Part II and argue in the context of this review, on why should he remain central to such discussions on the Indian knowledge systems.

Moving on to the other papers in this section, Kavita Sharma’s paper is interesting to read, though she is not clear in talking about the Mahabharata and Vyasa and so on, or what is the central point being pursued, and what are the central arguments in the context of this volume that are being sought to be conveyed. This paper represents the difficulties that the people who read classical Sanskrit texts face; particularly those in India wanting to use Sanskrit texts to buttress arguments, as in the case of these two volumes being reviewed, about the greatness and uniqueness of, for example, Indian knowledge systems. Yet, at the same time, do not have systematic training to deal with these texts. They usually end up nowhere, as in Kavita Sharma’s case, when they use these texts to make a point. Since there is so much to extract from and upon which to reflect on these texts, they start meandering all over and at the end, one is not clear what the intention of the undertaking is. How to read old texts and interpret them is itself a science for which training and methodology are mandatory. The problem is that for all the eagerness and anxiety to talk of the importance of Indian knowledge systems, there is hardly any systematic training on how to read classical texts, which far exceeds the mere knowledge of a language like Sanskrit. This is a conversation one has had with many a Sanskrit language teachers in India and Asia, to which we shall deal within Part II of the review.

As a matter of fact, the paper by Avadesh Kumar Singh is another example on how to read texts, and stands out as a better exposition of *Natyasastra* than the paper of Paranjape. It is devoted to “an exposition of and analysis of the first chapter of the *Natyasastra*.” While Paranjape is very right in saying, “We need to defossilize these texts by injecting a new life in them,” yet his paper is like the voyage of Columbus in 1492, setting out with the right objective but landing up in the wrong country. Referring to the classical Sanskrit texts, he adds, “These are by no means ethnocentric texts, contemptuously referred to as ‘Brahmanical’ by those who little understand the genealogy of that term but use it merely as an expletive, a term of abuse.” The problem, however, is that such polemics (since ideology again takes precedence) as those of Paranjape do not help in any manner or contribute to a situation where a student or a young scientist interested in these texts is guided and helped to do it. In a situation where Sanskrit is taught and when students who pursue the language write their tests in English, unlike the students of other languages who write it in the language they pursue and not in English, the widespread impression is that learning Sanskrit is only a clever ploy to score 100% in language tests. Beyond that, Sanskrit as a
language has no value. Who is to blame? We will return to this issue when we make some analysis and commentary on the contributions in these two volumes, on language in general, and on the relationship between ‘Ecology, Culture and Knowledge’ and the ‘Economics of Language.’

Returning to the Natyasastra, Avadesh Kumar Singh’s fine paper is exemplary in drawing out the diverse critical traditions in Indian thought. More importantly for me, Singh as a scholar of literature is also able to be self-critique on how literature departments in our universities have become similar to retailers for Western wholesale dealers, who deal with thought constructions like deconstruction, postcolonialism and post-modernism and end up running meaningless seminars on these topics. He validly points to what is contained in “Literary Criticism” in the English syllabus and in English literature departments, where there is so little of Indian literary criticism. Equally telling is his criticism of the ways in which we swiftly dumped our rich critical traditions when the West was either craving for Sanskrit or reviving their critical traditions. His references to Prof. G. N. Devy and Prof. Aijaz Ahmed in the context of referring to Indian literary criticism in English are extremely relevant. His paper has some very useful Appendices including Sanskrit compositions, Indian poetics in Indian languages and works in Hindi on Indian poetics. What is the relevance of all these to the students of science? The answer resides in the fact that it gives us some excellent insights on why we must read in a focussed rather than a random manner, and more importantly on how we must read our own traditions if we can.

Philosophy, Logic and Language


The first contribution was delivered as a valedictory address by Geshe N. Samten in Hindi and was subsequently translated and published in this book. He spoke in Hindi because he did not want to speak in English, which he calls a ‘non-Indian’ language! Perhaps he should have spoken in Tibetan (which could also be a non-Indian language but which is his mother tongue). Such petty quibbles over linguistic parochialism aside, it is a contribution that is thought-provoking and one must congratulate the organisers of this symposium from which these two volumes emerge for including Buddhism, at least as a Valedictory address, although the question ‘why not Jainism’ does also arise as indeed for a number of other lines of faith, including animism. The organizers know better. Going back to the paper, a translated and published (in English ironically) version of an extempore talk in Hindi makes
it difficult reading. The first part though gives pause for reflection. As he says, “No \textit{parampara} or tradition can be considered alive until and unless it combines the traditions of \textit{sruti} and of \textit{pratipatti}. It is a criterion of considering a tradition as dead or alive. Just because certain texts of a system/tradition are preserved, it does not mean that the \textit{parampara} is alive. To do so we need to find out if it exists in the form of \textit{sruti parampara} and its \textit{pratipatti} i.e., the tradition of practice. The combination of the two keeps a tradition alive” (Vol. II page 406).

One does not know if he is alluding to the fact that Buddhism is a living tradition while the diverse Indian traditions, which are bundled under an envelope term, ‘Indian knowledge systems’ exist in texts and not in practice. Later, he says, “The Buddhist tradition which existed in places like Nalanda, Vikramshila, etc., had disappeared in India, but is still preserved in Tibet”. He does not, on the contrary, go into why Buddhism died in India. Seeking an answer to that question may perhaps give us also an insight into why Indian knowledge systems are in such a parlous state, which most contributors in this volume lament, saying that these are being neglected and relegated to the background in comparison to so-called modern knowledge systems. This contribution also shows how Buddhism was open to being subjected to examination and scientific observation by western scientists with regard to Tibetan meditation practice.

In the end, Geshe N. Samten makes a very pertinent point with regard to the revival of traditions and traditional knowledge systems, in this case, Indian knowledge systems, which I find in this review article to be worth quoting in full. He says, “When we compare Indian with Western or Modern with classical, we should not be depreciative in our disposition because both traditions have tried to contribute to the development of humanity in their own way” (emphasis added). The West has made some remarkable studies in this direction and there are a number of things that can be taken from them. The Indian tradition always incorporated any idea worth incorporating, irrespective of its origin. Thus, there is nothing like the concept of absolute purity and if anyone from us claims of absolute purity of tradition she/he speaks of the impossible. We follow the \textit{Yuga-Dharma}, as our tradition accepts that the age leaves its impact on every tradition and we move ahead accordingly. Both in the West and in India, ancient and new traditions and systems of knowledge should strive to enrich and serve humanity. I am sure that the Indian glory would not remain limited to the \textit{sruti} only but manifest itself in concrete terms in days to come” (page 411). I read this passage and thought how relevant it is in this contemporary era, especially in India for our young scientists to keep this perspective in mind; more so when they read some of the contributors to these two volumes, who are so parochial and express an almost racist (verging on, dare I say it, ‘casteist’) superiority about their traditions.

The next contribution on the different schools of philosophy that is part of the Indian ontology is useful, in part because the author of this paper Shashiprabha Kumar does not miss to recognize the Jaina writers, such as Siddasena Divakara and Mallavadina, in the
development of the ‘philosophy of being’ in the Indian philosophy. Referring to one of the contemporary Jaina writers, though the author does not mention who he is referring to, states that this Jaina writer who tried to trace the common link between the different schools of philosophy in India, is, according to him, an important guiding principle in the concept of “identity and difference” (page 419) (3). Keeping to this concept of “identity and difference”, accordingly, five schools of philosophy can be classified, represented in Shashiprabha Kumar’s list as Advaita Vedanta, Buddhism, Samkhya, Vaisesika and Jainism.

Renu Malhotra’s contribution, the third in this sequence, is all praise for the Vedantic Sanatana Hindu Dharma and its uniqueness, compared to other traditions. She opens her paper with the following statement, which needs quoting at length. She says, "A human being is considered the crown of creation by all traditions. However, the reasons for thinking this way differ greatly between the two main source traditions of the world as we know them. The two traditions referred to are, the Vedic dharma based traditions of Bharat/India on one side and the Judeo-Christian and Islamic religions, on the other side. Each side (emphasis added) has had its influence on the world at different times. However, only the Vedic Sanatana Hindu Dharma continues, unbroken since time immemorial. At the present time, the need to reaffirm this ancient tradition is very great indeed as the world seems to lack much of what is noble and thus useful to humanity”. Apart from its anthropocentric view of the universe its ‘us’ versus ‘them’ reduction of history and humanity seems odd in a collection of assumedly scholarly articles on 'Indian knowledge systems'. She continues in this vein about the Hindu tradition and concludes that “Vedantic Sanatana Hindu tradition when well understood produces a vision for humanity unmatched anywhere else” (emphasis added). The fact that such contributions are here says something about the ideology underpinning these efforts, which the reader should be able to ascertain quite easily.

The next four articles, mentioned at the beginning of this section, are all contributions by language study specialists and linguists. They will not only need special discussion later in this review but also will be treated, not just as an outsider’s perspective on language but from another perspective on language itself which we will elaborate later.

Knowledge Formation, Dissemination and Practice

This is the last and final section of these two volumes. The title of Part VII is a somewhat curious formulation to head this section if one considers the four contributions in this section. The title is an apparent afterthought on Indian knowledge systems. The first contribution is ‘Syncretism in Indian Knowledge Systems: A Case Study of Durga Puja’ by Debashish Chakrabarty, the second, ‘Narrative as Epistemology in the Brahmana Texts,’ by Atanu Bhattacharya, the third, ‘Folk Wisdom and Environmental Crisis: A Contemporary Case Study from the Western Himalayas’ by Raghubir Singh Pitra and finally, ‘Saraswati
Hieroglyphics and Bharatiya Cultural Continuum: Mlecchita Vikalpa and Bharata Sabhyata’ by S. Kalyanaraman.

The title of this section questions what exactly it seeks to organize in this section apart. The first contribution by Debashish Chakrabarty makes for a compelling read and is a brilliant contribution on the so-called ‘margins’ of mainstream Sanskrit culture. This should have found a place much earlier in these two volumes and been juxtaposed with Kapil Kapoor’s paper. The latter, apart from providing a much needed intellectual honesty to this effort, would have made the collection more interesting to read. The editors, however, must be lauded for including such an article and not editing it out since it ‘speaks truth to knowledge and power’ under examination in these two volumes.

The notion that Indian traditions always had a corridor dimension outside the sanctum sanctorum gets reinforced in this contribution. It opens with a nice kind of query, the kind that provokes serious enquiry though on the surface it seems like a trivial question. “Durga Puja always has been a source of intrigue for me. One of my earliest queries, as my parents inform me, was why the Goddess rode on a lion and not the Bengal Tiger. As one grew up, the questions increased in complexity, but the essential query remained the same – why Durga in Bengal, the land of Kali? It was no wonder that the search became a lifelong passion”. He traces the journey of Hinduism through four broad stages, “the Vedic (from the Rgvedic to the latest Brahmana literature), the age of the mahapuranas (during the Gupta empire), the age of the upapuranas (twelfth and thirteenth century CE) and finally, the colonial and post-colonial phase. He quotes the Matsya Purana where he says that the spirit of change is asserted. He relies on the work of Kunal Chakraborti (Chakraborti, et al 2001), to say that, “The need for the upapuranas” and the singular promotion of Goddess worship of various kinds, “was to enable the brahmanas to gain a foothold in Bengal where Vedic religion had the least impact” (emphasis added).

Most importantly, he goes on to say, “The Puranas, therefore, tried hard to strive over internal differences of the sectarian brahmanas and project, consistently, Buddhism as the deviant ‘other’. The Puranas urged the rulers and the local populace to patronize the brahmanas by giving them gifts for conducting of sacrifices and doing rituals on the rulers’ behalf. Kings were instructed to follow the advice of the brahmanas, exempt them from taxation, grant them land, and above all protect their property and privileges.” He then quotes Kunal Chakraborti, to me a very seminal passage as to why ‘ideology’ triumphed over ‘knowledge’ in the evolution of what may be called Indian knowledge systems. Chakraborti says “the contemporary land-charters came remarkably close to the Puranas in endorsing the Brahmical world view. Buddhism under the influence of the Tantras lost its distinct profile as an institutional religion in the eyes of the laity. While Buddha was appropriated as an incarnation of Visnu, lay followers were eventually subsumed within the expansive framework of Brahmism, which emerged triumphant, at least in the ideological sphere by the twelfth century.”
Debashish Chakrabarty refers to Kunal Chakraborti’s analysis of how Brahmanism, I would say with great cunning (Pierre Bourdieu, et al. 1999) while incorporating and assimilating Durga into its fold also superimposed her with Brahmanical attributes. Other goddesses were made part of her as mere manifestations. He then quotes passages from the Devi Purana where Indra and other gods shower praises on the Goddess (really very beautiful descriptions of the Goddess which to me has many ecological readings too) and points out how subjugating Durga to satisfy brahminical conditions of acceptability at the same time did it without upsetting brahminical notions of hierarchy and superiority in that pantheon. There is a wealth of scholarship to draw from in this paper with regards to ‘Indian knowledge systems.’ In particular, looking at his contribution from an ecological prism and the paper’s references to so many aspects from nature also provides arguments from my perspective as to how or why ecology somehow in discussions of Indian knowledge systems, except in an instrumental sense, was not critical or central.

The next paper by Atanu Bhattacharya on ‘Narrative Epistemology in the Brahmana texts’ also makes for notable reading as a scholarly paper and in my view could be read along with Debashish Chakraborty’s contribution to understanding how Brahmans used narrative as a way to legitimize ritual actions in the development of Vedic religion. Latter being important for constructing the ‘narrative as epistemology.’ This is a critical connection to examine the evolution of Indian knowledge systems, the epistemological dimensions of Indian knowledge systems, and its relationship to rituals and how specific systems of knowledge are legitimised as knowledge.

The last two papers in this collection are oddities. The first, ‘Folk Wisdom and Environmental Crisis: A Contemporary Case Study from the Western Himalayas’ by Raghubir Singh Pitra is full of good intentions but turns out a hotchpotch of a text in the end, nothing beyond. Folk wisdom here becomes psychology and how that relates to ‘environmental crisis’ becomes a very incoherent and convoluted attempt where folk becomes ‘native’; finally at the end of the paper expressing gratitude to ‘the natives’ as part of the Acknowledgements. One wonders in which epoch we are reading this paper. How such papers can pass the test to be included in volumes with such high ambitions in constructing ‘Indian knowledge systems’ is baffling.

Equally puzzling is the inclusion of the last paper ‘Saraswati Hieroglyphics and Bharatiya Cultural Continuum: Mlecchita Vikalpa and Bharata Sabhyata’ by S. Kalyanaraman, in the volume. The paper is over 100 pages, and appears to be a separate booklet or pamphlet. How does this paper contribute to the thrust area of Indian knowledge system perplexes one. This tedious and needlessly protractive paper is another hotchpotch of a contribution with all kinds of sources and references on the Saraswati Hieroglyphs and the so-called ‘Bharatiya Cultural Continuum’. The editors referring to this contribution, in their introduction to the volumes, say that this is an “exhaustive essay” on the topic which brings together “epigraphy, archaeology, numismatics, history, satellite photography and
contemporary observations to knit the story of the Sarasvati river and its influence on the civilization and on Indian life”. In spite of the Editors bending backwards by pointing to the many knowledge domains plus ‘contemporary observations’ that comprised this paper, to justify its inclusion, this convoluted exercise in this paper is nothing but an attempt to dissociate our history from the Indus Valley civilization and tie it to a ‘mythical’ Sarasvati river. To do the latter, one supposes the first exercise would be to show that the ‘Sarasvati’ was not mythical! To what end? All one can say is that this is another pamphlet devoid of any merit that does not belong here unless the editors are also signalling indirectly an underlying ideological dimension bereft of knowledge intentions to the efforts set out through the symposium and in these two volumes. In concluding this part of the review one can say without hesitation that it is these contributions that devalue the overall effort and disperse the focus of these volumes, thereby diluting their value from a scholarly perspective.

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Fake science and the knowledge crisis: ignorance can be fatal

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Computers, the Internet and social media enable every individual to be a publisher, communicating true or false information instantly and globally. In the ‘post-truth’ era, deception is commonplace at all levels of contemporary life. Fakery affects science and social information and the two have become highly interactive globally, undermining trust in science and the capacity of individuals and society to make evidence-informed choices, including on life-or-death issues. Ironically, drivers of fake science are embedded in the current science publishing system intended to disseminate evidenced knowledge, in which the intersection of science advancement and reputational and financial rewards for scientists and publishers incentivize gaming and, in the extreme, creation and promotion of falsified results. In the battle for truth, individual scientists, professional associations, academic institutions and funding bodies must act to put their own house in order by promoting ethics and integrity and de-incentivizing the production and publishing of false data and results. They must speak out against false information and fake science in circulation and forcefully contradict public figures who promote it. They must contribute to research that helps understand and counter false information, to education that builds knowledge and skills in assessing information and to strengthening science literacy in society.

1. Introduction

Seek truth from facts [1]

实事求是, shì shí qiú shì

Quoted from the Han Dynasty Book of Han, AD 111
Ignorance of the truth, or knowledge that is not acted upon, can be fatal. This basic principle applies at levels from personal to planetary. Fakery affects science as well as everyday social information and, since the two have become highly interactive globally, a vicious cycle is now operating on an increasing scale. The fake news/fake science cycle undermines the credibility of science and the capacity of individuals and society to make evidence-informed choices in their best interests.

At the individual level, lack of reliable knowledge about how to maintain personal physical, nutritional and health security can result in avoidable harm or death. An illustration is the child illnesses, permanent disabilities and deaths that have resulted worldwide from the fabricated scientific report [2,3] that the measles, mumps and rubella (MMR) vaccine causes autism. Despite the proven record of efficacy of vaccines in preventing infections by deadly diseases, the widespread dissemination of this lie, especially through social media, resulted not only in record levels of measles infections in Europe [4] in 2018 but has added fuel to a growing, broader phenomenon known as ‘vaccine hesitancy’ [5,6].

At a collective level, false information can alter attitudes and policies on crucial ecological, social and political issues and, in the extreme, can place entire populations at national, regional and even global levels at risk of harm. For example, the denial of anthropogenic climate change, dismissed without counter-evidence as ‘fake science’, has resulted in the international agreement on climate change losing universal acceptance and its impact on the level of global warming is likely to have disastrous consequences worldwide in the twenty-first century [7]. Portrayal of ethnic groups, foreigners or foreign states as enemies through fake stories is an old technique which has been given new potency by modern methods of mass communication and can provoke genocides and wars [8]. Fake Twitter accounts have reportedly been used to send millions of messages aiming to influence attitudes towards Brexit in the 2016 UK referendum and views on candidates in the 2016 US presidential election [9].

2. Validated information needs to be acted upon

Awareness of the evidence that smoking causes severe illnesses and that tobacco kills up to half of its users has not yet enabled the 1.1 billion smokers around the world to quit their addiction or governments to introduce outright bans on smoking. Denial, fake news, the deliberate undermining of true data by portrayal as ‘junk science’ to distort public health policy, fabricated information, distortion of media framing and covert illicit trading have been documented in the decades-long battle by the tobacco industry and its supporters to sustain their lucrative but fatal trade [10,11].

Examples such as climate change and tobacco illustrate the difficulties that both individuals and society can have in determining what is factually correct, how to recognize the biases and vested interests that may lie behind information available and how to balance risks against benefits at personal, national and global levels.

3. Evolution of scientific validation

A critical factor is the question of who is accorded authority to determine reliability of facts and make judgement about the veracity of information on offer. Since ancient times, those with wealth, power and elevated hierarchical positions were treated as privileged sources, as were some individuals regarded as selfless seekers of wisdom in the domains of spirituality, scholarship or science.

Since its introduction by Francis Bacon (1561–1626), the evolved scientific method has included unbiased observations that are evaluated for reproducibility and subjected to careful self-criticism and logical thought about their meaning and implications, then offered for inspection by the world at large. The establishment of learned societies and the publication of journals, beginning with the Philosophical Transactions of the Royal Society, first published in 1665, provided a mechanism for presenting information that could be critically examined by the scientific community. If disproved, the prevailing models and theories would be replaced by new ones that were more consistent with the contemporary state of knowledge. This provisional character of science is not a weakness but is one of the key reasons for its strength.

The evolution of this process, into the second half of the twentieth century, established a ‘gold standard’ for the reliability of knowledge. It has been the bedrock of the esteem in which science has been held, as an honest and impartial source of evidence-based knowledge, not only to advance the frontiers of the field but also to inform the public and politicians and aid their decision-making.
1918 landmark report by Richard Burdon Haldane to the British Prime Minister signalled the strength of the evolving relationship between science and policy, with Haldane arguing for the principle that politicians should stay out of decisions about research funding, listen to expertise, take time to think and reflect before reaching a conclusion and, when asking scientists for advice, resist telling them what that advice should be [12].

4. The changing landscape: the revolution in knowledge production

While the degree to which scientific inputs to policy formulation are important continues to be debated, the current revolution in knowledge production has further complicated the issue. An illustration of the extent to which the landscape has changed was seen in the centenary year of the ‘Haldane Principle’, which witnessed a major scientific report commissioned by the US government and issued by 13 federal agencies—warning of the consequences of climate change and therefore at odds with the Administration’s policies—being rejected by a number of leading politicians, including the President, on the grounds that they ‘don’t believe it’, while they (baselessly) accused climate scientists of being driven by money [13,14].

In 1991, Harnad described four stages in the means of production of knowledge in human beings [15]. The first three were the emergence of language (hundreds of thousands of years ago) and invention of writing (several thousand years ago) and printing (over 500 years ago). The fourth had only very recently begun, with the invention of the Internet and the capacity it provides for anyone in the world to be a publisher—to communicate any information they wish, true or false, instantly and globally.

Facts and their denial are no longer determined by any type of authority, but in principle by every individual, regardless of his or her education and reputation or studiously acquired knowledge of a field. The manipulation of data by anyone (including scientists) becomes ever easier. Due to the ready availability of information and communication technology (ICT) tools and access to the Internet and social media, there now exist countless ways to create and distribute products of unknown veracity, including manipulated textual and pictorial material. The predictions of the anarchistic philosopher of science Paul Feyerabend that ‘anything goes’ and of the conceptual artist Joseph Beuys that ‘every human being is an artist’ have thus become reality.

In his 1943 essay on the Spanish Civil War, the writer George Orwell recognized the way that people in politics and wars make use of the available propaganda mechanisms to create their own versions of the truth, expressing his fear that ‘the very concept of objective truth is fading out of the world’ [16]. This ongoing challenge has been exacerbated and accelerated greatly by ICT and the fourth revolution in knowledge production. As Harnad recognized, each of these knowledge revolutions represented a profound, qualitative change both in HOW human beings communicate and think and in WHAT is thought.

5. Consequences for science and for science publishing and assessment

The impacts of the fourth revolution, barely to be seen three decades ago, are now dramatically evident, including in contemporary language. A signpost was the declaration by Ralph Keyes in 2004 that ‘we live in a post-truth era’—a stage of social evolution that is ‘beyond honesty’, in which ‘deception has become commonplace at all levels of contemporary life’ [17]. More recent signposts have been the emergence in 2017 of the term ‘alternative facts’ to describe inaccurate data and the designation of ‘truth isn’t truth’ as the 2018 Quote of the Year.

There are growing impacts both on the interface between science and society and within the domain of science itself. It has been argued that, in the current political and media environment, ‘distrust in the scientific enterprise and misperceptions of scientific knowledge increasingly stem … from the widespread dissemination of misleading and biased information’ [18]. The philosopher Bruno Latour has observed that ‘facts remain robust only when they are supported by a common culture, by institutions that can be trusted, by a more or less decent public life, by more or less reliable media’ [19]. While surveys about the public’s view of the trustworthiness of scientists produce results that vary with time and place [20,21], in his 2017 book on the ‘death of expertise’ Tom Nichols described the many forces trying to undermine the authority of ‘experts’ [22], so that the term itself has started to be used in a contemptuous way to justify dismissing their advice [23].
Facing this challenge, it is especially important that the scientific world as a whole upholds the highest standards of ethical behaviour, honesty and transparency, aiming to sustain the gold standards of research integrity and validated information. Sadly, a range of forces are working counter to this aspiration. People in the world of science are not immune from the personal ambitions and prevailing pressures that drive behaviour in general.

As recently described [24], three closely inter-related sub-systems (science advancement, reputational rewards and financial returns) collectively form an overall scientific publishing system that has become heavily flawed. It encourages scientists to distort and exaggerate their results in striving for new grants, promotions and distinctions; and encourages publishers to cherry-pick work, hype results and distort refereeing in the competition for high status and correspondingly high profits from publication charges. Both authors and publishers are incentivized to game the system to their mutual advantage. In the extreme, the perverse incentives generated result in authors fabricating data, predatory journals hunting for papers and fake journals being created that seek only the authors’ fees for article processing.

The scale of the fake science problem is becoming increasingly evident. The percentage of scientific articles retracted because of fraud has increased by an order of magnitude since 2000 and high rates of retraction are seen for the most prestigious journals, illustrating both the extent to which flawed claims are perpetrated by scientists seeking prominence and weaknesses and even fakery in the current practice of peer reviewing [25]. A recent investigation of publishing in predatory ‘open access’ journals and fake conferences has revealed a global ecosystem of predatory publishers churning out ‘fake science’ for profit [26]. The intrusion of such journals into the traditionally respected space of science publishing seriously undermines the integrity and credibility of science and, if not stopped and sanctioned immediately, could turn out to be fatal for the field as we know it.

It is a fundamental strength of the scientific system that knowledge that is incorrect will eventually be discovered and discarded. However, the pace and scale at which material that is at best dubious and at worst deliberately false is now being published is creating a crisis. The consequences are very damaging for the science enterprise, with a loss of respect for the results of science and the scientific method leading, inter alia, to a steep decline in funding, jobs and students wishing to enter the field. The crisis is also damaging society, creating an ‘anything goes’ environment in which ‘alternative facts’ are not tested and decisions affecting the lives of people everywhere are not informed by authentic data or valid conclusions. Thus, in the new age of the fourth revolution in the means of production of knowledge, scientific publishing has become a part of the problem of fake news, rather than a bulwark against it.

### 6. Ways forward

Fake science and fake news are complex phenomena involving a variety of causes, channels of dissemination and consequences. Solving the challenges they pose will not be accomplished by a single approach or simple set of measures, but will require concerted effort by a wide range of actors across sectors.

To address the general societal problem of fake news, several initiatives now underway or being discussed offer promising approaches. Apart from those directly involving science and scientists, which are discussed separately below, they include the following.

Efforts are needed to counter the spread of false information via social media, through modifications to computer algorithms that favour ‘trending’ of stories without a factual basis [27], and development of tools that help identify and build skills in recognizing false claims [28–30]. The limitations of large-scale automated approaches and the ingenuity with which they can be gamed must, however, be recognized [31].

There should be more efforts to increase the responsibility taken by social media services for the content they permit online. The fundamental issue of whether social media should be regarded as ‘platforms’ that are not responsible for content (as the social media maintain) or as ‘publishers’ who can, like traditional print publishers, be held liable for the content they disseminate (as some critics of the present position propose), with many legal, regulatory, financial, ethical and operational ramifications, remains in dispute [32,33]. Meanwhile, there has been widespread dissatisfaction with the results of self-regulation by social media to date, and highly publicized failures in areas including politics, racism and health have led to calls for more regulation and/or more action by social media [34,35]. Initiatives required include efforts to increase the speed and scope of measures to remove offensive and injurious materials and to develop algorithms to detect and exclude fraudulent sources.

Scientists must not remain bystanders in the battle against fakery in news generally as well as in their own domains of expertise. They can contribute to understanding the phenomenon of fake news, which
has typically been studied along four lines: characterization, creation, circulation and countering [36]. Multidisciplinary effort is needed to understand better how the Internet spreads content and how readers process the news and information they consume, as well as how social media platforms are manipulated to amplify particular stories through the use of fake accounts and ‘bots’ [37–40]. As an example, WhatsApp has selected 20 research teams worldwide, including from India, to work towards understanding how misinformation spreads and what additional steps the mobile messaging platform could take to curb fake news [41].

Scientists must be willing to speak out when they see false information being presented in social media, traditional print or broadcast press [42]. They must use these media fully themselves [43] to offer facts and evidence in succinct layman’s language while emphasizing the breadth and depth of the scientific consensus which underpins the present state of knowledge and pointing to the lack of scientific rigour in the false information [44–46]. They must be willing to contradict public leaders and opinion formers who condemn or dismiss valid science without offering verified evidence of their own, as has happened, for example, in the USA and India [47–49].

For the longer term, scientists must be better advocates for and contributors to the generation of a more scientifically literate society [50]. The ultimate defence against fake facts is the capacity of each individual to examine critically the information on offer and to reach judgement about its trustworthiness that is based on evidence and reasoning. Scientists can contribute to inculcating ‘scientific temper’ in society. This term, coined in 1946 by Jawaharlal Nehru, describes a way of life, a process of thinking and acting which uses the scientific method and may, consequently, include questioning, observing, testing, hypothesizing, analysing and communicating [51].

The role of journalism remains important and development by scientists of stronger links with reputable journalists can encourage clearer and more accurate reporting of research [52].

Within the domain of science itself, individually and collectively through their professional associations, academic institutions and funding bodies, scientists must act in order to put their own house in order, through promoting ethical practices and research integrity, dealing with the problems of reproducibility and retractions [53], developing policies and practices to de-incentivize the production and publishing of false data and results and the use of ‘predatory’ journals that have inadequate peer review, and making maximum use of emerging artificial intelligence capacities [54] to detect and expose falsified data and images. Examples where measures are already being adopted or explored include India’s use of a ‘white list’ to discourage researchers from publishing in predatory journals [55].

Education—both broadly as part of the development of life skills and specifically in the culture and methods of science—is an essential part of the long-term solution, so that young people are equipped with knowledge, skills and tools to be able to critically examine information and assess its veracity [56,57]. As noted by the President of the European Research Council, ‘We need to train a new generation of critical minds. Science is not about learning facts by heart, established long ago; it is about knowing how to call into question and move forward. The majority of youth rely mostly on social media to get their news, so we must tackle this issue through improved news literacy, and it is the task of our educators and society at large to teach children how to use doubt intelligently and to understand that uncertainty can be quantified and measured’ [58].

Research indicates that pre-emptively inoculating people before they receive misinformation (prebunking) is more effective than refutation after receipt (debunking) in reducing the influence of misinformation. Synthesizing separate lines of research from education, cognitive psychology and inoculation theory (a branch of psychological research) provides a coherent set of recommendations for educators and communicators. Scientific explanations that involve clear communication of scientific concepts and the current scientific consensus are ideally coupled with inoculating explanations of how that science can be distorted [59].

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PERSPECTIVE

A Report of the Workshop on ‘Advances in Earth System Science’ Organized by the Department of Geology, Banaras Hindu University (BHU) and Indian Academy of Sciences (31st October – 1st November, 2018 at Varanasi)

(A joint publication by Dialogue and Current Science)

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A workshop on ‘Advances in Earth system science’ under the aegis of the Indian Academy of Sciences, Bangalore, convened by N.V. Chalapathi Rao (BHU) was held from 31st October – 1st November, 2018 at the Banaras Hindu University, Varanasi. The workshop was a part of the 84th Annual meeting of the Indian Academy of Sciences. An editorial board meeting of the Journal of Earth System Science (JESS; published by the Indian Academy of Sciences) also was held during that time. About 50 delegates (Fellows of the Indian Academy of Sciences and the editorial board members of the JESS) belonging to the various domains of earth system science viz., earth, planetary, atmosphere and oceans, gathered on a common platform to deliberate on various contemporary topics. Five technical sessions were convened and twenty one talks were held.

The inaugural lecture was delivered by Vinod Gaur (CSIR - 4th Paradigm) who emphasised the importance of the First principles approaches to address fundamental problems in Planetary Sciences Research and Education. New views of the origin of the solar system were updated by J.N. Goswami (PRL). The Himalaya is one of the places on the earth where
seismicity is a grave concern. V.C. Thakur and B.R. Arora (WIHG) provided an overview of Seismotectonics of the domain and stressed on the role of Plate boundary and wedge thrust earthquakes. The evolution of various branches of earth sciences and their culmination into earth system science was traced by R.N. Singh (IIT-G). Crustal architecture and Moho topography beneath the eastern Indian and Bangladesh margins from latest marine data sets were presented by K.S. Krishna (UoH). Based on the diffusion chronometry of garnet grains S.K. Bhowmick (IIT-KGP) brought out pulsed tectonic patterns in the evolution of early earth hot orogens. Based on the presence of Martian rare mineral jarosite, Saibal Gupta (IIT-KGP) postulated that analogous environment can be found in the Rann of Kutch and documented the presence of jarosite. R. Bhutani (Pondicherry Univ) summarised the various radiogenic isotopic clocks used to under the evolution of the earth and summarised their pros and cons. The importance of self potential method in subsurface exploration of mineral deposits was demonstrated by A. Biswas (BHU).

Biomass burning is a major hazard especially in the Northern India. Chemical characterisation of he carbonaceous aerosols and their implications to atmospheric radiative forcing and climate was elucidated by M.M. Sarin (PRL). Glacial melting due to enhanced temperature is a global problem. S.K. Bhattacharya (IIT-KGP) demonstrated, from oxygen isotopes, a decrease in snow/glacier melt contribution during 2002-2004. Predication of monsoon and climate is a challenging problem. A.K. Sahai (IMD) enumerated the challenges involved in subseasonal predictions. The atmosphere and oceans are coupled systems and this aspect is further explored by V.V.V.S. Sarma (CSIR-NIO) who provided evidence or modification of coastal waters by atmospheric deposition pollutants. Depleting groundwater is a major concern of the Northern Indian plains and A. Mukherjee (IIT-KGP) delineated the measures for groundwater security of India. The role of tropical Indian ocean warming and its impact on regional climate is highlighted by C. Gnanaseelan (IITM, Pune). By using a time varying model temporal evolution of hydroclimatic teleconnection and long-lead prediction of Indian summer monsoon rainfall was demonstrated by R. Maity (IIT-KGP).

An exclusive session was devoted to the Young Associates of the Indian Academy of Sciences. Various ways to estimate spatio-temporal variations of surface water availability at regional scales and their challenges and opportunities were provided by Riddhi Singh (IIT-B). Dating of lunar surface morphology by various remote sensing techniques was provided by K. Yhoshu (Nagaland Univ). Evidence for high rates of nitrogen fixation in the Arabian sea was presented by Arvind Singh (PRL). A numerical method for flood risk assessment was given by N. Hazarika (Nagaland Univ).

The valedictory session was addressed by Ram Ramaswamy (President of the IASc) and Rakesh Bhatanagar (VC, BHU) and several delegates (A.K. Singhvi, M.M. Sarin, V.C. Thakur, P.C. Pandey, Riddhi Singh, Arvind Singh and R. Navalgund) expressed their views regarding future courses of action which are summarised below:

- Atmospheric deposition of iron dust, via dry-fallout and wet-scavenging, is a dominant external source of iron to the open ocean. Further studies are needed to consider these issues and
impact on ocean surface biogeochemistry by utilising a wide range of approaches from fundamental chemistry, through modelling and field work.

- Although no quantitative estimates are yet available for rapidly changing GHG (greenhouse gases) budget of Asia, the direct/indirect evidence of ocean acidification (OA) due to CO2 and other anthropogenic gases are catching-up the attention of the scientific community. A systematic study comprising of modeling combined with regional air-to-sea fluxes of the relevant species is most essential to assess relative impacts of CO2 versus the other anthropogenic gases to coastal waters.

- Workshops like this one should be organized routinely to allow free interaction between various disciplines of Earth System Science. In the future, such workshops may also be thematically oriented to include scientists from at least one different discipline than Earth Sciences to foster inter-disciplinary work. For example, a workshop on ‘Societal contributions of Earth Science: past, present and future’ can also include some social scientists and economists, who will help move forward the discussion on policy implications of Earth Science research.

- An understanding of the way humans are altering natural hydrologic cycles via various interventions should be looked into. We need to understand how these alterations can be managed to sustain the coupled human-natural systems. This effort requires a combination of data collection as well as modeling exercises.

- In view of the likely known impacts of climate change, understanding hydrology of the river basins of north India is very crucial. Impacts on agriculture, availability of drinking water for the large masses are socially relevant. While there have been many investigations, they either confine to smaller regions or look at a specific science issue. What is required is to look at the problem holistically and on the basin scale. This requires a networked, coordinated large project with expertise of many individuals and organisations. It also requires strong scientific leadership.

- India has had launches to the moon and Mars and in future Chandrayaan 2, Mars 2, Venus, etc. The group of Earth System Science should proactively participate in generating ideas, formulating science objectives of the missions and also in building instruments.

- The need to establish a theoretical physical mineralogy branch in India is felt which required strong integration of thermodynamics and computational chemistry.

- Increase interactive ocean-atmosphere studies to unravel how oceanic and atmospheric processes influence the biogeochemistry. Understanding the role of the thickness and intensified oxygen minimum zone influence the pelagic and benthic community. Development of coupled biogeochemical-physical for Indian Ocean as most models fail to capture the processes in this region.

- Integration of Geology and Geophysics departments of the country under one umbrella “Department of Geosciences” or “Department of Earth Sciences”.

- Inclusion of programmes like Hydrology in Geosciences. Although many civil and agriculture Departments have already included it in their courses and research.

- Some introductory courses on fluid dynamics as related to mantle convection should be included. Emphasis should be more on quantitative research rather than the subjective like palaeo research.

The main takeaway from the workshop is the utmost need felt for integration of various disciplines of the Earth system science to address scientific problems of contemporary importance. The role of modelling and addressal of global scientific problems by Pan Indian large working groups was also highlighted. The sessions were well attended by ~ 300 students, research scholars and faculty of Banaras Hindu University.
Observations

on the

Draft

of

National Education Policy – 2019

By

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Bengaluru
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Allahabad
PREAMBLE

The Draft National Education Policy-2019 (DNEP) comprehensively deals with education at various levels ranging from pre-school, to higher secondary, college and university, including professional courses. It has also addressed the issues of governance for these institutions and has made several recommendations with the aim of bringing about fundamental changes in the education system, especially with regard to autonomy, governance, and quality of learning experience. Many of the individual suggestions in the DNEP are well-conceived and welcome.

However, the DNEP as a whole also contains many drastic recommendations that likely will damage, rather than improve the entire fabric of education system. In particular, the DNEP does not make a compelling case for why radical alterations to the fundamental structure of the education system are required. An alternative approach could be to add novel elements to strengthen existing diverse academic structures that have evolved organically, in some cases over a century, while adapting to the diversity and region-specific realities of the Indian education eco-system. Moreover, at multiple places, the DNEP contains prescriptions/assertions that need a revisit and re-evaluation.

*The National Science Academies accessed this report from the MHRD Website and decided to participate in the consultative process made available to all. These joint observations on D-NEP-2019 have been prepared with wide consultation with their Fellows. This being the first such opportunity to provide their inputs to DNEP and contribute to a step in Nation building, the academies have strived hard to provide serious inputs keeping in mind the best interest of Education in Future India. The academies offer to provide the services of their Fellowship in revising and/or improving upon various aspects of NEP.*
Further, it would have been desirable, if a synthesis of the present system, reasons for partial implementation of past education commissions and the causes for their ineffective delivery were considered along with discussion on how lapses in the past implementation strategies would be addressed to ensure against a repeat failure.

Like health, education is a heavily decentralized domain, and a top-down approach of legislating policies is unlikely to gain traction in India, with its varied eco-systems for education. Moreover, education is on the concurrent list and, as such, prescriptions for over-arching and highly centralized national level regulatory bodies would need due diligence in respect of the involvement of states in the spirit of federalism. Similarly, the availability of the DNEP document in Hindi and English only has already disadvantaged stakeholders in many States.

In its present form, DNEP despite being a policy document, is a strongly prescriptive document sweeping aside many key elements of the education system that have evolved by natural selection over a long period of time. With democratization of knowledge and availability of technology for easy access to information, DNEP should have focussed more on *how to teach* and not only on *what to teach*. In the spirit of any good educational program, the State should only address the issues of maintaining quality and encouraging teachers and students towards achieving academic excellence; thereby helping realize India’s demographic dividend. While an adequate exposure of ancient Indian
educational traditions and institutions is desirable, this may be limited to the need to teach students about significant ancient Indian contributions to early developments in sciences, mathematics, medicine, engineering, agriculture and the fine arts. In addition, it would also be advisable to include instructions on geo-heritage, archaeology, palaeontology and biodiversity of India (in both marine and terrestrial realms) to provide a wholesome view of India and its natural heritage.

The landscape of education and technology is rapidly evolving and the focus in the future should be on developing robust systems that keep pace with these developments.

This comment on the DNEP has been prepared by the three National Academies of Sciences and draws from extensive discussions with a wide range of educationists (teachers and researchers), students (school children, undergraduate and post-graduate and Ph.D. students) and other professionals. It focuses on some of the most pressing issues of concern, rather than attempting to be comprehensive and detailed. In the following, specific itemized comments that need careful revisiting have been flagged. It will require substantial deliberation to work out the detailed modalities for implementing some of these, and the three National Science Academies would be willing to assist in that task.
A. SCHOOL EDUCATION:

This phase of learning is the most important in the lives of citizens and thus needs careful planning, and meticulous implementation of the plans and policies. As noted in the DNEP, in order to achieve these ends, *much greater financial outlay is needed so that all schools across the country have the requisite infrastructure and competent teachers who are remunerated appropriately.*

Demographic trends indicate that in the years and decades to come, India will need to deal with much larger numbers of students who will require quality education. Many of these will be first-generation learners and would therefore require competent teaching in order to acquire the skills that would help fast-track their quality of life. Additional measures would be needed to make the teaching profession an attractive career option, to innovate on pedagogy, and to optimally use technologies and laboratory experiments to support the learning process. As parents have an important role to play in a child’s education in the formative years, all primary schools dealing with first-generation learners should have active programs that engage parents to make them aware of their roles and train them in activities that enhance learning abilities of their wards.

In the sub-sections below, we flag some issues of concern that need a careful revisit.
A1. Reform of school examinations and grading of students (DNEP-Chapters 2, 4 and 8, esp. P4.9):

- An undue premium on examination, arising due to a large and aspirational young population faced with a paucity of institutions of high quality and opportunities, needs to be addressed. At present, the entire education system has become subservient to “success” in “public examinations”, such as the school-leaving examinations, or the entrance tests for seeking admission to institutions of higher or professional education. Consequently, examinations, by and large, are only rewarding short-term memory, and basic learning of concepts per se is compromised. While implementing the various proposals in the DNEP, care needs to be taken that such limitations of the examination system are minimised, and the focus of the examination system should be restricted to testing the conceptual understanding of the subject.

- Some of the major issues holding back school education are: i) outdated syllabi, ii) poor or even non-existent infrastructure, iii) poorly trained teachers with abysmally low pay and very harsh working conditions, and, iv) political interference in syllabus-setting, teacher appointment and administration. The DNEP needs to adequately address these issues through due consultation with all stake-holders at the Central and State levels.

- The current ‘No Detention Policy’ till class 8 has been impractical, and has diluted educational standards. While the DNEP does refer to the need to revisit this policy (DNEP- 8.4.2e), it proposes State Census Examinations in classes 3, 5 and 8.
(DNEP- P4.9.4). This is likely to go to the other extreme of putting a burden of examinations on students, even at young ages. It would be advisable to have only a system of continuous assessment of aptitude and development of basic abilities during classes 1 to 5, with advice and feedback to parents, avoiding formal examination. Thereafter, examinations focusing on core concepts, skills and higher order capacities (as envisaged in DNEP- 4.3.1) could be introduced in a gradual manner, leading to State Census Examinations (i.e. Board examinations) after classes 10 and 12, respectively.

- The DNEP proposes that State Census Examinations be offered in a range of subjects, with students having the flexibility of choosing their subjects, and the semester when they want to take these board exams (DNEP- pages 105-106 in section 4.9, P4.9.5). Allowing students, a wide flexibility to choose their subjects and the time of examinations is impractical. Flexibility in choosing courses to study, subject to some constraints based on inter-dependencies of various disciplines (see A.8, below), is good, but that flexibility should not be extended to choice of the subjects the student is to be examined in. Moreover, the envisaged computer-based multiple-choice examination system (DNEP- P4.9.3) totally precludes assessment of abilities like power of expression and writing skills, thereby making it difficult to properly assess the understanding of core concepts by students.
The DNEP document stresses the need for formative assessment and has coupled this with a National Tutors Programme (NTP) (DNEP- P2.5, P2.7, P2.8) and Remedial Instructional Aides Programme (RIAP) (DNEP- P2.6, P2.7, P2.8) to help students who fall behind. However, for NTP and RIAP to succeed, a broader social movement is also required. This calls for action outside the field of education as well. The suggestion in this regard made in DNEP- 2.17, while attractive in principle, raises concerns about the lateral entry into the educational system of people chosen for reasons other than their academic qualifications. Indeed, this suggestion goes against the spirit of the recommendation that the practice of para-teachers be stopped (DNEP- P5.1.8). Moreover, if despite attempted remedial action a student still lags behind, will he/she be detained and asked to repeat the course? Thus the vexed question of ‘no detention’ as a policy remains largely unaddressed.

In attempting to ensure uniformity in the board examinations (classes 10 and 12), the respective boards provide standard answer-templates to examiners. This has resulted in severe straitjacketing of both thought and language, and has encouraged rote learning. Such practices need to be effectively regulated and modified. The DNEP, while it recognizes this problem and mentions possible solutions (DNEP P4.7.1, P4.9 pages 104-105, P4.9.1, P4.9.2, P8.2.1b), does not actually provide any detailed mechanism for its resolution.
A2. Diversity and advisability of a national curriculum (DNEP-P2.11, P 4.1.1):

While the DNEP does state the need for a diverse education across all levels in seeking an all-embracing policy, its operational details do stand the risk of excessive straitjacketing. For example, DNEP fails to fully recognize that our enormous diversity in terms of education, culture and historiographic components demands fairly local prescriptions/examples.

- In view of the above, a nationally-mandated detailed curriculum, at the school or HEI level is not desirable. At the school level, the common programme should only pertain to mathematics, science, aspects of language(s), the shared history and social science constructs etc. In addition, each state and region should be encouraged to further inculcate knowledge of local history and culture, with the use of local examples in teaching modules, as far as possible, as also stressed in the DNEP- Chapters 4 and 6. Due and formal emphasis on extra-curricular activities including NCC/scouting/girls guide training and sports should be given at all levels of school education, as envisaged in DNEP 4.6.4.1.
A3. Merging of secondary and higher secondary education (DNEP-page 28, P 4.1.1d):

This suggestion, supposedly aimed at improving matters, would actually cause further deterioration of the school system for the following reasons. An established goal of the 10+2 system is that every child should get generally similar education for the first 10 years, and specialize thereafter. Merging classes 9 and 10 with the +2 levels as a single component would reduce the common component and at the same time, would not let many to diversify into more vocational fields after the 10th standard. Further, the proposed clubbing of classes 9, 10, 11 and 12 together into a single unit, may force many students to discontinue their schooling at class 8, instead of after class 10, as at present. This is not in consonance with the goal of enhancing the reach of foundational education (DNEP- Vision Statement and Chapter 6).

- The 10+2 system itself is working fine, and should continue along with other desired changes as discussed later.

A4. Starting school at 3 years (DNEP- P 1.1b; 4.1.1a):

- The idea of creating a framework for learning through play, discovery and activity based approach at foundational stage is welcome. However, there appears to be a mismatch between the statements in Chapters 1 and 4, in this regard. Therefore, care must be taken to avoid any kind of formalism up to age 6, especially given the prevalent tendencies to do so in schools. For
this reason, it may not be a good idea to attach the play schools/\textit{anganwadis} with formal schools.

- A large number of crèches/\textit{anganwadis} and playschools, will be needed. These should be opened in both urban/rural areas at locations close to the children’s homes. There must be a strong regulatory body for such institutions to prevent abuse, especially of the children of poor parents.

- Segregating the care and education components of ECCE (Early Child Care and Education) between two ministries of MWCD and MHRD (DNEP- P1.3) goes against the integrative logic of the ECCE concept, and is likely to result in difficulties of coordination.

- Regular schooling should begin only from 6 years onwards, rather than at 3 years as envisaged in DNEP- P 4.1.1a. Text books as a medium of learning should only be introduced from class 1 (at the age of 6 years) onwards in a gradual manner. Children should learn more from social interactions and their natural surroundings during their first 6 years.

- Attaching playschools to regular schools (DNEP- P1.2 a,b,c) is not desirable because the needs of the two differ regardless of their being in rural or urban environments.

- The rationale of creating \textit{school complexes} (DNEP- Chapter 7) needs further thinking and clarification in terms of concept and practicability. While sharing of resources is desirable, the exact
linkages between the institutions constituting the complex require elucidation.

- Also the modalities and the factors determining the admissions of a student to one of the schools in a school complex need to be enunciated clearly.

A5. Education in the local language/mother tongue; multilingualism and the power of language (DNEP- P4.5):

Three Language formula is in general welcome. But implementing a three language formula including local/state language and mother-tongue from pre-school onwards (DNEP- P4.5.3) is not desirable because of the following:

- For a young child, especially from rural areas, or a first-generation learner, “three or more languages (including writing)” (DNEP- P4.5.3) would be an extreme burden. The rural child, in particular, would hardly have an occasion to practice his/her knowledge or appreciate the necessity/advantage of additional language(s).

- Multiple mother-tongues are often represented within a single small classroom and, as such, it is impractical to try and cater to mother-tongue (DNEP- P4.5.1, P4.5.2) beyond the extent, when coincides with the state language in relatively linguistically homogeneous locations.
• There is, and will likely remain, a serious shortage of infrastructure for teaching the third language (often, even the second language!). Therefore, learning of three languages from age 3 onward (DNEP- P4.5.5; P4.5.6) is not practicable.

• Care should be taken to see that the children in classes 1-3 are not overburdened in terms of curriculum, as envisaged in DNEP-pages 47-48 of Chapter 1, and P4.3.

• **Therefore, early classes should include only two languages – the State language and English / Hindi. From class six onwards, learning of and exposure to English will be necessary in all cases.** Further, in keeping with the idea of course flexibility (DNEP-P4.4), another third Indian language could be made optional from class 6 till class 10. **The medium of instruction – whether State language, English or Hindi - should be left to the discretion of individual schools. However, it is desirable that till class 5 the medium of instruction is the State language as the learning process for children is better.**

• It is important to devote sufficient resources and efforts to developing good textbooks across all disciplines in various state languages, as noted in DNEP- P4.8. **There is no need to translate technical terms in English to State languages: these terms should be used as such.**

• **Access to a good grounding in English, as the most commonly used international language of communication and science, must be**
ensured for students from all backgrounds (contra pages 81, 82 of Chapter 4; but see also page 83).

A6. Semester system in classes 8–12 (DNEP- P4.1):

This is not at all desirable, for the following reasons:

- For many subjects, a single semester offers too little a time for meaningful learning of many aspects. Essentially, a semester consists of a maximum of 14 weeks, or even less, of actual teaching. The Semester system needs additional sets of examinations, and thereby reduces time available for instruction. A semester system also creates undue pressures on teachers, as their work on evaluation gets doubled.

- A young student needs to internalize certain concepts and knowledge that she/he is expected to carry through life. Some of this is best done only by repeated application of such concepts/knowledge in diverse contexts, and this is difficult to achieve in a semester system. Moreover, semesters tend to fragment the learning curves, especially in the case of school students.
A7. Vocational education in school and beyond (DNEP- P4.4.1, P4.4.4 and 4.6.6):

This is a welcome step. We do need more emphasis on vocational training. The following two approaches are possible:

- **Compulsory vocational training for all:** Vocational training should be made compulsory for all streams of education from class 6 till class 10. However, this would require a large outlay and careful planning so that the training is effective and purposeful.

- **Separation into academic and vocational streams in classes 11 and 12:** A transparent and objective mechanism for this segregation needs to be evolved and practised. Separation into academic and vocational streams after class 10 would require an appropriate system of counselling the child and parents to advise about the child’s potential, aptitude and future prospects in a given stream.

- Skill development courses should, in general, be designed based on regional strengths and contexts for gainful employment.

- Stand-alone vocational courses of good quality should also be provided: *the existing ITIs should not be disbanded but must be substantially strengthened* so that those with interest and capabilities in specific vocational fields can get relevant good-quality training, enabling them to succeed in their chosen profession.

- In addition to the usual vocational training in common professions, vocational courses for school-leaving students need
to be developed for (a) nurses and paramedics (both genders),
(b) modern agriculture and agricultural technologies, (c) water
resource management, (d) pollution monitoring and other such
need-based disciplines that are likely to enhance future
employability.

A8. Curriculum and flexibility of choosing subjects

The idea of promoting flexibility while choosing courses at the school
level (DNEP-Chapter 4) is laudable and should promote inter-
disciplinarity. However, this will also require the establishment of
systems of coordination between subject faculties to create appropriate
baskets of course combinations. This is due to the fact that many courses
have prerequisite knowledge requirements, and not all combinations of
courses may be academically relevant or desirable.

- Special emphasis ought to be placed on Mathematics due to its
  wide applicability in diverse subjects, even in areas outside
  STEM.

- Courses in applied and specialized disciplines, such as
  Biotechnology, Nanotechnology etc., should definitely not be
  offered at the school level. Such courses compromise the
  purpose of school education in providing foundational
  conceptual understanding of different disciplines, and training in
  analytical thinking, an run counter to this basic tenet.
A9. Regulation and accreditation of school education (DNEP-Chapter 8):

- The DNEP refers to the need for a “revolution in our approach to governance and regulation” (page 178, beginning of Chapter 8). Revolutionary changes, especially in large and diverse educational systems such as ours, however, may cause more damage than improvement. This therefore, requires strong and persuasive justification buttressed by effective planning. The DNEP does not, however, make a compelling case for the need of revolutionary large-scale structural changes proposed in the mechanism of how school education would be delivered and monitored.

- There is a proposal for States to make “clear separate systems for policymaking, regulation, operations and academic matters” (DNEP- P8.1, paragraph 1), suggesting separate bodies for each of these responsibilities which, under the present system, are all under one Department of School Education (DSE) of the States. The proposal in DNEP (pages 178-179) suggests that these responsibilities be split between a new Rajya Shiksha Ayog (for overall monitoring and policymaking), a DSE with redefined responsibility (for educational operations and service provision for the educational system of the entire State), a new State School Regulatory Authority (SSRA: for accreditation and audit
purposes, covering infrastructure, security, academics, probity and governance of schools), a reinvigorated SCERT (for academic matters like “standards setting and curricula”), and Boards of Certification/Examination in each State that will “assess core capacities in each subject, but will have no role in mandating curricula (including syllabi or textbooks)”. The DNEP states that the purpose of this plan is the “separation of functions to eliminate conflicts of interest” (DNEP- Chapter 8: page 179 paragraph 1, and highlighted on page 180). Nowhere is any clear statement made in Chapter 8 as to what these “conflicts of interest” might be, or why such a drastic restructuring of the States’ educational apparatus is needed. In our opinion, drastically restructuring the States’ school education regulatory systems, and having separate bodies in charge of policymaking, regulation, operations and academic matters, is not necessary and, would actually be counter-productive. In particular, it is not a good idea for the body that oversees the school education policymaking to be different from the body that implements the policy on the ground. Similarly, why should the bodies handling policymaking, examinations or policy implementation be different from the regulatory body or the body responsible for curricula? All these aspects of school education are inter-related, and it makes sense for one apex body (the State DSE), with appropriate departments, to deal with these aspects in a holistic manner. We believe what is required is a streamlining and
strengthening of the existing system. This will achieve the same objectives without the need of creating multiple disjointed new bodies.

- We strongly suggest that the proposals in DNEP- P8.1 not be implemented. Most of the important reforms envisaged in DNEP-P8.2, P8.5 and P8.6 can be implemented within the existing system by strengthening it. We also do not think that self-accreditation by schools (DNEP- P8.2.3) is a good idea, as it relies unduly, and somewhat naively, on the honesty and idealism of school level management. With regard to regulation and oversight of private schools (DNEP- P8.3), we endorse the basic notion that private schools should not be “commercial enterprises” and that schools and education are not ‘marketable goods’ (DNEP- P8.3 paragraphs 1 and 2).

- We welcome the proposals under DNEP- P8.3.1, P8.3.2, P8.3.4, P8.3.5, P8.3.8 and P8.3.9 Regarding the starting up of new private schools, we suggest that DNEP- P8.3.3 may consider DSE rather than SSRA as the evaluating agency (see our comments above on the undesirability of multiplying regulatory bodies). There appears to be some disconnect between the goals of DNEP- P8.3.6 and P8.3.7. The proposal that private schools need to function as not-for-profit organizations (DNEP- P8.3.7) is welcome, but is inconsistent with the notion that private schools should be “free to set their fees” (DNEP- P8.3.6) needs reconsideration. While it is
envisaged that the percentage fee increase will be regulated by an appropriate body of the State (DNEP- P8.3.6), there needs to be regulation even on the initial fee structure proposed by any new private school.

- Regarding the implications of DNEP on the RTE Act 2009 (DNEP-P8.4), we endorse the proposals under DNEP- P8.4.1, 8.4.2b,d,e and f. Regarding revisiting Clause 12(I)(c) of the RTE Act, we believe that only the implementation of this clause, and not its rationale, need to be rectified. Our specific suggestion is to directly implement the proposals under (i), (ii) and (iii) of DNEP- P8.4.2c, rather than worrying about “autonomy of institutions “in this particular context, because revisiting the very premises of this clause would go against the notion of social justice that is otherwise so strongly enunciated in the DNEP. Similarly, we do not believe that it is a good idea to downplay the role of inputs, as envisaged in DNEP- P8.4.2a.

A10. Other issues

- **Teacher to Student Ratio** for all classes should indeed be 1:30 or less, as envisaged in DNEP- P2.14 and P6.1.3c. Moreover, in classes 1-5, and in pre-school, it is desirable to aim for a Teacher to Student Ratio of no more than 1:20.

- **Expansion of the mid-day meal scheme** to include breakfast is a welcome proposal. However, teachers must not be given the responsibility for cooking meals and/or procuring foodstuffs or the
census etc., as also stressed in DNEP-P5.2.3. Such distractions compromise their self-esteem, their commitment to- and competence for-teaching.

- **Hands-on experience in laboratory and field work** has progressively declined in recent years. This must be reversed through *appropriate support for development and provision of infrastructure and opportunities for meaningful laboratory experimentation and field work.*

- **The designing of practical exercises, whether in the laboratory or the field, also needs to be revisited.** A certain proportion of practicals, especially in the first couple of years of exposure to such work, serve to introduce basic experimental techniques and practices. Such practical exercises are, by their very nature, largely consistent across institutions/regions and based on experimental protocols whose outcome is well known, even to the students. *By class 10 onwards, at least fifty percent of practicals should be ‘open-ended’, research-style exercises, where the emphasis is on teaching students as to how a study (laboratory or field) is set up, and executed, and how data are analysed in an unbiased spirit and rational inquiry.* In these exercises, the ‘results’ should not be of the ‘textbook’ kind that are known in advance to the students. Subsequent exercise(s) can be built up on what the results of the previous ones were, to exemplify the ‘scientific method’ in action.
• **Three-year tenure track system for appointment of school teachers (DNEP- P5.4.1):** This is not desirable, given the ground realities and the sheer scale of the task of adequate teacher recruitment. Moreover, given the proposals in the DNEP for making the process of teacher recruitment more rigorous (DNEP- P5.1.1 and P5.1.2), and the provisions for greatly strengthening professional development programmes for school teachers (DNEP- P5.3, P5.4.2-6), there is no pressing need for a three-year tenure track system which will only make school teaching unattractive due to the delay in the attainment of job security. This goes counter to the very ideas laid out in the DNEP- pages 113-116 of Chapter 5. At the same time, the proposed assessment mechanism (DNEP- P5.4.5) should identify teachers who have failed in their job (not taking classes, mistreating students, incompetent teaching and the like), and a mechanism should be put in place to remove such teachers after due warning.

• **Equitable and inclusive education (DNEP- Chapter 6):** Overall, we endorse the laudable goals pertaining to equitable and inclusive education, set out in Chapter 6, though it may be expected that human and infrastructural resources and finance may become limiting factors for their attainment. *One point that needs to be further stressed under DNEP- 6.8 is that facilities for focussed learning of mainstream science by visually-impaired and all other differently abled children should also be developed by NIOS.*
Regular Upgradation of skills of the teachers: There is also a need for developing systems that enable continuing education to teachers for their skill enhancement. This would require enabling teachers an access to recent literature on new pedagogic techniques and avenues for experimentation. This important element of teaching needs care and augmentation of resources to enable teachers to upgrade their skills. As a linked policy, a system to evaluate the teaching-quality of teachers is required.

B. Higher Education

The DNEP devotes ten chapters (DNEP- Chapters 9-18) to the issue of higher education (HE) in India, and correctly summarizes some of the key shortcomings in the present system of HE, such as fragmentation, specialization, relative lack of access, autonomy, research and availability of required numbers of quality teachers, as well as problems of governance and administration (DNEP- pages 203-206 in Chapter 9). Outlines of suggested measures to address these shortcomings are presented in Chapter 9 (DNEP- P9.1 to P9.8), and elaborated at length in the following nine chapters. There are many appreciable and innovative ideas put forward in this large section of the DNEP, with which we generally concur. We appreciate the thought and effort that has gone into trying to provide a comprehensive road-map for how to improve the HE system in India.
However, there are many specific suggestions about which we have serious misgivings. The HE system in India, with its often worrisome diversity, has evolved organically over a long period of time since the first colleges and universities were set up more than 150 years ago. In our opinion, this diversity needs to be respected and maintained as it serves the important purpose of offering students a variety of higher education institution (HEI) experiences, ranging from the relatively multidisciplinary to the narrowly specialized. The DNEP appears to push a viewpoint in which HEIs must necessarily be multidisciplinary and large, which is unnecessarily restrictive in its vision.

In the sub-sections below, we highlight some issues of grave concern which should be completely rethought lest these end up inflicting severe damage to the HE system.

**B1. Three categories of only one kind of Higher Education Institutions (HEI) (large and multidisciplinary), including professional and vocational institutions (DNEP- P9.1, Chapter 10, pages 211-215 esp. P10.1, 10.3, Chapter 11, 16):**

In a fairly radical move, the DNPEP envisages a massive restructuring of the types of HEIs in the country. In this policy, all HEIs, including those focussing on professional or vocational education, are mandated to become large (> 5000 students) multidisciplinary (> two programmes or majors in the arts and humanities, and in science and mathematics, and at least one in the social sciences) by the year 2030 (DNEP- P10.3),
or face closure (DNEP- P10.14). While we agree that the option of a multidisciplinary, liberal arts education should be encouraged and be made available, it is also important to cater to students who may wish for a more narrowly specialized HE. In the spirit of flexibility in choosing courses (DNEP- Chapter 11), we believe it is best to also have a diversity of HEIs, ranging from the broad/large to the specialized/small, that students can choose from. Consequently, we urge that this proposal of only one kind of HEI (with 3 Types) be dropped entirely from the DNEP, for the following reasons.

- The proposed distinction between Research Universities, Teaching Universities and Teaching Colleges (DNEP- P10.3) is arbitrary and confusing. Labelling them as Type 1, 2 and 3 (DNEP- P10.3) further suggests a hierarchy of quality and, thus, will perpetuate the damaging distinction like the one we already have between the research institutes and universities.

- The DNEP prescriptions in this regard also appear to be contradictory: on the one hand we have the designation of Research versus Teaching Universities and Colleges and, on the other hand, the document states that “the categorisation of HEIs into these three 'Types' is not in any natural way a sharp, exclusionary categorisation, but is along a continuum” (DNEP-P10.3). Since faculty in the ‘Teaching’ Universities are also expected to engage in research, and vice versa, the categorization of ‘Teaching University’ and ‘Research University’
is uncalled for. This distinction runs counter to the basic concept of a University.

- A stand-alone college with only under-graduate teaching, and no research, also serves no purpose beyond what is already a current practice.

- The DNEP is not clear about fates of existing universities narrowly focussed on languages, sports, energy etc. DNEP itself recommends a National Institute for Pali, Persian and Prakrit, and states that only such “institutes supporting language programmes will be affiliated with and preferably located in universities” (DNEP- P22.4). Whether all such institutes with a narrow focus will be ‘stand-alone’ or be made parts of other full-fledged universities is not clear.

- Similar confusion also remains as to the future of research institutions, mostly funded by the Central Government (e.g. CSIR labs, IISc., TIFR, JNCASR, RRI, IIAS, IISTEP, NIAS, HBNI, PRL, CCMB, BSIP, WIHG, AcCSIR etc.). The DNEP (P.10.7) envisages all these institutions becoming Type 1 HEIs, which is clearly impossible for most, if not all, of them. In the next paragraph of the same section, it is recognized that research institutions may not be able to become Type 1 HEIs, and it is suggested that such institutes “may choose not to grow into Type 1 institutions, and should instead closely align and work with proximate Type 1 or 2 institutions for engaging their own faculty in adequate teaching and mentoring opportunities”, (DNEP- P.10.7). It is also
not clear what HEI status these research institutions would then have. Moreover, while the goal of utilizing faculty at such research institutes in teaching/mentoring at nearby universities is laudable, and should be encouraged, it should not be mandated.

- A similar problem will be presented by numerous small, often discipline-specific colleges affiliated to some of the better universities in the country. Many of these colleges provide excellent education, while not fulfilling the definitions of “large” and “multidisciplinary” as laid down in the DNEP (P10.3). It is imperative that such institutions be allowed to retain their character.

- While we welcome the principle of integrating vocational education at all levels from school to HE (DNEP- Chapter 20, esp. P20.1, P20.3 and P20.4), the proposed phasing out of all single-stream HEIs, including those offering professional/vocational courses (DNEP- P9.1, P10.1d, P10.3), is undesirable and can lead to serious disruption of existing professional education, especially in agriculture, medicine and engineering streams, and only slightly less in the case of law and management. As in the case of research institutions, it is hard to envisage AIIMS, IARI, Law School Universities, IITs or IIMs (let alone smaller professional institutions), becoming multidisciplinary HEIs (as envisaged in DNEP P16.1.1), raising serious questions as to their fate under the DNEP’s proposals. The suggestion that
professional councils (e.g. NCTE, AICTE, MCI, BCI etc.) be kept out of policymaking for professional education (DNEP- pages 293-296, Chapter 16, P18.3.1) is also not well conceived and will prove detrimental. Professional education, unlike a general liberal arts or scholarly education, is specifically oriented towards serving the specialized needs of important sectors like agriculture, medicine, engineering, law and management. As such, it is crucial that professional bodies have a large stake and say in policy making for academic training in these sectors. To transfer this responsibility solely to HEIs would be counter-productive.

- The prescriptions of the DNEP about professional education are also in parts contradictory and confusing. On the one hand, it suggests that professional education be completely incorporated into the envisaged large multidisciplinary HEIs (DNEP- P11.3.1), but on the other, it mentions “tight collaboration between HEIs and different professional institutions” (DNEP- P16.3.1), and also talks about setting up new agricultural universities (DNEP-P16.6.2).

Our suggestions in this specific context of the proposal to have three types of HEIs are:

- There should be three categories of HEIs, namely, Colleges, Autonomous Colleges and Universities. Colleges will primarily be teaching institutions (UG/PG) affiliated to a given university.
Autonomous colleges will be independent in their faculty appointments, curriculum design, examination and the award of degrees. Universities can be public, private, or private-aided categories. Conversion of existing colleges to autonomous college must be selective on basis of their infrastructure, quality of faculty, academic strengths and competence. If such colleges are to provide their own degrees, other laws that provide for only a duly ‘recognized’ university to be eligible for issuing a degree, would need appropriate statutory changes.

- Those colleges which are found to be below the threshold may be initially affiliated with neighbouring universities with a possibility of becoming autonomous when they cross the threshold.

- The practice of affiliating non-autonomous colleges to universities should be allowed to continue (contra DNEP- P10.14a). Affiliation offers a degree of control over academic standards. All affiliated colleges may not be able to transform themselves into Type 2 or 3 HEIs, as envisaged in DNEP. This should not be a reason to do away with them. What is needed is a strengthening of the affiliation system, especially in State universities, by ensuring that (i) Universities should not in general have more than 100-200 affiliated colleges; (ii) based on their quality and disciplinary diversity, large colleges should be encouraged to become autonomous; and (iii) appropriate statutory changes in the governance of the university may be made so that the governance of the university and its departments are not overly
influenced by affiliated colleges and the appointments in these are based purely on academic merit.

- **Research should not be made mandatory in colleges, but should be encouraged**, especially if the college also offers postgraduate courses.

- **Research institutes and professional institutions should be permitted to remain at their chosen size and level of specialization.** Those among such institutions that wish to enlarge themselves to multidisciplinary HEIs may be encouraged to do so, but this should not be made mandatory, Similarly, involvement of faculty from such institutions in teaching/mentoring at nearby universities can be encouraged, recognized and rewarded appropriately, but should also not be made mandatory. Research institutes that are Deemed-to-Be-Universities should be permitted to continue issuing their degrees.

- **Both teaching and research are important for universities. However, emphasis on each activity may vary between Universities.** Therefore, appointments and promotions should be judiciously based on assessing a combination of research, pedagogy and mentoring, as also stressed in DNEP- P9.5.

- We welcome the idea of Missions Nalanda and Takshshila. We suggest that the mission Nalanda be given relative priority without making any distinction whatsoever between institutions (e.g. HEI type 1, 2 as in DNEP).
B2. The freedom sought to be given to private HEIs offering professional courses to set their own fee structure (DNEP-P16.5.1) is unjustified. Moreover, the condition that private HEIs must offer scholarships to half their student population should not result in the fees for the other half being sharply increased: this aspect needs to be adequately regulated. A serious auditing of their fee-structure, salaries paid to teachers and other staff, and the learning outcome should be mandatory for private HEIs. Indeed, as suggested for private schools (DNEP-P8.3.6 and P8.3.7), private HEIs – professional or otherwise – may also be required to function as not-for-profit organizations, with oversight of fee structures by an appropriate body of the State or Central government.

B3. Mentoring of faculty by active but superannuated scholars (DNEP-P13.1.9 and P14.3.1): can be useful, but this would require extreme care to ensure that the scholar so chosen had enough experience, and proven teaching abilities, during a scholar’s regular career to undertake such a role. Expertise available with the National Academies could be harnessed for mentoring and monitoring of institutional-quality roles.

B4. Legal education and curricula should adhere to law as enshrined in the Indian Constitution and legal statutes, and not be
directed towards the “culture and traditions of people”, as suggested in the DNEP (P.16.7). An appeal to “traditions” and “mythology” has no place in the legal education policy of a democratic nation.

It is a concern that although the DNEP mentions the Constitution multiple times in different chapters, and also lists constitutional values (e.g. P11.1.2, ‘secularism’ is not mentioned as a constitutional value despite being in the very definition of our Republic!

B5. Redefining B.Ed. courses for training of school teachers (DNEP-Chapter 15): A large fraction of the specialised B.Ed. colleges are indeed of dubious quality and need to be restructured or shut down, if they cannot improve in a reasonable time-frame (DNEP- P15.1.1). The proposed rigorous monitoring of teacher education (DNEP- P15.1.2) is also welcome, as is the “creation of substantial new teacher preparation capacity” (DNEP- P15.2.3).

There are, however, some drawbacks to the proposal for the 4-year B. Ed. integrated programme to become the minimal degree qualification for school teachers (DNEP- P5.5.1, P15.2.1). This 4-year B. Ed. is proposed to be offered only in multidisciplinary HEIs as a dual-major liberal Bachelor's degree, in education as well as another academic subject (DNEP- P15.2.1). In addition, a post-B.Sc. 2-year B. Ed. (DNEP-P5.5.2) and special and more individualised B.Ed. programmes for “unusually highly qualified individuals, with demonstrated experience and disposition towards teaching” have been suggested. (DNEP-
P15.2.1). We have several concerns, as noted below, with these proposals.

- As these programs are of different durations, their relative importance for teaching and hiring needs to be defined. Further, the relationship of these programs in terms of different levels of school education needs to be clarified.

- A graduate of a 4-year B.Ed. programme with a major in say History or Mathematics would have learnt too little a component of the major to be competitively eligible for a Master’s degree in that subject. Thus, anybody pursuing such a 4-year integrated B. Ed. programme would be severely restricted in choice of future profession, and, indeed future studies. Should we ask an 18-year youth to commit to a teaching career? It should be realised that for a variety of social and economic reasons, a school-teaching job is rarely the first-choice as a profession in India. Unless this aspect is adequately addressed to and improved upon, the 4-year B. Ed. may not attract the best of students and this would further reduce the quality of those qualified to teach.

- Therefore, introduction of 4 year B.Ed. program, is not desirable.

- Our suggestion is that a two- or one-year B.Ed. Program should be available for those who have completed a 3-year or 4-year Bachelor’s program, respectively, instead of a four-year integrated B.Ed. programme. Moreover, it may not be practical for all teacher training institutions to become multidisciplinary HEIs (DNep-
P15.2.4), even though they may be of high quality and, therefore, they do not warrant their shutting down. There should be an option for high quality teacher training institutions to continue and offer the post-B.Sc. options in B.Ed. courses, alongside such courses offered by multidisciplinary HEIs.

- The proposal to provide a large number of merit-based scholarships for those opting for B.Ed. Programmes (DNEP-P5.5.1) is welcome. However, these should primarily be based on merit, rather than rural or urban background and should eventually lead to respectable jobs with commensurate remunerations.

**B6. Availability of manpower**

- The proportion of vacant positions in various HEIs in the country is indeed alarming (DNEP- Chapter 15, page 256). The proposed massive increase in numbers of HEIs in coming years would aggravate this shortage unless adequate steps are taken to identify and appoint competent faculty at various levels. The current practice of postponing faculty selections and making bulk appointments at one time, based on cursory interviews, is counter-productive. NEP must ensure continuous faculty renewal following the best practices that are adopted at some of the better institutions in the country. The current practice of seeking re-
approval to fill a sanctioned post that has remained unfilled must be discarded. A sanctioned post must remain available for ever.

- **Appointment of contractual/ad-hoc faculty compromises competence and efficiency and this practice should be phased out at the earliest.**

- Salary of faculty and their working conditions/environment must attract the best talent in the country to teaching and research in universities and colleges rather than making them look for ‘greener pastures’ elsewhere. The infrastructure at colleges and universities should be conducive for their academic growth. *Minimum salaries at all institutions - private or public, research institute or university - should be at par.*

- **A five-year tenure track system for faculty recruitment in HEIs (P13.1.6) is not a good option in the Indian context.** Unlike in the USA, in India, it is difficult for faculty not making tenure at one institution after 5 years to get a job elsewhere due to age-limits and perceived stigma. The stress and burnout of this system in India falls disproportionally on young women faculty who are often starting their families at that time. *The existing one-year (extendable to 18 months) faculty probation system is most suited to the Indian scenario and should be continued, with due attention given at the initial hiring stage to ensure that good candidates are being chosen, free of extraneous considerations. A five-year tenure*
track system can be permitted as an option for some institutions, upon strong justification, but it should not be made the norm.

- A system of periodic assessment for faculty’s academic performance (mentoring, teaching, outreach, and research) should be developed to identify non-performers. A transparent mechanism should be put in place to remove such individuals.

- One of the hurdles that make the universities and colleges less attractive for competent faculty is the generally poor capabilities of the non-teaching and supporting staff. The non-teaching staffs also need careful selection, and they should have avenues for good and continuous training to improve their work-culture and efficiency.

- The DNEP document is not clear about fate of the large number of existing institutions with poor infrastructure and teachers who are not adequately trained or motivated. Will such existing institutions be upgraded and will the teachers be retrained? Appropriate mechanisms need to be evolved to improve or to close such institutions and terminate the services of less competent faculty, keeping the interests of students in mind. Careful and transparent systems to achieve this will be needed.

- Towards this projection of national requirements of manpower and teachers on a short and medium term basis is needed.

- The large increase in student intake mandated periodically by governments, without taking into account the lack of
infrastructure and teaching manpower, has contributed substantially to the deteriorating standards of students who are declared ‘qualified’. Any further such ‘growth’, without first creating the required infrastructure and teacher strength would only result in ‘producing’ more poorly -trained and unemployable individuals.

- Ad hoc announcements for new courses and institutions for non-academic expediencies should be replaced with a proper structured analysis by a set of experts, who will examine all aspects of the viability of new courses/institutions in both public and private domains. The National Science Academies will be willing to provide relevant services from experts.

B7. Continuous professional development of teachers through refresher-type courses etc. (DNEP- Chapter 5, pages 116 and 119, P5.3.1, P5.3.2, P15.3- paragraph2, page 288, P15.3.1)

- All faculty members need opportunities to continuously enhance their knowledge base and pedagogical skills. The idea of universities running refresher-type courses for teachers is a forward-looking step. However, the current scheme of Refresher Courses at some Universities, through initiated with good intentions, has deteriorated considerably due to lack of proper monitoring and auditing. Such Refresher Courses need to be re-
energized and enhanced, and be subjected to proper monitoring and auditing.

- The National Science Academies have been conducting high-quality refresher courses for university and college science teachers for many years. The Universities and other Academies could draw from this experience, and these can be strengthened further with enhanced resource allocations to the Academies.

B8. Research component in all universities and colleges (DNEP-P11.4 and Chapter 14): Given the large number of students in a typical Bachelor’s or Master’s class, it is impractical to demand that all or even a large fraction of them actually engage in research.

- Such a move has resulted in rampant plagiarism, without generating the expected ‘curiosity’ in young minds. This will also put an end to the undesirable practice of sending students en masse to other academic institutions to complete curriculum-mandated research paper at UG/PG level. Opportunities for working on a research project at UG/PG level should be provided only to those who are genuinely interested and competent and in institutions, where appropriate facilities exist.

- In order to generate and strengthen analytical ability, the pedagogical methods need to be changed so that students do not receive only ‘knowledge’ in class room but also learn and develop good concepts. The summer training/visitor-ship programs for
college students and teachers run by the academies and some institutions could be strengthened and used. In exceptional cases, the flexibility of working towards the research project at reputed research institutes may be retained.

- **While research by faculty and students alike needs to be encouraged, research should not be trivialized.** Given the size of its university populace, India is not behind in the quantity of research, but in terms of quality, it lags far behind. *It is not necessary to consider China as a model but there is for certain, a room to learn from others.*

- **Government should not mandate the topics of research to be carried out by individuals at HEIs (as envisaged in DNEP-P11.4.2d).** Government may suggest thrust areas of societal importance when working on funded national mission-mode projects. *However, it should not attempt to mandate areas for basic research which is key to future development.* The usefulness of basic knowledge in the long term should in no way be underestimated.

**B9. Curricula at HEIs (DNEP- Chapters 11 and 12):** The proposed 4-year Bachelor’s programme is in tune with an earlier proposal of the Science Academies. In light of the earlier proposal, instead of having separate 3 and 4-year Bachelor’s programs (DNEP- Chapter 11 page 227), we suggest a Bachelor’s program of 4-years duration, with the
possibility of exit after 3 years with a general Bachelor’s degree, while those who continue and successfully complete the 4th year, receive a Bachelor’s degree with Honours/Major. Generally, only a small proportion of those pursuing Bachelor’s courses are really competent or interested to take up higher studies for academic careers. The proposed Honours and General degrees at Bachelor’s level would help students in choosing the next level of their career and would also help in reducing the burden of uninterested students at higher levels.

• We endorse the suggestions of the DNEP (P11.5.1) regarding multiple options for Master’s programs, and phasing out of the M. Phil. degree. A two-year Master’s program should be available for those who complete the 3-year Bachelor program but later wish to continue for a Master’s degree. Those completing the 4-year Bachelor programme may directly join a PhD program, if they so desire. They may also have the possibility of exit after one year of course work with a Master’s degree.

• Teaching and learning at all levels should be geared to helping students in developing self-learning abilities, find innovative and sustainable solutions to local problems (local, societal, professional) using globally accepted/validated knowledge, as envisaged in the DNEP (P11.1.1, P11.1.2, P12.1.4 and P12.1.5). It should also be ensured that curricula include training on how to distinguish between reliable and dubious information from the
internet. This will require changes in curriculum, examination system and pedagogy.

- **A one-size-fits-all approach for defining curricula must be avoided.** While broad definitions about the learning outcome should be defined by the regulatory bodies like UGC etc., details must be left to individuals HEIs for defining curricula keeping in view the local requirements, faculty strengths and competence, as also indicated in the DNEP (P12.1.1).

- Emphasis on marks or grades at MCQ based entrance being the sole criteria to enter the HEIs (including medical and engineering institutions) has been a disincentive for students to learn anything outside his/her main interest, and encourages proliferation of coaching and tutorial classes. *Entrance to HEIs should be based on a more holistic assessment that also includes critical thinking and writing abilities etc.*

- A key issue for the nation is and will be the employability of students and redeploy ability through training of people in view of increasing pace of change in technologies. *The education system should provide for such training, as also suggested in the DNEP (P19.7.3).*

- **Massive Online Open Courses (MOOC):** The DNEP (P12.3) sets great store on O.D.L. and MOOC. However, these categories of learning systems cannot completely replace in-class teaching since teacher-student contact is an indispensable part of
education. It would be a rare MOOC that may replace a good teacher, or even a good set of textbooks. Moreover, the standard of a very large fraction of the currently available MOOC is not up to the mark. Therefore, the DNEP (P12.3.12) correctly emphasizes the need for a substantial review and improvement in quality of these e-learning materials. *In general, however, MOOC and e-Pathshala courses should at best be used as supplements to in-class teaching.*

- **The National Knowledge Network, which is surprisingly not mentioned in the DNEP, has provided a significant number of tools to teachers and students. These activities must be further strengthened.**

**B10. Transforming the regulatory system (DNEP- Chapter 18):** The DNEP suggests creation of several new regulatory bodies, either as a replacement of existing ones or to be set up de novo. Justifications for these suggestions, and the utility of the proposed new bodies are not clear (DNEP- P18.4). It needs to be emphasized that mere creation of a new body does not solve the issues arising from the suboptimal functioning of the existing one. We note our serious concerns about this in the following:

- The advantage of replacing UGC with NHERA (DNEP- P18.1.2 and P18.1.4) is not clear. The DNEP also does not make it clear if the proposed HEGC would function independent of NHERA. A
proliferation of separate bodies in charge of different aspects of HE governance and funding will likely be disruptive to their efficient functioning.

- The UGC system must be revamped to get rid of its inefficiencies, and modify its extremely bureaucratic setup.

- Academic matters are best handled by academicians with proven track records and there is a need to revisit and implement several of the recommendations of Kothari Commission.

- We believe that the various existing bodies (UGC, AICTE etc.) should continue with establishment of an inter-council/commission coordination body. The proposed General Education Council (GEC) comprising active academicians, can function as the coordination and advisory body for the various councils rather than becoming a 'super-manager'. The science academies can assist with this process.

- As was stated by the National Science Academies in reference to the earlier proposal to replace UGC with HECI, we reiterate that the existing UGC system be strengthened by ensuring that the UGC Act and the academic autonomy of higher education institutions are implemented in letter and spirit. Functional autonomy buttressed with generous and optimal funding, and the timely release of funds, will facilitate administrative and regulatory procedures and help ensure excellence in HE.
B11. National Research Foundation and financial outlay

- The proposed significant increase in research funding is a welcome idea since Indian researchers have been lacking this level of investment so far. However, the advantages of creating a new funding body, the NRF, are not clear since the scope and charter of NRF is somewhat similar to what was envisaged when SERB was created. Unfortunately, the SERB has got significantly diluted from its original vision. Therefore, instead of creating one more agency, it would be better to expand and strengthen SERB, as also the other existing agencies.

- The budget statement a few days ago, does not resonate with the statement on NRF. The NRF in the budget and that in the DNEP do not look the same. Therefore, a clarity on the reason, the role, the scope, the areas of activities and the funding of NRF is needed. Further its relationship with other sources funding would need clear elucidation.

- Bringing all funding streams under a single monolithic umbrella is fraught with problems. For example, normally no funding agency supports more than one project to any individual researcher. Most of the active experimentalists, therefore, approach and get supported by different funding agencies to work on multiple questions at any given time. A single funding agency will severely restrict such options, assuming that this funding agency will not fund more than one project at any point of
time. Multiple funding opportunities need to be provided to good researchers in the country, who are likely to generate testable hypotheses during the conduct of a project and must be financially supported to carry out work to test these hypotheses.

- **We suggest that, while increasing the funding allocation to SERB and other agencies should be strengthened. Specifically, separate agencies should be created and/or the existing ones strengthened for funding major projects in humanities and social sciences. The STRIDE scheme recently launched by UGC can also be provided with enhanced financial outlay so that inter-disciplinary research involving social sciences etc. gets adequately supported.**

- **There is a dire need to enhance support to faculty members for participation in conferences (in India and abroad) and for unhindered and timely access to literature.**

- **A robust and a functional system for open access to literature to all is direly needed for teachers to update themselves on a regular basis.**

- **DNEP proposes recognition of truly outstanding research through a system of awards. This is a welcome step to encourage teachers. It may however be mentioned that already a plethora of awards for excellence exist in the country and it will be desirable that a system is created that multiple recognition of same individuals in avoided. We also suggest that these awards should be tailored towards providing substantial research/
teaching funding to the awardees, should be available at all age levels, more at younger ages, and be sufficient in number so that no competent teacher/researcher is left out.

- The DNEP proposes that it would secure funds for its corpus also through donations from industry. *We suggest that such private funding should also be available directly to the faculty/institutions on a competitive basis. A certain fraction of the CSR from industry be ear marked for such a corpus fund on a non-lapsable manner.*

**B12. Evaluating institutions: accreditation (DNEP- P18.2):** The DNEP proposes a binary i.e. Yes/No grading by NAAC after the year 2030, with all HEIs not getting accreditation being required to “cease operations” (DNEP- P18.2.1). This may not serve the basic purpose of NAAC grading which, besides providing accreditation, also helps funders and students to assess the overall academic ranking and strengths/weaknesses of an HEI. *Evaluation by NAAC is designed to help HEIs identify shortcomings and rectify them, rather than to simply be a binary judgement about whether the HEI should continue functioning as is or be shut down. The role of NAAC as a mentor should also be developed.*

*A more nuanced evaluation by NAAC will be:*

- A - meaning ‘Good’, to be encouraged with more freedom, funds, etc,
- B - meaning ‘Satisfactory’, to be encouraged with more funds, etc.
C - meaning ‘Unsatisfactory’, to be given a fixed time to improve or else risk being shut down following re-evaluation.

D - meaning ‘Poor’, to be shut down as soon as possible.

As of now, the NAAC criteria and methodology for grading are extremely rigid and of a one-size-fits-all type. For example, The Tata Institute of Fundamental Research was penalized for not having an anti-ragging committee! Obviously the criteria and methodology for assessing the varied kinds of HEI need to have a reasonable degree of context-dependent flexibility.

**B13. Common Exit Examination for MBBS (DNEP- P16.8.3):** The proposed mandatory common exit examination for MBBS, and other disciplines is highly undesirable because, (i) large numbers make it impractical to undertake holistic testing, which is likely to restrict the exam to MCQs as in the current national entrance tests at different levels, a practice already recognized to have led to dilution of academic quality; (ii) each medical institution must retains its local flavour in terms of expertise, regional needs etc, which cannot be examined in a ‘homogenized’ examination system; (iii) such a practice would further promote the proliferation of ‘coaching shops’, a very undesirable outcome.

*Each medical college (public or private) needs to have a requisite infrastructure for teaching, learning and hospital facilities to ensure good learning and conduct its own examination.*
We also recommend that MD-Ph.D. programmes should be encouraged and formalized so that bio-medical and clinical research develops in the country.

B14. Evaluating faculty & emoluments (DNEP- Chapter 13):
Inclusion of more levels in a faculty cadre (DNEP- P13.1 page 258) may appear useful in terms of faster promotion; however, it runs a greater risk of promoting more corruption, sycophancy and politics in the life of a faculty member. As stated elsewhere in the same chapter of the DNEP (P13.1.10), there should be three levels in the teaching cadre, viz., Assistant Professor, Associate Professor and Professor, with the fourth level of HAG Professor, as applicable. After a certain number of years (optimally 5), a faculty member in one level may be assessed for promotion to a higher level. Some upgradation within a level may be automatic after a prescribed number of years of service in that level, unless there are complaints or evidence based issues against the faculty member concerned.

- Currently, the salary of an Assistant Professor at Universities and UG colleges is lower than that of a counterpart at research institutions/IITs/IISERs etc. Only at Associate Professor (after 12 years of service) level do they become comparable in terms of salary. Such discrepancies have led to a “class system”, with attendant resentment, within the HE system, and need to be corrected.
• **Endowed Chairs may be created for distinguished Professors.** The few endowed Chairs, to be created everywhere, should come with a grant for research, secretarial help etc. The occupancy of such a chair could be either until superannuation or for a fixed term. Private donors should be encouraged to endow such Chairs across the country as a part of their CSR.

C. **Other Issues**

C1. **Technology in education (DNEP- Chapter 19):**
There is no doubt that technology should be leveraged for both academic and governance aspects of education. This proposition has long been well accepted in the academic community. Generally, the role of technology should be more as a supplement to sound pedagogic practices, rather than replacement. Where technology does largely help is in extending the reach of education to the differently abled, or to those living in remote locations, or those outside the formal system. Large parts of this chapter's contents pertain to broad policy regarding the future of some technologies in education governance, with only a few policies pertaining to role of technology in education per se.

• The purpose of the proposed NETF, partly to be funded by NASSCOM (DNEP- P19.1), to create an industry-linked, over-arching and centralized body, remains unclear in respect of its relevance to education. It will also have access to a lot of data of students, teachers and institutions at all education levels.
nationwide, which raises serious concerns about privacy that are not adequately dealt with in the DNEP (Chapter 19, page 342, last paragraph). The proposal for a body with such a broad mandate as the proposed NETF needs to be strongly justified before its creation can be supported. Presently no clear justification is provided. We feel that inputs from the IT-sector for guidance/suggestions on education technology research and deployment, especially in areas like automation, can directly be provided to the apex bodies managing education in each state through existing mechanisms. Further, AI and cloud technologies, their role in pedagogy and in the improvement of the quality of students in a country with a vast canvass of varied cultural and educational levels and systems may need to be discussed extensively before their inclusion in the education policy.

- The proposed NRED (DNEP- P19.5.5 and P19.6.1), will collect very detailed data and academic records on all students/teachers/institutions from school to HEIs. However, the purpose of such detailed collection of personal data has not been clarified. Unless the purpose is made clear, we cannot support such collection of deep personal data. Collection of such concentration of data, especially given its potential linkage to Aadhar No. (DNEP- P19.6.1b), its integration with data on “educational information management systems for community
monitoring” (DNEP- P19.6.2), and the statement that “Data is a key fuel for artificial intelligence based technologies”), cannot be supported, especially because there are many examples of misuse of personal data. Explanation of mechanisms to protect privacy must be explicitly stated. (DNEP- P19.7.4). This aspect also needs careful legal scrutiny in view of recent observations of the Supreme Court of India in respect of issues of privacy of individuals.

- This proposal is therefore not desirable in its present form. If there is to be a database set up for governance and planning purposes, it should be restricted to institution-level information about enrolment, teacher strength, number of courses etc., and should not include data at the individual-level.

- Some of the recommendations about technology in education (DNEP- P19.2.1, P19.2.2, P19.2.3, P19.3.1, P19.3.3, P19.4.1c, P19.4.2, P19.4.3, P19.4.4, P19.4.6a, P19.5.2 and P19.5.3) may be moved to other appropriate sections of the DNEP document.

- In sum, the proposals made in Chapter 19 need much greater elaboration and justification to show their relevance to education policy. Until these are provided, we recommend that these proposals not be immediately implemented as a part of the NEP.
C2. Annual outlay by the government on education (DNEP- A1.4): The DNEP gives an estimate of the annual expenditure under different heads as a % of the annual expenditure of the Government. In addition, however, a realistic assessment/planning can only be done if some actual estimates of year-wise expenditure under different heads are also made available and mechanism and accountability be brought in to ensure there are no delays at the disbursal level.

C3. School education is the foundation for a satisfactorily productive career of an individual: Therefore, the public schools, which cater to a major proportion of the country’s rapidly growing population, need much greater attention in terms of financial outlay and adequate administrative support and incentivization of teachers. A basic minimum wage for teachers at all levels must exist and be linked to inflation, such that there is automatic revision.

C4. Fees in Governmental HEIs: Fee structures in all central/state universities and institutions need a rational review so that not only the availability of resources and infrastructure can be improved, but only those seriously interested would come for higher education.

C5. Current emphasis on development of buildings and physical infrastructure be shifted to favour improved facilities for research
and teaching. For example, if the institutions work in two to three shifts, the effective size of infrastructure at each institution is automatically doubled/trebled.

C6. Governance of all institutions of learning (school to HEI) must be free of all non-academic influence and interference, and relatively autonomous, as stressed in DNEP- Chapter 17. In particular, appointments of Vice-Chancellors/Directors for HEIs must be based only on considerations of academic excellence and proven administrative capability, as stressed in DNEP- Chapter 17, page 310 last paragraph. Such leaders should be selected by a national board that comprises only academicians. Implementation of the recommendations of the Kothari Commission about who should be a Vice Chancellor is strongly urged.

Repeated references to the role of persons of high “eminence” in the leadership of HEIs (DNEP- P17.1 page 311 paragraph 1, P17.1.1 and P17.1.3) should clarify that these need to be only the people eminent in the field of education/academics. Otherwise, this may become a means for non-academic-academicians to occupy high positions in the governance of HEIs, which is not at all desirable. Similarly, emphasis on “leadership and management capacities” (DNEP- P17.1.10 paragraph 4) should not become a means to introducing non-academicians into leadership roles in HEIs.
C7. New research institutes should be planned and initiated with close academic linkages to existing universities, such that the existing disparity between universities and research institutes can be gradually minimized.

C8. The semester system should be re-visited to identify problems in its delivery and implementation. The current model of semester education is often inadequate, especially due to the severe shortage of teachers and teaching assistants required for effective transmission of knowledge and skills in such a model of HE. There is a need to rethink patterns of evaluation, with emphasis on testing concepts, analytical ability and power of expression rather than short-term memory. It is necessary to have an in-depth discussion to consider better ways of implementing the semester system.

C9. Establishment of an apex body like the proposed Rashtriya Siksha Aayog (National Education Commission), with the Prime Minister as its Chairman and four Ministers and senior bureaucrats constituting 50% of its members (DNEP- Chapter 23), is undesirable. This would bring education under heavily centralized political control. While it is desirable to have a body coordinating the activities of existing bodies pertinent to education at various levels, it must be recognized that school education, higher education and professional education are very different and specific domains. As such,
relevant existing bodies in each of these domains need to be strengthened and governed largely by domain experts, rather than bureaucrats. Any Aayog/Committee created for coordination among bodies looking after diverse aspects of education must be an autonomous public body, independent of the government, and primarily comprising of educationists and academicians of proven academic record and probity. The CABE under the MHRD could be considered for such a role, but it would need to be headed by academicians of high repute.

C10. Given the severe challenge posed to national well-being by unrestrained population growth, it is desirable to leverage education at all levels from school to HE to facilitate reduction in population growth rates, as has already happened in some of the States with relatively high literacy. Similarly, even to achieve the desired level of quality in learning experience, the growing population needs to be controlled for the proposed changes in the education system to be truly and widely effective.

Finally, the DNEP may also provide clear road map and definitive time lines for implementation, as in the end, howsoever noble the intentions may be, the success of any such effort is determined only by the competency of its implementation.
Selected articles from Confluence

(An editorially moderated discussion forum)
Educational Potential of Students’ Movements

GAUHAR RAZA

Protest, Student

Posted December 26, 2019

Summary

Should students take part in political protests? Some people think yes, others disagree. But why this difference of opinion and what might happen when students take part in such protests? Gauhar Raza examines the issue and feels that “When students come out on streets, their banking system of education gets disrupted and they are likely to acquire the ability to become catalysts for social change and, more importantly, question the balance of power.”

Full Article

‘The worst illiterate is the political illiterate, he doesn’t hear, doesn’t speak, nor participates in the political events.’

– Bertolt Brecht

My first memory of someone telling me ‘You should study, do not indulge in activities that may jeopardize your future’ goes back to school days. When I was in class 6th, a very respected teacher, referring to an ongoing agitation in AMU Aligarh, said, ‘Politics is a bad thing, you should not indulge in it, focus on your studies. You can do politics when you grow up’. The conversation took place in Urdu language and he repeatedly used the word ‘siyasat’, which I did not understand. I asked my father ‘What is siyasat (politics)?’ My father replied, ‘Politics is a form of education that makes you a citizen. Good and responsible politics makes you a good citizen, bad and irresponsible politics makes you a bad citizen’. Since then, I have heard this assertion probably millions of times, obviously not always directed towards me. During a personal conversation, the words chosen by the...
adviser are a function of the age the listener. For example, when you are a student, the teacher will say ‘You are a student complete your education, then you can participate in politics’. If you are unemployed, then the argument is ‘Seek a job first, once you get it you can do politics’. If you are employed, then you are told ‘Don’t indulge in politics, you may lose your job, or the conduct rules don’t permit it’. When you are married and have a family, they tell you ‘Don’t indulge in politics, you have responsibility towards your family’. And finally, when you are old, they tell you ‘You are old and sick, look after your health, why are you indulging in politics’? The moral of the story is that they do not ever want you to get educated in politics which shapes the society, the nation and the whole of humanity.

Those who say that ‘Students should not indulge in politics’, can be divided into two categories. In the first category, we can put all those who use this position for ‘political’ purposes. And secondly, there are those who have a very narrow vision and skewed definitions of citizenship, politics and education. For the latter category, education is only a tool to secure a job, politics, as opposed to education, is a route that leads to political leadership, and citizenship is limited to an act of casting one’s vote, preferably only after five years. Let me deal with the second category first.

Education for a majority of people is limited to what Paulo Freire, the Brazilian educationist, calls the ‘Banking Model of Education’. The teachers must deposit ‘information’ into students, for which, either society or parents have paid, and students must receive the information passively, for the simple reason that it is a commodity which has been paid for. Freire aptly describes the impact of such an education when he says ‘It is not surprising that the banking concept of education regards men as adaptable, manageable beings. The more students work at storing the deposits entrusted to them, the less they develop the critical consciousness which would result from their intervention in the world as transformers of that world. The more completely they accept the passive role imposed on them, the more they tend simply to adapt to the world as it is and to the fragmented view of reality deposited in them’ (Freire 1996). Most of us are happy with the results. The system, sometimes efficiently, but more often inefficiently, produces docile doctors, engineers, managers, historians, sociologists, economists, workers, mechanics, etc., who ‘adapt to the world as it is’. The degrees given away are a proof of passivity and submissiveness of the citizen shaped through this pedagogic modus operandi. Those who are in favour of this system of education develop extreme ‘cognitive dissonance’ when students indulge in any activity that may convert them into active agents of transformation of the social order that they live in.

The recent protests by students in universities across India has, once again, unsettled this section of the society. They are worried about the educative, disruptive and transformative nature of participation in a protest. When students come out on streets, their banking system of education gets disrupted and they are likely to acquire the ability to become catalysts for social change and, more importantly, question the balance of power. The danger that the students may thus become political and thinking beings permanently is far more unsettling. The consequent perception of ‘permanent damage’ caused by a protest
forces this section of the society to vehemently oppose participation of students in politics. The old arguments are resurrected: ‘Students should not indulge in politics, their duty is to study, universities should not be converted into centres of political activities, politics is a dirty game student must keep away from it, etc.’

Ironically, most members of this section of society never tire of lauding all major student movements that have had significant impact across the world, about which they have read in school or college. The Vietnam War Movement in USA, the Occupy Universities Movement in France, the Anti-Pinochet Movement in Chile, and the Anti-Apartheid Movement in South Africa are but a few examples of great transformative movements in which the role of students was significant. They may also hold student leaders like Bhagat Singh, Rajguru, Sukhdev, Dhanvantri and Ehsan Ilahi, in high esteem and argue that the Indian freedom movement (Swadeshi-1905, Non-cooperation-1920, Quit India-1942) would not have succeeded without wider participation of students. For this section of the society, these are events of the past, fossilized into passive pieces of information, which just have exchange value. It scares them immensely when through participation in a protest, the younger generation realises a connect between the past and the present. This connect leads to exploration of their own ability to transform social reality. Bhagat Singh, Steve Biko, Patrice Lumumba, Martin Luther King Jr., come alive out of the text books and the realization dawns that we could also become ‘transformers of the world that we live in’. The banking system is so ingrained in the thought processes, that people in this category, more often than not, do not even realize that the argument ‘students should not participate in politics’ is a highly political assertion.

People in the first category, i.e., those who use the argument that students should not get involved in political issues for political purposes, are far more difficult to reckon with. They know the explosive potential of a students’ movement. They were themselves often groomed as politicians while participating in protests as students. They have followed the trajectory and have risen to positions of power, by replacing the older generation. They are fully aware that a protest may throw up new political leaders who may challenge their authority, unhinge them, or may even render them completely irrelevant. This is the category of highly motivated people, who not only propagate the idea that ‘educational institution must be free of politics’ but also actively sabotage or suppress students’ movements. They leave no stone unturned to block the political path that they themselves have followed.

A good example of this behaviour is the present students’ protest which was suddenly started by a bunch of students in Jamia Millia Islamia, New Delhi. The response of the state machinery was brutal and sharp and, instead of quenching the fire, it further inflamed students, and within a few hours, the protest spread to multiple universities across the country. Thanks to modern communication channels, international support from universities across the world also boosted the students’ confidence. They realized the educative potential of a sustained public debate and gradually prepared themselves for a prolonged struggle. Besides discussing all issues related to Citizenship Amendment Act and
National Register of Citizens, a remarkable feature of this protest is the public reading of preamble of the constitution of India, in English and regional languages, that has almost become a ritual.

The strident opposition to this protest comes from those who participated in anti-emergency protests in the 1970s as part of the JP movement, and are presently in positions of power. This category of politicians are trying to crush the dissent using state power, and have also unleashed propaganda against student participation in protest. The discourse has stooped to such a level that students are being accused of wasting public money, and their subsidized food charges and hostel fees are being shown as a proof of burden on tax payers. The political leaders in the power of position are well aware of educative resistance, it has a potential of spreading beyond the four walls of educational institutions, and therefore they are scared of it.

I was always worried that the present generation has had no opportunity to get educated beyond the four walls of educational institutions. The present movement, which has spread to many universities around the country, will surely educate them to become catalysts of social change instead of passive and submissive citizens.

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*Disclaimer: The opinions expressed within this article are the personal opinions of the author.*

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**Reference**

Perceptions of Science Built in the Science Classroom

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Posted December 30, 2019

Summary

If you went to a public place where you were surrounded by people and randomly posed the question “What is science?” or asked “Is it important to learn science?” what do you think will be the answer? In this article R Ramanujam explores this question, dwelling on how a perception of science is built up by the way people are educated in science in school. School education shapes what people believe is science and what is meant by the scientific attitude in a manner that leaves a lot to be desired, he argues. He touches upon how education needs to be looked at to address this issue.

Full Article

What the public sees as science

Some of us in Tamil Nadu Science Forum (a voluntary group committed to science communication and science education) took up an exercise in the mid-1990’s, towards understanding public attitudes to science. We would stand in crowded bus stands during peak hour, and accost people with questions like, “What is science?”, “Do you think it is important to learn science?”, “What was your experience in school?”, and even, “Given an opportunity, would you wish to learn (more) science again?” This was no research study conducted by scholars to produce an authoritative report, but genuine curiosity on our part. As science communicators, we wanted to have some first-hand experience of listening to people express their views on science. We carried this out in big cities like Chennai and
Madurai, in towns like Virudhunagar and Dindukkal and in rural areas of Sivagangai and Vellore districts. When we shared our experiences among ourselves, there were some surprises, some confirmation of our own perception of people’s thinking, but we did learn a great deal from the exercise. It greatly influenced our own approach to science communication.

From the educated public, those who had completed school education, an overwhelming majority (close to 80%) identified science with the subject taught in school. There was almost a consensus that science was important, and almost half said they had liked science in school. On the other hand, less than half expressed interest in learning any science again.

In contrast, most people who had either never been to school or dropped out of school identified science with its impact on everyday life, in terms of technological progress. (Perhaps because we were standing at bus stops, a typical example was the use of bus and train, as opposed to bullock carts in the past. Another was advances in medicine.) Rather interestingly, more among this set expressed willingness to learn science, though with an apprehension of incapacity (“Where am I going to be able to learn all that?”).

While one should be cautious about drawing generalized inferences from personal experiences such as this, it is surely pertinent to ask what perception of science does school education engender in the student. Perhaps a longer dialogue on the role of science in society would elicit a more considered response on what constitutes science. However, it is important to note that science is a compulsory subject of study in the ten-year school curriculum, and the lived experience of these (long) years does have a high impact on our reaction to the term “science”.

Stepping back from this, we need to ask: how does (school) education shape the social perception of science? How does it contribute to the public understanding of science? How influential is formal education in this regard, as opposed to culture, media, politics and other social means by which the public acquires such perceptions?

I have emphasized the school here for several reasons. For one, tertiary education has very low reach in India. For another, attitudes formed in school age are known to deeply influence adult perception as well, and they can be remarkably resilient to the impact of any acquired wisdom later.

**Expectations from policy**

The 1968 National Policy on Education of the Indian Government was the first to suggest making mathematics and science education compulsory for ten years in school. This was confirmed by the 1986 Policy on Education as well. The latter argued for strengthening science and mathematics education, because, “all areas of development are science and
technology based and for that we need experts, middle-order workers and scientifically literate citizens”. It specified how the curriculum should be designed: “Science and mathematics curriculum will be designed for the secondary level for conscious internalization of healthy work ethos. This will provide valuable manpower for economic growth as well as for ideal citizenship to live effectively in the science/technology based society”.

An interesting formulation there, and rather different from the tone one encounters in the National Curriculum Framework 2005 document. The latter says that science education should enable the learner to “acquire the skills and understand the methods and processes that lead to generation and validation of scientific knowledge”. The emphasis is on processes, i.e., experimentation, taking observations, collection of data, classification, analysis, making hypothesis, drawing inferences, and arriving at conclusions for the objective truth. It speaks of cultivating the scientific temper.

The Draft New Education Policy 2019 focuses on critical thinking as an essential aspect of science education in school. It does not spell out the processes involved, but talks about “hands on” activities that would be “fun” for the children. The DNEP talks at length about the role of technology in education, but this is delinked from science education.

How do these policy prescriptions relate to what actually happens in the science classroom? How do they relate to what the public perceives as science? Does the national education system have a clear prescription for how to translate the policy objectives into classroom experiences in such a way that education shapes the public perception of science?

**Impact of science on our lives**

At this juncture, we should also ask what impact science has had on Indian lives in these early years of the 21st century. A large section of the Indian population, perhaps a majority, in rural areas, lead lives that are largely untouched by modern science and technology. The mobile phone has penetrated deep into Indian society, but the Internet and smart phones are yet an urban and semi-urban phenomenon. Otherwise, the bus and the tractor, the medical centre and the agriculture “extension centre”, constitute their access to modernity. At personal levels, the school is the only arena that provides a formal entry into the world of science for these people. Even their view of science as the provider of modern technology and progress is limited by the few benefits that technology brings to their everyday reality.

For the urban educated sections as well as for the upwardly mobile sections from small town India, science is principally associated with school for a good reason. Their major expectation from the education system as a guarantor of secure employment, with the potential for affluence, leads them to view science education in an instrumental fashion. Thus the predilection for entry into engineering and medicine at the undergraduate level,
and a resultant pressure on performance in science (and mathematics) examinations at school level. This also results in undisguised contempt for the humanities and social sciences as “useless” among the Indian middle class. (Commerce is considered “useful” but definitely holds second place, presumably for those who cannot make it to the exalted professions.)

In recent times, an added dimension has entered this perceptual realm, one that is visible especially in southern India: that of the globalised metropolitan self. The big boom in the Information Technology (IT) sector and IT-enabled services has led many youngsters to perceive themselves as a part of the global elite, living urban metropolitan lives influenced by global norms. For these sections, and those who aspire to them, science education is a route to a specific form of modernity, one that liberates from agonising everyday Indian reality while yet providing comfortable lives by Indian standards. Once again, science education is seen as instrumental in social aspiration.

At social levels, in the realm of cultural behaviour, science has had remarkably little impact. For most people, the tenacious hold of a range of superstitions on (private and public) belief systems is not even challenged by any understanding of science. The social impact on private lives remains compartmentalised, accommodating contradictions, rather than addressing conflict in belief. There is hardly any public atmosphere of debate that posits these, or attempt to seek cultural routes to a synthesis. Recent discussions in social media in the context of the Annular Solar Eclipse (December 26, 2019) is a case in point. While there is visible interest in eclipse viewing and support for the underlying science, a vast section of the population that includes the formally educated elite continues to believe that one should not be out and about during the eclipse, lest “harmful rays” cause damage. The embargo on eating during the eclipse or the advice to pregnant women to avoid “harm due to the eclipse” is considered normal social behaviour, co-existing with compulsory science education in schools.

At political levels, the impact is even less. In general, we have little expectation of evidence based governance or policy making, and any democratic role one might expect science to play in informing public engagement with policy remains unaddressed and unfulfilled. The major questions of developmental alternatives and sustainable environment, where science can be expected to play a leading role, are decided in committee rooms where political and economic imperatives rule. There is indeed no political mechanism by which science can play such a democratic role. There are many cases in point: the public reaction to Coastal Regulation Zones, or to the Gadgil committee report on the Western Ghats, or to Genetically Modified crops, to nuclear energy, to Sterlite Copper, to hydraulic fracturing projects, to the Sethusamudram project, ..., to name only a few. These quickly degenerate into shrill support or avid protest amidst general apathy, with little reasoned debate in the public realm based on sound science.
Interestingly, the one notable impact science, especially science education, has had among the educated sections is on attitudes to the environment. We will discuss this later, but this influence on perception does have political import.

**Science in the science classroom**

Having lamented on the lack of any major impact science education has had in India, we now return to why this is so. To address this question, we need to enter the science classroom.

Here is a class where Newton’s laws of gravitation are being taught. What does that mean? Typically the statement of Newton’s laws is explained, and the children (eventually) learn these statements "by heart". In a good school, we can expect illustrations from everyday life that show these laws in action, so to speak. During examinations, children are mostly asked to state these laws. Children are unused to studying a life situation and seeking explanation for phenomena based on these laws.

Later on, equations are introduced and then the formal game takes over: getting the units right, doing the substitutions well, seeing what is given and what is asked, and solving equations.

What about the questions that are never asked by the students nor raised by the teachers, or the textbooks? Why are these called laws? How do we know they are true? What is the realm of their applicability? The book talks of balls rolling down inclined planes, but do Newton’s laws apply to living beings? (When a dog is at rest, it seems to change its state of rest and run away without any external force being applied, does this not violate Newton’s first law?) How did Newton find these laws? What did people believe about these matters before Newton?

What I am referring to here is not the absence of such philosophical explorations in class, but to the absence of any discussion at all in the science classroom. A culture of silence is death in a science classroom. Without an atmosphere of debate, there is little hope of inculcating the spirit of scientific inquiry, the scientific temper. If questioning does not become a habit in science class, it is unreasonable to expect any questioning of deeply ingrained cultural practices.

In another class, the subject matter is the boiling point of water. Every child learns that water boils at 100 degrees Celsius. A teacher might discuss the term Celsius, perhaps. Another might talk of altitudes changing the boiling point. But in how many classrooms can we expect an experiment whereby students use a laboratory thermometer to actually boil water and record the temperature at which it boils? If they did so, what is the likelihood of
their getting 100? If they did not get 100, would they raise the question of what then the textbook means by stating 100 as a fact? How is this difference negotiated?

Once again, the point is not to expect children to ask such questions necessarily, but to remark that science thrives in the negotiations stated above, it lives in these discussions. Most importantly, such experimentation emphasises the process of science, rather than its product. Lack of experimental culture robs science education of its very soul, leaving only the skeletal structure of facts for children to perceive.

The third blow to science education comes from rigid written question answer modes of assessment. The tyranny of the textbook ensures that all answers come from this fount of wisdom, and rote memorisation of textbook material is the only way to perform well in examinations. Process understanding of science stays well outside tests and exams, working with hands remains entirely outside school.

All this also means that science education has little relation to technology. Children do not perceive technology as based on sound scientific principles, harnessing conversion of energy by work. A child learning that air has weight has no opportunity to learn that it is indeed this principle that lets huge trucks be held up by small tires filled with nothing but air.

Added to all these is the problem of inadequate teacher preparation: they have little experience of doing science themselves, coming out of this very system, never having negotiated these difficulties. A college degree does not guarantee a healthy predisposition towards experimentation or any ability to carry on a classroom discussion, or provide access to material outside the school textbook. When the teacher does not interrogate the textbook, the tyranny of the textbook is perpetuated.

**Environment: a case study**

In 2003, the Supreme Court made environmental education mandatory in 28 states in order to fulfil the fundamental duties of citizens to “protect and improve the natural environment” as set out in the Indian Constitution. By now, all states have environmental education in their curriculum. Indeed, there is no subject called science at primary school, it is named environmental studies. Much of this curriculum relates to the endangerment of India’s forests and wildlife, and in recent years, threats to biodiversity are discussed as well. Thus in the last two decades, a new generation of youngsters have come of age, schooled in the basic principles of environment conservation.

Interestingly, these curricula build a narrative around saving trees, the damage done by plastic, etc that point to the realm of individual action. National and international treaties on environment conservation are also included, that offer an impression of socio-political
action. The use of fossil fuels is discussed, both in terms of non-renewability and global warming. But all these are stated as facts, with little explanation of how they were arrived at. Moreover, rarely do school curricula address the question of just why the environment continues to be degraded, when all this knowledge is available in society. While some facts are memorised without discussion and critical engagement, there is little hope of experimental verification, or projects that children may take up in their physical environment exploring these very issues in their own neighbourhood. All this results in an un-situated environmentalism, often leading to a romantic picture of “saving the earth”, without questioning one’s own lifestyle, socio-economic causes, corporate greed, governmental inaction (or corruption), and other such causes. Indeed, for a student who has never engaged with physical material and soil, has built artifacts or made things grow, attitudes to environment conservation would also be bookish.

We see such romantic environmentalism turn into anti-science and anti-technology attitudes, while tacitly accepting corporate raids on natural resources with the complicity of those in power. There are many cases in point, a particularly tragic one being the opposition to the India-based Neutrino Observatory. On the other hand, the country badly needs sustained political activism on environment, based on sound scientific understanding of our natural resources, for participation and influencing developmental debates.

The way forward

In many ways, whatever we have discussed also suggests the way forward as well. The priorities of science education need to change in the following ways:

* We need to change our classrooms to focus on the processes of science and critical discussion, rather than dole out facts.

* Experimentation must occupy a central place in science pedagogy.

* Every student must acquire facility in working with wood, metal and soil, make things with their hands.

* An understanding of technology should be integrated into science education.

* Assessment should move away from testing memory to encourage process of science.

* Teachers must be provided with a vast range of educational resources.
These are necessary, if we want to build a scientifically literate society that uses science as a tool of democracy, and for bringing a billion people out of poverty.

They are also within the realm of possibility: we lack not in ideas or ability or resources, but only in direction.

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This article is a part of the Confluence series on Perceiving and Reacting to Science.
Green Movements and Public Perception of Science

T. V. VENKATESWARAN

Public perception, Science
Posted December 5, 2019

Summary

From being seen as the panacea to all ills, scientific advances are today being seen by many as an alien legacy or a partial cure at best. Though science is still respected by many, there is a tendency to discard much of what scientists say in fields like GM crops, and other technology, even while accepting the dire prognosis made by climate scientists. How did this choice come into being. T V Venkateswaran probes these questions in an article that explores the evolution of ideas pertaining to science and the people.

Full Article

The triumphalist story of modern science has many sides. Going back to the days of Galileo and Copernicus, the manner in which ascendency of human rationality over the dogma and faith emphasised emerging scientific method as a remedy for human ignorance is one such staple tale. Vanquishing evils such as smallpox, rinderpest, diphtheria, bacterial influenza, measles, mumps, rubella, and tetanus is another narrative. The world population has multiplied about eleven times since the start of the Industrial Revolution in the 1750s. According to an estimate, even today, about 815 million people regularly go to bed hungry around the world. Nevertheless, due to modern science and technology, according to FAO, we grow about 1.5 times the world food requirement. The root causes of food insecurity and malnutrition are poverty and inequity rather than shortages. The role of S&T in eradicating hunger is yet another dimension to be thought about.

Coming out of the shadows of colonial exploitation and suffering from ‘underdevelopment’, for a newly independent country like India, science and technology offered tantalising possibilities. “For everything in this world, for wealth, for the soul, for life, for success, the truest guide is science. To seek guidance in other things is heedlessness, ignorance, and
departure from the right path”, said Mustafa Kemal Atatürk. “It is science alone that can solve the problems of hunger and poverty, insanitation and illiteracy, of superstition and deadening custom and tradition, of vast resources running to waste, or a rich country inhabited by starving people... Who indeed could afford to ignore science today? At every turn, we have to seek its aid... The future belongs to science and those who make friends with science.” declared Jawaharlal Nehru. So did leaders of most newly independent colonial countries.

Nevertheless, there are dark aspects of the story. Modern science played handmaiden to colonialism by reifying the race and colonial prejudice. New inventions, such as the electric bulb, far from making the life of the majority brighter, aided and assisted capitalism in exploiting more. Production hours were extended, and the workers were robbed even of sleep. Development in communications and transport enabled razing of forest in India and Southeast Asia to fuel the expansion of railways in Europe. The technological developments sustained the Satanic mills of the Industrial Revolution. Modern irrigation facilities enabled more production but also consolidated rural assets to be held by fewer hands. Developments in modern medicine cured dreaded diseases but also became playfield of big pharma corporates. Indeed science and technology had the power to alleviate poverty, reduce drudgery, make a dignified living. However, in the hands of capitalism and colonialism, what resulted was misery and hardship. The environmental movements that emerged in the 1960s were located in this fissure.

**Beginnings of environmental movement in India**

In India, since the 1970s, along with growth and development, rapid deterioration of the natural world and human living environment was witnessed. The impact of unrestrained industrialisation was becoming visible. Naturally, social movements fighting for equity and social justice were concerned about the deteriorating and appalling living condition that is being engendered. Ecology was also an emerging discipline. Observing the rise of this new consciousness, Anil Agarwal cheerfully wrote in 1984-85 “Newspapers give prominent display to environmental horror stories. Editorials demand better management of natural resources. Government statements on the need to preserve the environment are now commonplace. There are new laws for the control of air and water pollution and the conservation of forests... Party documents and party manifesto take care to mention the importance of environment...”

When ecology was emerging into a discipline and being institutionalised within academia, the first generation of professional ecologists almost without exception had a close connection with movements on the ground. The dirtying of river water, smells and shoot cover over the living area were visible, and these became triggers for environmental consciousness. Further, thanks to the scientific studies, the looming dangers of air pollution, groundwater depletion, damage to the ozone layer, climate crisis and global heating came to light. Even while the public intellectuals doubted a particular claim, suspected a specific
institution, or were wary of the corporate or government influence, ‘science’ as an institution and methodology was held mainly trust. However, there were notable dissenters.

In the public psyche, all these changed with the Bhopal disaster. Hiding behind the garb of confidentiality even the meteorological data on wind speeds and direction, so central to any attempt at computing the numbers likely to be affected by the MIC, was not made public by any agency. No serious attempt was made by any institution to test samples such as water, plant life, food, and so on to assess the damage caused by the leak. In the absence of scientific data, experiential, anecdotal evidence of the people and authoritative assertions of the ‘experts’ only remained making it impossible to have a real scientific approach to handling aftermath of the disaster. Public confidence in the autonomy of science institutions came under question.

“The Bhopal disaster has stunned those responsible for pollution control, and put fear in the hearts of millions of industrial workers and people living near factories. However, Bhopal is not the only disaster; subtle and invisible processes continue to undermine human and natural resource base.... Satellite data has confirmed that India is indeed losing more than a million hectares of forest every year, something that forest departments have consistently and perversely sought to deny. All our hill and mountain eco-systems, the cradles of our life-giving rivers are deteriorating rapidly. Even in heavy rainfall areas where forests should be in full bloom, the land is becoming a barren desert. Every day, thousands of hectares of India’s rich biosphere slide into a vast wasteland; the only difference is that today the word ‘wasteland’ has become part of official vocabulary Environmental degradation threatens every Indian” said a joint statement issued by environmental activists three years after the Bhopal disaster. It was a fundamental turning point that exposed the inability of the State to handle a major industrial disaster. A fundamental rupture emerged between scientific institutions (including ecology departments) and green grassroots movements.

Several environmental movements emerged in this period. Some saw the seeds of environmental destruction in the application of modern science and technology emphasised the ‘traditional’ knowledge systems and their interactions with ‘modernity’. Organisations like Kerala Sasthra Sahithya Parishad (KSSP) noted that the abuse of science and technology leads to human misery and environmental degradation. Organisations like the Center for Science and Environment viewed the need to articulate policies and laws and work as a watchdog. A few others campaigned for the preservation of ‘beautiful scenery and charismatic species’. While a plethora of movements abound in India, two are significant for their reach and influence on the larger psyche.

**Peoples science movements (PSMs)**

The grassroots struggles like the Silent Valley agitation, Chipko movement, and several local-level struggles related to air and water pollution laid the foundation for the emergence of environmental struggle under the aegis of PSMs. The movements were also worried
about the global environmental crisis, such as ozone layer depletion. In addition to the deterioration of living space (contamination of drinking water sources), occupational health (e.g., silicosis, asbestosis) was, for example, a primary concern of the environmental movements.

The gaze of these peoples science movements (PSMs for short), exemplified by Kerala Sasthra Sahithya Parishad (KSSP), Chipko movements and so on, were focused on the places where we live, work, learn, and play, be it natural spaces such as a forest or an artificial territory such as a factory. These movements, premised on the concerns of an equitable and just society, argued for the use of science and technology for the betterment of the majority and underprivileged.

Inspired by the tradition set in by J. D. Bernal, scholars from this genre, extended his analysis of ‘science and society’ to examine the roots of environmental crisis. Marx famously noted, “…all progress in capitalistic agriculture is a progress in the art, not only of robbing the labourer but of robbing the soil; all progress in increasing the fertility of the soil for a given time, is a progress towards ruining the lasting sources of that fertility.” He saw the capitalist system thrived only by the exploitation of soil and labour. Here, the soil was a metaphor for ‘natural resources’. There is no intrinsic value to natural resources in the market, but only the rent associated (exchange value, market) with such resources. Thus all commons, be it air, water, are exploited unmindful of longer-term consequences. Nevertheless, in a social system, if the State intervenes to punish those who, say, pollute and favour those who do not, smelling the profit, industries may run towards less-polluting routes and concomitantly cleaning up pollution will itself emerge as a profitable business. However, the Marxists point out that in the logic of the market, the vicious cycle of pollution is not severed, and the overall load of pollution does not reduce.

Capitalism’s insatiable hunger for profit (not growth per se) is seen as the central font of the environmental crisis, and the remedy was seen to lie in replacing the capitalist system with a more equitable and just society. Indeed, such a society where the wants of all people are equitably and justly satisfied implied a need for more advanced science and technology and not less. Those rooted in working-class politics, saw the advancement of science and technology as an essential aspect of building a sustainable socialist future. The struggle for empowering workers, protecting public health, and preserving landscapes was seen as part of a single effort for attaining economic and social justice. The imagined future in this strand of environmental movement had a prime place for science and technology.

While agreeing with all growth is not progress, these movements seek to have a development of all sections of the society, with environmentally sound production, distribution and consumption. Building such a society calls for more advanced science and technology and not less. Thus, these movements oppose GMOs because they promote corporatisation of agriculture which leads to both destruction of the environment as well as the exploitation of small and marginal farmers, but not the technology as such. Pointing out that the divide between poor and rich countries in the world can also be roughly mapped
into another kind of division – that between gene- or biodiversity-rich countries and patent-rich countries, the PSMs argue that the real debate is on who controls the technology. As a preserve of giant transnational corporations, GM technologies have the potential to transform the very nature of agriculture, especially in developing countries such as India, in a manner that is detrimental to small and marginal farmers. Further, the concern they eschew is how the public-funded research system in India is increasingly made subservient to the needs of private corporations, many of them foreign-owned. They argue that if India wishes to take advantage of advances in science and technology, they have to be based on local needs and need to be backed up by indigenous efforts at developing technologies.

Today the movements for an equitable and just society rooted in working-class politics are not the ideologically dominant among the green movements. Their voices have become feeble and do not command the following they used to earlier. However, they are among the most active grassroots movements even today.

**The new green movements**

Displacing the PSMs, increasingly ‘Science/development/violence’ genre (hereafter, SDV) movements are seen at the centre stage in the environmental debates in recent times. Although comprising various shades of thoughts, they are united in seeing modern science as a ‘western project’, asserting a systemic relationship between vivisection and the scientific project, on the one hand, and between triage and development theory, on the other. They further foregrounded the interaction of the ‘traditional’ knowledge systems and ‘modernity’ (and modern science) and construed an incommensurable chasm between the ‘Indic’ civilizational ethos and ‘modern Western science’.

The foundations of the ideology of SDV movements were laid in the 1980s. The philosophical and ideological underpinnings that originated in the writings of a diverse set of people and groups such as Patriotic and People-Oriented Science and Technology Group (PPST), Claude Alvares, Dharampal and Ashis Nandy remained polemical with hardly any substantial ground-level action. They were inspired by the then-emerging ‘social turn’ in the science, technology and society studies.

Until the late 1980s, SDV was more of an ideological trend among the intellectuals with very little grassroots following. Two important events, one intellectual and other historical, gave a boost to these movements. The collapse of the Soviet Union in the 1990s paved the way for the ascendancy of neoliberal ideology. The ‘postmodern turn’ in the social studies of science pulled the rug from under the feet of science.

Critique of a specific institution of science or a specific claim of a scientist not standing scrutiny, or even a whole discipline, say phrenology being discredited is not new. As a human endeavour, like any other, science is fallible and influenced by prejudices. However, the normative objective of the enterprise of science was considered to be ‘objectivity’. The
Green Movements and Public Perception of Science

social turn and ‘postmodern’ philosophies questioned fundamental ontological and epistemological groundings of science.

Some ideas fabricated by humans are social constructs. The biases of the scientific workers in a field can influence the conclusions arrived at. Many times, if we fail to be adequately self-reflective, we see what we want to see, in particular, in areas where ideology plays an important part. Nevertheless, postmodernism went further and claimed that all entities and explanations of modern science are ‘socially constructed’. French philosopher Bruno Latour ridiculed as anachronistic archaeologists who concluded that Rameses II died of tuberculosis. How could he have died of a bacillus discovered in 1882 and of a disease whose aetiology, in its modern form, dates only from 1819? For postmodern philosophers, Koch did not discover hitherto unknown and unseen, but objectively pre-existing bacillus, as ‘common sense’ would warrant. His ‘discovery’ and ‘explanation’ is akin to the explanations given by ancient societies invoking faeries and spirits for a disease. In this view, the ‘belief’ that electron has a charge is just like the claim that ‘gemstones’ emit ‘charm rays’. For scientists, nitrogen is nitrogen, but under the postmodern frame, food grown from organic manure may have an exceptional ‘power’, which plants grown from ‘artificial fertilisers’ may lack. Both are just stories that are socially constructed, and there is nothing that privileges modern science over the ‘traditional beliefs’. One of the ‘green’ protagonists asserted in the same vein, ‘natural neutrinos are harmless; ok, however, how do you know that neutrinos produced artificially from ‘neutrino factories’ are harmless?’.

Most of the strands in the SDV movements in India are strong ‘nativists’. Before the arrival of modernity (and capitalism), humans (at least ‘Indic’ civilisation) were living in harmony with nature. The serene ‘garden of Eden’, which we should have acclaimed and emulated, was poisoned, when the Industrial revolution (for some even the advent of agriculture) tempted us to ‘contaminate’ sacred nature with the ‘artificial’. The craving of modernity to control nature – ‘controlling’ virus with vaccination, rivers with dams, for example – created a friction between humans and nature; the root cause of violence and environmental crisis. The solution? Shun all that is ‘modern’ or ‘artificial’ and embrace which is ‘traditional’ and ‘natural’. Degrowth, go ‘organic’, be ‘natural’. While for some it is returned to pre-modern mediaeval times, for others it is going as far back as ‘glorious past’ of Vedas (or Tholkapiyam).

There is another strand that grows from the celebration of ‘other ways of knowing’. Alternate healing, zero budget farming and whatnot. Most of such claims have not even an iota of evidence. But so what? The methodology of modern science is but one way of ‘knowing’; ‘other ways of knowing’ are equally acceptable. There is no way one can ‘rationally’ choose between the two.

Bewitched by the postmodern turn, science is not just seen as a tool that is being misused by the powerful, but power and exploitation as constitutive of the science. Hence the power (or patriarchy and any other prejudice) cannot be disentangled from modern science. Science, or at least individual strands of research, are unwelcome and perhaps even seen as
evil. One of the environmentalist protagonists argued that ‘naively you undertake fundamental scientific research on the neutrino. But what you don’t realise is the dangers. All the research in the area of nuclear physics/ particle physics will be used ultimately for making weapons and destructions.’

Beautiful outdoors, unpolluted pristine nature sans humans are the primary concern in this vision. Urban areas, workplaces and other ‘artificially constructed’ living places of the vast majority of the people are mostly out of sight, in fact, to be denounced and condemned. Consumption has to be reduced, cities have to be razed, and folks returned to romanticized villages. In the binary narrative of ‘nature = good; artificial = bad’, a climate of uncritical romanticism of ‘traditional’ sets in and mobile phones, modern agriculture, vaccines and all of the modern medicine becomes suspect.

By placing the blame for the environmental crisis at everyone’s doorstep, the salvation is projected in individuals voluntarily changing their lifestyle changes. Advocacy of individual efforts, like consuming ‘organic’ products, home remedies, ‘slow’ living, and vociferous opposition to almost every research, in particular research in genetic engineering and so on are the signet of the new green movements in contrast to working-class movements that talked of more ‘social projects’ such as public health, civic improvements and increased consumption of the impoverished.

The emerging third trend

Although we have focused upon two dominant trends, it would be woefully incomplete if the third trend, which is at its nascent stage in India, is not mentioned. Green capitalism; or eco-capitalism. Vociferous articulations can be heard in seminars and think tanks, however, yet to catch the imagination of grassroots movements. Ironically, the arguments are premised upon the analysis of capitalism by Marx. The ultimate goal or purpose of capitalism is not the destruction of habitats, depletion of natural resources or production of destructive technologies for its own sake. Marx made it clear that the exploitation of capitalism is not premised upon the brutality of capitalist individuals. Many of the individual capitalists might be bleeding hearts, loving caring and concerned. The purposefulness of capitalism lies in its constant accumulation of wealth through profit. It is in the pursuit of profit that capitalism capitalises on nature and abuses it. Thus, if a less-polluting production technology is relatively more profitable, the logic of capitalism will demand that the capital flow towards it. However, if it is the opposite, then, whatever be the human and environmental cost, the drive for more profit will prevail.

It has dawned on a section of capitalist ideologues that the business, as usual, is not an option today, and perhaps the end of the road is around the corner. If the trends of exploitation of natural resources and global warming continue in the same manner unchecked, then the material basis for profit-making and wealth accumulation will be eroded irrevocably. Why not use this to leverage environmental protection. Enact laws to
punish pollution and reward the ‘clean’. The market will ensure in the long run; only the ‘clean’ industries will survive. These voices are coalescing into eco-capitalism. Green tax, carbon credits and polluter pays are some of its mantras.

There are two crucial impediments for eco-capitalism in India. The ‘free market’ and neoliberal State is anathema to State intervention. Eco-capitalism relies not just on the unregulated market but crucial State intervention. Call for more stringent State regulation appear to be a throwback to Nehruvian era. This is one dilemma.

Further, for eco-capitalism to be feasible, there must be a permissive climate for ‘market place of ideas’, and the State must be seen as an honest and impartial adjudicator. However, in the reality of Indian society, grassroots movements are under vigorous attack, even legitimate struggles for even implementing various environmental legislation is labelled extremists, and the actors are castigated as Luddite and agents of ‘western imperialism’. Coupled with this, the perceived failure of the State to deliver, increasing gaps between rich and the poor, lived experience of poor legal and administrative implementation, eco-capitalism is not an attractive position.

**Technology and lifestyle choices**

One must hasten to state that technology critique is not anti-science, be it GMOs or nuclear power. Even if rigorous risk assessment processes and the possible ways in which the technology may cause harm are identified and their probability estimated, a society may choose not to have a particular technology on other grounds collectively arrived by public reason. Unlike science, technologies are not given; they are made in drawing boards. Technology shapes the possibilities and shapes the relationship between individuals and social organisations. Technology is political. Hence a particular social group may accept or reject technology. One certainly must not mistake opposition to a particular technology as indication of irrationality.

In a like manner, the call for action for lifestyle changes, or lesser carbon footprint is by itself not regressive. Indeed the current production and consumption, unless compelled by social forces, are mostly unmindful of waste. Accumulated waste depletes natural resources and pollutes, ultimately leading to an environmental crisis.

Nevertheless, the “environmental classism” in the advocacy for lifestyle change and technology choice must also not be missed. Technologies that provide ‘green living conditions’ for the leisured and affluent may not satisfy the needs of a person toiling in an inhuman working condition. Ensured of clean and safe living spaces, the prosperous, dream of escaping to wild places to feel “ecological” or “natural”. The contradictions between poor people ‘irrationally’ refusing to leave the dirty shanties and slums along the streams and river banks and take up alternate ‘beautiful’ sites far removed from the city, and the urban
environmentalist’s appeal to ‘beautify’ and ‘clean’ the cities are well known in any urban area. The vast majority of the poor have little elbow room to make lifestyle choices.

**Public mentalities**

Environmental movements try to foment public mindsets, just like all other social movements. From an impressionistic generalisation of the messages circulating on social media, one leads one to conclude that the popular consciousness today is more influenced by the anti-science rubrics of new green movements. ‘Traditional’, ‘organic’, ‘alternate science’ are some of the key buzz words.

Romanticism, the dominant image of the messages, presents the pristine ‘nature’ as a site of awe, wonder, escape, and even spiritual experience of nature sans humans is presented as reverent. In some small measures, as an antidote to the brutish exploitation of natural resources under capitalism, romanticism acts as a bulwark against complete expropriation. However, in the popular consciousness, romantic ‘nativist’ narratives pit ‘natural’ and ‘traditional’ against ‘artificial’ and ‘alien’. A mentality of the deification of ‘natural’ (and traditional) and castigation of ‘artificial’ (and modern) is engendered. Natural farming is better than artificial, natural ingredients are better than synthetic. Of course, vaccination is against nature, and one person even went so far as to advocate parturition at home rather than at a maternity hospital.

From the perspective of the new green movement, ‘modern science’ (= western science) is inherently anti-nature, violent and if not the main, at least one of the crucial root cause of the ecological crisis. Second, the methodology of modern science is not universal. There are other ways of knowing. Hence ‘evidence’ and ‘reason’ need not be authorised by modern science and its institutions. This, on the one hand, implies no amount of ‘scientific evidence’ about sticky, tricky areas like nuclear power or GMOs will ever convince people, making the grounds for public reason complicated. On the other, pseudoscientific claims like gemmology, alternative healing, and so on, gain respectability and currency.

Further, when the new green movements equate the pursuit of science with the “death of nature” and, contend that reason has estranged us from the natural world, irrational and neo-Luddite sentiments are bound to arise as consequences. Interestingly, one of the founding ideologues of the new green movement flatteringly wrote an essay titled ‘Science, colonialism and violence, a Luddite view’.

However, the most insidious of the eco-mentalities is a conspiracy theory. Convinced that a secret, omnipotent individual or group for their ulterior motive, covertly control the political and social order, conspiracy theories thwart any attempt for rational discussion. Indeed by giving a name and a face to an otherwise intricate web of impenetrable global
systems, conspiracy theories help the ordinary person to make sense of the complex world that is beyond his/her grasp.

As long as the target of conspiracy theories is to claim that humans did not land on Moon or Earth is flat, they are mostly harmless. However the modern-day urban legends include obesity in the society is a plot of sugar lobby; vaccination a ploy to prompt male infertility with an ulterior motive to annihilate a particular minority ethnic or cultural group; chemotherapy and other such cancer treatment are game plan of big-pharma to make money, while the ‘real cause’ of cancer is just a lack of vitamin B 17 which can be set right by eating lots of apricots.

**Public perception of science**

Has the overwhelming influence of new green movements thrown the Indian public into the lap of anti-science? Surprisingly, at the same time, we can witness overwhelming public trust towards the claims of climate science and scientists, whereas mistrust and cynicism are hallmarks of response to specific areas off technoscience such as GM crops. Barring occasional barbs, public-funded Space research receives adulation while the public reaction to even State-supported nuclear research is often dubious.

The assertion by the climate change scientists under the aegis of IPCC of human-induced global heating and climate crisis is accepted by and large climate change contrarians’ denials have very little purchase. Why the disconnect? Surely public unreason cannot be an explanation. Why do many people trust science when it comes to climate change but not when it comes to, genetic engineering or nuclear power?

Very many survey reports show the Indian people, by and large, are not inimical to science and technology. For example, Kumbh Mela surveys conducted for the past 25 years show a steady increase in the scientific information level among the masses and a perceptible reduction in the prevalence of certain superstitions. The surveys also show the currency of extra-scientific, irrational, mythological ideas in tandem with scientific information. In quotidian life, the ordinary person invokes scientific, rational, irrational, extra-scientific, religious, and other information to rationalise an action. However, collective behaviour is not just the sum of the individual behaviours. It is, as Gauhar Raza points out, ‘a function of historical legacy, cultural value system, economic determinants and political affiliations’ (Raza, et al., 2018).

What do climate scientists stand to gain by faking the data? Conspiracy theory speculates that garnering research funding is the motive. In India, as most of the research is funded by the State, and as obtaining grants has no impact on job security, the logic of conspiracy seems too thin in the Indian context. Maybe the climate scientists are leftist radicals masquerading as objective out to wreak capitalism by denying it its life-giving oxygen- oil, petrol and fossil fuel. In India bogey of socialism is yet to take root, despite decades of
neoliberal economic policies. In fact, in popular imagination, socialism still has a sheen. In Indian psyche, climate scientists are ‘socialist’ they are ‘good guys’ (and girls). Like the Moon landing, Area 51 or Bermuda triangle, for an Indian mind, conspiracy theories associated with climate science are lame, having no material consequence.

However, GM crops being overwhelmingly associated with big-agribusiness, is another story. Big business, particularly after the neoliberal economic policies and emergent crony capitalism, often is found to have of skeletons hidden in the cupboard. From the willful faking of data on adverse effects by the tobacco industry to recent intentional manipulation of the exhaust fumes test by a famous automobile manufacturer, big business has lied, bribed and twisted the arms of administration. In the popular notion, founded upon such numerous lived experiences, honest big-business is a fairy tale, modern-day superstition. The overwhelming public scepticism of GM crops emerges from the association of the research and development with suspect entities. Mistrust breeds when nuclear power appears to be shrouded in secrecy.

Indeed fertiliser and insecticide lobbies were seen as driving the research agenda of the green revolution. However, as most of the research took place in public-funded institutions, the scientific institutions and scientists were seen as independent. The public confidence in these institutions remained intact. However, in the recent period, with public sector agricultural research declining and diminishing, in particular in areas like GM crops, popular perception sees that the direction of research priorities in agriculture is predominantly shaped not by the relative merit of different technologies, but rather the priorities of the private sector. In like manner, confidence in the health care systems in on the wane. Recent controversies and disquiet about the proposed Human Challenge Trials for Vaccine Development are a product of such fears.

**What is to be done?**

While several factors will influence the public reaction and perception, one of the main factors is the public engagement of scientists and science institution. The call for the scientific institution to open up to the public is seeing increasing purchase. However, the interaction is still framed in what the science communicators call as the ‘deficit model’. Sure enough, the public will know much less than an expert on neutrinos; in this sense, the attempt to present the science in a simple way is welcome. However, dialogue implies understanding concerns beyond understanding scientific principles. Where are the ecologists, chemists, engineers, in the green movements? The public engagement must go beyond the simple ‘popularisation’.

Further, the public image of scientific community builds for itself matters crucially for earning public trust. If the scientific community is seen as silent, subservient to the powerful, say, when pseudoscientific claims are peddled, it does not inspire confidence among the public and the movements. Often, the State-funded institutions are perceived to
be gagged by the 'government rules'. Hence, a vibrant scientific community engaging in matters of public importance is an essential requisite.

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Reference

The Draft NEP and the Question of Finances

SUKANYA BOSE AND ARVIND SARDANA

National Education Policy, NEP

Posted July 11, 2019

Summary

The Draft National Education Policy is an ambitious document that aims to bring in widespread reforms in the field of education and research. But do we have enough money to realize these goals? Sukanya Bose and Arvind Sardana examine this question.

Full Article

The Draft National Education Policy has underlined the importance of public investment to build an equitable and high quality education system. The policy approach on investment in education suggests an increase from the current 10 percent of overall public expenditure of education to 20 percent over a 10-year period. If implemented, it means that the governments would have to allocate one out of every five rupee of public expenditure on education by the end of the ten-year period. Assuming that the growth of public expenditure keeps up with the growth of GDP (both in nominal terms), the share of public expenditure on education to GDP should increase. The impact of according a higher priority to education would be to enhance the resource envelope and release the resource constraint which has been an important roadblock in implementation of Right to Education (RTE) for all children in India. Whether this will translate into reality or remain a pipedream remains a moot question. However, even in its design, the financing issue requires greater clarity and thought, as we argue below.

What is the normative? The devil is in the detail

Any financial estimate of resource requirements needs to be based on a understanding of what is desirable and what it would cost. It implies detailing out the physical norms and
financials required for the same, so as create a normative framework. This is a well-established principle and one that has been the basis of most costing models followed worldwide. A clearly defined component-wise norm is necessary for transparency, accountability and feedback. For the estimates provided in the Draft NEP the underlying normative assumptions have not been published/spelt out. Unless one were to engage and debate with the design and construction of normative that underlies the overall countrywide estimates referred in the draft NEP, the latter will not hold water.

It would be instructive to recall that the trajectory of educational expenditure to GDP in Kothari Commission Report (GoI, et al. 1966) was based on a view of the required per child spending and the components of spending in terms of teacher and non-teacher costs, pupil teacher ratio, assumptions on population growth, priorities to different levels of educations, etc. Over the years, the estimates have grown in detail and sophistication, such as to better translate the social vision on educational development (Tapas Majumdar Committee, 1999). The overall countrywide benchmark of an expenditure path laid down in the draft NEP — whether expressed as a proportion of GDP or as a proportion of public expenditure — makes sense when it is derived from the normative estimate of what is desirable and the gaps that it is supposed to meet. These details are missing, even though public discussion and scrutiny of this information, and a feedback is vital.

One may also point out here that the financing of education is an important component of public policy and merits a separate chapter rather than being pushed to a sketchy addendum in this important document.

**Too little, too late?**

One of the stated objectives of NEP is to “achieve access and participation in free and compulsory quality school education for all children in the age group of 3-18 years by 2030.” There is a proposal to amend the RTE Act to include “availability of free and compulsory quality pre-primary education”. “Availability of free and compulsory quality education for Grades 9-12 will also be made an integral part of the RTE Act.” The suggestion of the NEP to extend the RTE to secondary as well as pre-school children is a welcome step, if only, it is backed with adequate resources, preparation and planning. The ambit and coverage of justiciable right to education would be extended massively. Has it been provided for? Not really!

In a recent study, we have estimated the requirement for financing the right to education of children between the age group 6-14 years of age (Bose, Ghosh and Sardana, 2019a). This is the elementary school age group. Our objective is to estimate the normative resource requirement for universalization using a set of reasonable norms. Unit level data on schools

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is the basis for estimation as the RTE norms must apply to every school. The population of out of school children, estimated at roughly 15 million children are included in the calculations. In trying to arrive at normative resource requirement, component-wise financial and physical norms are discussed and evaluated. It may be noted here that the last official estimate of financial requirements for universalization goes back to 2009-10, around the time when the RTE Act came into being. Despite a clear clause in the RTE Act on the responsibilities of the Central government to prepare financial estimates for the implementation of the provisions of the Act, there are no recent estimates of resource requirements. Our study may be seen as an attempt to address this lacuna.

How do our estimates compare with the suggestions of draft NEP? Table 1 puts the two estimates side by side. The additional requirement for elementary education as per our estimates – when normalized with overall public expenditure – stands at 4.9 percent in 2017-18. That is, over and above the existing spending on elementary education, an additional 4.9 percent of the overall public expenditure (of 2017-18 level) would be needed to close the various gaps. This would be necessary to fill the teacher gaps, bring about a parity in pay around a decent salary norm, run teacher education institutions and teacher training programmes, provide for an adequate management structure, provide for maintenance of schools, learning resources and students’ entitlements etc. Besides adequately providing for those who are in public and aided schools, the estimates include the cost of inclusion of out of school children. There is substantial progress needed, if the children are to be provided with an education that is worthy of being called so rather than a dysfunctional system.

<table>
<thead>
<tr>
<th>Source</th>
<th>Additional Requirement</th>
<th>Percentage of GDP</th>
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<tr>
<td>Bose, Ghosh and Sardana, 2019a</td>
<td>Elementary Education for 6-13+ age group as per the RTE Act and reasonable system level costs</td>
<td>4.9</td>
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<tr>
<td>Bose, Ghosh and Sardana, 2019b</td>
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<tr>
<td>Draft National Policy on Education, 2019</td>
<td>Foundational literacy and numeracy – National Tutors Programme / Remedial Instructional Aides Programme / Libraries</td>
<td>0.2, 4.1</td>
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Table 1 A Comparison of Additional Requirement as percentage of overall Public Expenditure per annum

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[2] Refer to Section 7 of the RTE Act.

[3] As a proportion of GDP, additional resource requirement works out to 1.4 percent (all-India estimates) for the year 2017-18. This is inclusive of 7th PC hike on wages of public sector employees. (See Chapter 4, Section 4.5 in Bose, Ghosh and Sardana, 2019a).

[4] CAG (2017) speaks about the deficits and the non-compliance in the implementation of RTE.
Compared to the additional requirement of 4.9 percent of expenditure for elementary school level, the draft NEP has proposed the magnitude of 4.1 percent of expenditure (plus one-time expenditure on capital creation of 0.4 percent) on entire school education.\(^5\) Thus, a lower quantum of resources than what has been estimated by us as a normative benchmark for elementary level only is now proposed to be spread across a far greater number of pupil and expenditure heads. The allocations per student will be squeezed.\(^6\) If we are committed to RTE of equitable quality this appears to be an underestimate at first glance.

Further, given the glide path in allocations suggested – one percent increase every year – even the increased magnitude of 4.1 percent will kick in only by the end of the next decade (2030) as per the proposals of the draft policy. Whereas, the need for raising allocations is imminent and cannot wait for ten more years.

From the resources point of view, the essential idea of the RTE is to ensure the facilities of schooling in a time-bound and complementary manner so that the basic entitlement of every child is upheld. Both in terms of magnitude and timeline, the proposed increase seems inadequate when compared to the lofty objectives.

\[^5\] An additional 1.4 percent of total government expenditure is proposed for early childhood education in draft NEP.

\[^6\] It may be pointed out that the normative per student recurrent requirement are in a reasonable range (Bose, Ghosh and Sardana, 2019a). For the year 2015-16, it is estimated at around Rs.23,200 for general category states, on an average. Due to underlying differences in size of the schools and the mix of new to existing teachers, among other things, there is variability in normative per student recurrent requirement across states.

<table>
<thead>
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<th>Resources</th>
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<td>Schools – additional teacher costs / complex resources</td>
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<td>Food / nutrition (MDM+) – Breakfast / enhanced nutrition component</td>
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</tr>
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<td>Teacher education and continuing professional development of teachers</td>
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</table>
The unequal position of the states

For several states, the size of the overall pie available to them, rather than prioritization of expenditure, is at issue. Take the case of Bihar. Reprioritization of expenditure to 20 percent of the overall budget will not make any significant difference to the expenditure. The pie itself has to be increased substantially, and in an urgent manner. Between 2001-2 and 2015-16, expenditure on education (including art and culture) averaged about 18 to 19 percent of total expenditure (RBI, Study of State Finances).\(^2\) And yet, actual expenditure on elementary education in Bihar is only a fourth of the total resource requirement on it, as per our estimates.\(^3\) There is need to spend on multiple fronts which require substantial capital and revenue expenditures. Unlike some the other states, Bihar still has a very high percentage of enrolled children accessing public schools. By strengthening the public school system, there needs to be a conscious attempt to pre-empt the exit to low quality unaffordable private solutions. Besides, there is a very large segment of children who are out of school including children who have dropped out, whose education squarely is the responsibility of the state. Population growth in Bihar is one of the highest indicative of need for further expansion in the future. There is a very stark disparity between needs and the revenues of the state.

Bihar is not alone, though it is certainly the most extreme case. In fact, we have identified 16 states – 8 general category states and 8 special category states – that require special central assistance as the gap between requirement and actual expenditures is large relative to the revenue base (including the present Central transfers). We have argued that for these 16 states, elementary education today requires a special thrust. This is imperative if the objective of universalisation of elementary education is to be fulfilled, as per the RTE mandate. The quantum of the fiscal transfer to the 16 states would need to be substantial, estimated at 1.14 percent of GDP (Bose, Ghosh and Sardana, 2019b).

The new NEP has to engage with the different layers of financing. The sub-national financial issues and center-state distributions are central to the idea of a national policy if it is to forge the long-run development goals. How can there be greater parity such that every child irrespective of where she is born (and to which family she is born) can have good quality education? How can the financing move towards greater equity? Unless the

\(^{[7]}\) In the recent period there seems to have been a slippage though not large in the priority accorded to education. The 14th Finance Commissions’s recommendations on intergovernmental transfers may have impacted the spending patterns of states, especially vis-à-vis social sector spending.

\(^{[8]}\) Refer to Chapter 3 in Bose, Ghosh and Sardana, 2019a.
disadvantages and complexities are recognized upfront and addressed, the policy would not be able to usher in any substantial change.

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Technology in the DNEP and Science Education

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Posted July 11, 2019

Summary

R Ramanujam examines the NEP in the context of the role of Internet and Communication Technology in education and argues that one needs to be mindful of what exactly is desired before embracing technology wholesale in science education.

Full Article

A child and a machine

Once when I was participating in a rural Tamil Nadu Science Forum event, interacting with children of middle school age, we had a round of each student talking of what s/he wanted to `become' on growing up. Manikandan, a 11 year old boy, said he wanted to become a scientist. Rather pleased, I asked him what he wished to do as a scientist; he said he wanted to make an idly machine, and all the children laughed. It turned out that his mother was running a single parent family, making idlies and selling them at the bus stand. This was a natural ambition for a boy who was watching the everyday toils of his mother and helping her. Does India offer ways of realising such an ambition?

Manikandan made me think: what were the chances that he would actually get admission to an institute of technology, learn to build machines? Even if he did, would the science education received at school and the engineering curriculum build in him the needed capacity? After such education, would he even want to build an idly machine?
The shape of science education in the country and the attitude to technology in school education has had only negative answers for Manikandans. The Draft New Education Policy (DNEP) has only a little to say on science education at school and the attitude to technology expressed in it seems to foretell only further disappointment for the numerous Manikandans in the country.

**The equation: Tech = ICT**

In the DNEP, we find a great deal of talk extolling technology-based teaching / learning, but it seems to equate technology in school with the use of Information and Communication Technologies (ICT). Chapter 18 of the DNEP is devoted to the use of technology in education. It classifies the use of technology into four categories: teacher preparation; classroom processes of teaching, learning and evaluation; improving access to education for disadvantaged groups; planning, administration and management of the entire education system. All this clearly pertains to the use of ICT in the education system.

Is the use of technology in school only about bringing Internet connectivity to all schools, the use of multi-media, videos and hyperlinked material, so that distant voices can beam down content, textbooks can be supplemented by the extensive knowledge available easily on the World Wide Web, assessment is made flexible, and data easily collected? Why is it that mention of technology in education rarely refers to lathes, foundry or good old agriculture?

Rather interestingly, while policy documents and governments always refer to S&T, coupling science and technology together, such thinking remains alien to our school classrooms. Indeed, if there is one domain that calls for new curricular action in school, it is that of technology.

On the other hand, there is an increasing perception that 21st century modes of production will allow for small industries created by groups of individuals to innovate in ways that demand training in S&T. The East Asian and Western European countries have tried to integrate technology education into school science education, and the study of technology in relation to society is also given curricular stature in (some of) these systems. In Sweden, for instance, every high school has a workshop that typically includes a foundry and carpentry, and science laboratories are integrated with the workshop. The Chinese school system is currently transforming itself to such a model.
The questions we need to ask

If we are to speak of technology in education, what should be our understanding of technology? What should be the attitude to technology in the curriculum, and in teaching / learning practices? What attitude to technology is inculcated in the students?

School typically teaches the student to see technology as given, (as a potential consumer), and not anything s/he can participate in. Science education is compulsory, but has little to say about the relationship between science and technology. Social studies do not at all refer to how modern societies relate to technology. Our children do not develop a healthy and yet critical attitude to technology, one that is based on principled understanding. Technology assessment is not part of the curriculum even in the prestigious institutions of technology. All this together suggest that we are not even asking the right questions about technology in the context of education, let alone have good systemic answers.

When it comes to the use of technology for educational purposes, there are more questions to ask:

1. How does technology help the educational purposes that schools seek to achieve? What forms of technology do so?
2. How can technology enhance the educational experiences that can be provided to achieve these purposes?
3. How can the education system contribute to the development of such technology?
4. How do we ensure that these educational purposes are indeed being accomplished?

The author is not competent to provide good answers to any of these questions. What we can hope for is an articulation of some guiding principles that can help us answer these and related questions.

Technology in the science classroom

The 1986 Policy on Education asserts: all areas of development are science and technology based and for that we need experts, middle – order workers and scientifically literate citizens. It goes on to discuss how the curriculum should be designed: ... for conscious internalization of healthy work ethos. This will provide valuable manpower for economic growth as well as for ideal citizenship to live effectively in the science/technology based society.

The National Curriculum Framework 2005: lays emphasis on the process of science and critical inquiry. The DNEP singles out the inculcation of the scientific temper and critical thinking as the purpose of science education. It says that science education will inculcate
scientific temper and encourage evidence-based thinking throughout the curriculum. Evidence-based reasoning and the scientific method will be incorporated throughout the school curriculum.

Such emphasis on the process of science and the nurturing of the scientific temper is welcome, but these could also be ‘umbrella terms’. In the context of our discussion, we must point out that there is no explicit attitude to technology and working with the material world articulated in such a formulation.

The science classroom is the best place to introduce technology to students. This cannot be achieved by “lessons” on X-technology or Y-technology, to be learnt as information items and memorized. In fact, along with a factual and conceptual understanding of natural phenomena, students also need fluency in working with the material world in a way that builds on experimentation, observation, prediction and critical inquiry. Technology is best learnt by doing, by active engagement with material and energy conversion. Working with metal, wood and soil is essential for building a relationship with nature that is purposeful and wise. This needs the active and simultaneous engagement of the mind, the heart and the hands.

Articulating the goals of science education to include active hands-on engagement with the material world implies according primacy to wood and metal, to leaves and stones, to life forms and crystals: not by seeing them as pictures or video animations, (or worse, reading their descriptions in books) but touching, feeling and working with them. This is essential for developing an integrated feel for science and technology.

The DNEP refers to experiential learning in many places. It promises that children have “fun” when the learning is “hands-on”; but this is very different from the deliberate engagement with material for study that we are referring to. Even at the risk of stating the obvious, let us note that experiential learning is not the same as experimentation; the latter lies at the heart of science learning. Coupled with experimentation, an emphasis on quantification is a characteristic of science. Measuring, estimating, approximating, calculating and model building are everyday processes for any form of science, and these again are habits to be inculcated in the learning child, not only for sharpening her own abilities but also towards building a society that can critically engage with issues of technology use and its impact on the environment.

Students need to perceive the rootedness of technology in science, as also the technological potential embedded in science. They need to understand and internalize the fact that technology is the conversion of material and energy in different forms by doing work, by expenditure of energy, and that this is based on sound scientific principles. Such emphasis in science classrooms could offer an important direction for the future of our children.
Apart from hands-on experience, science pedagogy itself needs to actively make connections with technology. For instance, we rarely teach Pascal’s law by pointing out that this is indeed the principle that literally enables huge trucks to be held up on mere rubber tyres pumped with air. The sheer wonder of air holding up a heavy truck is important for the learning child, and further, the tremendous opening up of possibilities in the mind is critical for planting the seeds of technological innovation. Similarly, biodegradation is a phenomenon to be understood, but it is also important to see the possibilities of composting in technological terms. This is a connection mostly missing in our science curriculum, and a careful reworking can make science learning not only immensely enjoyable to children, but also useful to them and to society.

If we could reorient science education at school placing material handling, experimentation and quantification at the centre, the potential benefits would be immense. Providing linkages for schools with technology institutions requires more re-orientation on our part than great resource investment. A visit to a bicycle shop or a motor garage has immense educational value. Agriculture and animal husbandry are practised all around, and can be seen as opportunities for “science tours”. Indeed, within a few kilometres of every school, some manufacturing or industrial processing activity does take place, and active linkages for school and science curriculum with these institutions can be made. Science laboratories can be integrated with workshop practice, as in Scandinavian schools. Even while we wait for such a possibility to become a reality for our children, we can begin by opening windows and doors to simply make use of opportunities for technological education that are present around schools. This only calls for an enabling mechanism to be set up in terms of curriculum, syllabus, school functioning and new practices in teaching and learning.

Every time someone speaks of ICT and mentions how children take to such technology, how 4-year olds can operate mobiles when adults cannot, it is worth remembering that for crores of Indian children, working with wood and metal comes naturally too. They have always been good at handling any technology with their nimble fingers, not only mobile phone gadgets. It is the education system that has never taken this ability seriously.

**The hands and minds disconnect**

Why is it that such a disconnect between conceptual science learning and a hands-on culture of making things, accepted for so long, as a matter of course? Is it perhaps impossible to achieve an integration of the two? Are we perhaps talking of a new idea so revolutionary that nobody has thought of it before?

On the contrary, this is a very old idea, whose seeds were sown in India long ago. In the 1930’s Mahatma Gandhi advocated *Nai Talim*, a new style of education for a new country. Gandhi and Kumarappa built a curricular framework on a principle that called for integration of work and education. The village-based society they envisioned would not see
education as preparation for entering the labor force post-education, but as education through work. In *Nai Talim*, work raises questions inside the child’s mind: why does X work and not Y? How does material get transformed? Science provides answers, and the child is able to see how conceptual learning improves her work and results. This is admittedly a crude summary of the idea, but the critical point to note here is that Gandhi was not speaking of *vocational education* or work apprenticeship but education through work. What is relevant to this discussion is that such a viewpoint carries the potential to build a natural and healthy attitude to (basic) technology and the understanding of how material and energy are transformed through work.

The country chose a different trajectory in education, and the Gandhian vision of education was sidelined along with the Gandhian vision of development. The fear that bringing work into schools would merely perpetuate caste hierarchies was real. On the other hand, a brahmanical attitude that privileges intellectual work over physical work took root in school education. By now, theoretical insights and conceptual understanding are seen as important, hands-on activity gets mentioned only in the context of *making classes fun*. In practice, memorization and rote learning have taken over, and concepts take a backseat as well. The DNEP reminds us that students in ancient Indian *pathashalas* were famous for remarkable feats of memory, so are our current toppers in examinations. Neither the Gandhian vision of work in education nor the Nehruvian vision of inculcating the scientific temper in children have been realized in our school system.

With such a history, it is perhaps not surprising that recent discussions in the DNEP on technology in education equates technology with ICT use. ICT is “clean” technology. Here is technology that is not messy, one does not need to muddy one’s hands, no need to deal with hot metal, or worry about errors in measurement. Even the dangers relate to the mental world, not the material one.

The immense power of ICT

I am well aware that the idiosyncratic stance taken here on the nature of technology in the science classroom does injustice to the tremendous potential contained in the use of ICT in school education.

ICT does have a disruptive power that needs to be harnessed. (However, we should still questioning the uncritical fashion in which the DNEP seems to root for “disruptive technologies”; what assumptions underlie such acceptance?) We are all acutely aware of the tyranny of the textbook in our schools. ICT offers highly flexible modes of navigating educational material, through the use of hyperlinks and multiple windows. Thus, it can break into the linear structure of our textbooks. It can also tremendously help in localizing and even personalizing content, which is most welcome in a scenario where textbooks and curricula can create a false uniformity. The combination of these two features, namely,
flexible navigation and personalized content, can open doors to new pathways of learning. Consider a child interested in light, exploring art and photography on one side and physics on the other. Such breaking down of compartments is natural in ICT-enhanced education, and can be of tremendous value in situations where a teacher is unable to do this.

Once we start envisioning the possibilities, we can see that ICT not only has the potential to enrich our education but indeed can also provide a tool for educational objectives that we cannot accomplish without ICT. As an instance of the latter, consider the question: how would the world look and behave if the acceleration on earth due to gravity were just a tiny bit less? It is hard to imagine such a thing, much harder to quantify what we imagine. A computer simulation can achieve this very well, can make us think, and indeed lead us to more related questions and open-ended exploration. In a mathematics class, we could not only graph a cubic polynomial, but also pull the curve down, predict how the quadratic coefficient would change, and verify it. Try doing this on paper! Consider zooming into topographic maps in geography. Consider underwater explorations, visits to museums in another continent.

Another critical dimension on which ICT can be immensely helpful is teacher education and in teacher professional development, and this has been rightly emphasized in the DNEP. However, both the dangers of equating ICT and technology use and the potential of integrating technology into science equation need to be integrated into teacher education.

All such singing glories of ICT should always be viewed with healthy suspicion. The dangers of unsafe use of Internet are far too real and immediate to be ignored. We also need to be very wary of the seductive nature of ICT, especially when it is translated to mean instant access to fast-moving images, whether for entertainment or for education. While visualisation of abstractions is a meaningful educational challenge, instant packaged mobile visuals can disengage thought and abstraction, which can harm learning not only at that instant, but for future as well, by causing a craving for such quick answers, making it harder to think. Hands-on, minds-off is a real and present danger in ICT use and the classroom cannot afford to ignore this risk.

Even more problematic is the DNEP’s advocacy of ICT for improving access to marginalised communities. If access to quality education is denied to the socio-economically oppressed, the roots of such exclusion lie elsewhere.

**In conclusion**

To conclude, the DNEP is an opportunity for us to revisit the role of technology in school, underlining the need to integrate it into science education, but in terms of engagement with the material world. ICT has immense potential, but equating technology use in school with ICT is dangerous. The following points seem worth emphasizing:
1. ICT and its visual, simulational and interactive ability does offer a tremendous opportunity for empowerment in education, but this is only one dimension for a Technology Vision in Education.

2. We need to see students as constructors of knowledge and technology, and not merely consumers of the potential offered by technology.

3. Working with nature and material is essential in science education.

4. Technology can play a significant role in engaging students in learning, but this needs to be understood carefully in context and used wisely.

The mathematician and educator W W Sawyer wrote:

Do things, make things, notice things, arrange things, and only then, reason about things.

Ways of thinking are shaped by ways of doing in the material world. This is a fundamental tenet that discussions on science education and technology in education can ill afford to forget.

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Capitalizing Genome: The Business of Direct-to-Consumer Genetic Testing in India

SHASHANK S. TIWARI
DNA testing, DTC
Posted April 1, 2019

Summary
Shashank S Tiwari examines some of the ethical, social and regulatory issues linked to Direct To Consumer genetic tests in India.

Full Article
A recent article in Nature highlighted the ways in which various Indian biotech companies are driving innovation with the support of the government and free-flowing venture capital. The article begins by describing how a young Indian entrepreneur founded a couple of biotech startups, and it highlights one of her, direct-to-consumer (DTC) genetic testing company. Unfortunately, the Nature article does not discuss whether innovation in biotechnology, and more specifically in DTC genetic tests, is responsible to society. This article, therefore, aims to analyze emerging ethical, social and regulatory issues linked to DTC genetic tests in India.

Emergence of DTC genetic tests
The business of DTC genetic testing is attributed to the Human Genome Project, a venture that officially began in 1990 with the aim of mapping the entire DNA sequence of the human genome. By 2003, the entire human genome sequence had been completed, paving the way for the emergence of the DTC genetic testing business. When the Human Genome Project was launched, it was promised that the knowledge of the genome sequence would
help in understanding disease and human biology. To exploit this knowledge, three companies had launched their consumer genetic services in the USA by 2007–2007 and Me, deCODEMe and Navigenics. In subsequent years, many additional companies have started to offer genomics services in the USA and in different parts of the world, including India.

In recent years, a significant number of DTC genetic testing companies have emerged in India. Some notable names include Mapmygenome, The GeneBox, DNA Labs India, Indian Biosciences, Positive Biosciences, Xcode and EasyDNA. These companies offer various genomics services to the public, which include personal genomics (drug response profiles, nutritional needs, predisposition) diagnostics (preconception screening), nutrigenomics (DNA based dietary plans), fitness, sports, paternity, ancestry and pharmacogenomics (the role of genetics in a patient’s reaction to drugs) tests. The general public can buy genetic test kits online through companies’ websites or through e-commerce companies such as Amazon with a cost around INR 3,000 to INR 1,20,000 depending on the nature of each test.

After submitting a DNA sample (saliva or cheek swab), consumers can receive results in a few days. Similar to the West, the proliferation of DTC genetic tests in India has raised many scientific, ethical, social, and regulatory issues such as clinical validity and utility, genetic determinism, and potential misuse of genomics data. Additionally, the marketing strategy of many companies has prompted further questions about the nature of scientific practice in India.

**The ethics of marketing strategy**

In a time in which the Code of Medical Ethics Regulations and Advertising Acts is poorly implemented and enforced, and in the absence of any guidelines or regulations for DTC genetic tests, companies are free to make exaggerated claims about the benefits of their testing. They may also misrepresent their products to capitalize on the social and cultural beliefs of common people. For instance, a company, as a business strategy, has linked genomics with astrology to entice consumers to buy their tests. The company has even named one of its products *Genomepatri*, which sounds similar to *Janampatri* (birth chart) for this purpose. In a promotional message on YouTube, the CEO of the company emphasized the advantage of online genetic tests by highlighting the importance of astrology in human life. She said that the same way *Janampatri* helps people understand zodiac signs, planets and *gotra* etc. at the time of birth, genetic tests would help in understanding genetic makeup and genetic characteristics, including any mutations that may be present. Further, she elaborated that a person can enhance positive (genetic) traits through knowledge of genetic features coupled with lifestyle changes. According to her, these preventive measures are similar to astrology in which people do worship, perform *yagna* etc. to protect themselves from bad effects of the planets.
The above promotional message could be justified in the name of analogy. In communicating a complex scientific concept to a layperson, using analogy is a common practice. However, this particular analogy of astrology with respect to genomics might have far-reaching implications on the practice of science in India. It is worth highlighting that the Indian scientific community, by and large, consider astrology to be a pseudoscience, and any attempt to bring astrology onto scientific platforms has been strongly opposed. This analogy is potentially contrary to the concept of scientific temper as well.

Additionally, the publication of testimonials from eminent personalities on the websites of companies, also raises issues related to medical ethics. Sometimes, they contain statements by leading politicians, industrialists and other public figures of the country. Such testimonials have the potential to mislead the general public, as highly reputed and educated public personalities of the country seem to recommend the products. In addition to above important issues, there are also key scientific concerns with genetic tests that are especially relevant in India.

**Scientific issues**

DTC genetic tests include options such as DNA-based dietary plans, fitness, sports, paternity, and ancestry, to name a few, and they are all non-diagnostic in nature. Moreover, these personal online tests cannot accurately diagnose the presence or absence of a disease; they mostly predict the probability of one. And, because these tests are offered directly to the general public without interacting with a doctor, there are greater chances that consumers may misinterpret the results. The situation is further complicated by the lack of sizable numbers of qualified genetic counselors and geneticists in India.

The lack of available, validated genetic data on the Indian population is another obvious problem with DTC genetic services and this issue has been reported in media coverage. This might be the reason why many Indian companies are using data generated from Caucasian populations as reference data for their tests.

**Concluding remarks**

The innovations in genomics need to be sensitive towards emerging ethical, social, scientific and regulatory issues. Unfortunately, at this time India has no guidelines or regulations for genomics medicine though the Indian Council of Medical Research is completely aware of the situation. Indian biomedical agencies and health professionals including scientists need to come forward to produce a regulatory framework to protect consumers from possible health risks and economic exploitation associated with DTC genetic tests.
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The views and opinions expressed in this article are those of the author and do not necessarily reflect the official policy or position of either Confluence or the Indian Academy of Sciences.
‘Plan-S’ Model of Research Publication –
A Serious and Unwarranted Drain on
Money Meant for Actual Research

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Summary

The practice of authors or their funders paying for readers to read the work remains a fertile ground for may unwarranted practices and consequences.

Full Article

Research is an essential part of human civilization. The practice of sharing of the knowledge gained through research by the investigator with other fellow human beings has played a pivotal role in all the developments in human societies since their inception. The modes of sharing of the knowledge have evolved with technological advances from oral to written to printed, and now to ‘soft’ form on the internet. With the advent of formally organized science and technology, communication of new research findings also got more organized and led to publication of scholarly research journals, initially by learned societies and academies, and later by commercial publishers as the number of researchers and volume of their findings requiring dissemination increased exponentially over the years.

The current state of research publications is plagued by multiple, inter-related as well as independent issues which make the experience of publication a night-mare rather than a pleasure. On the one hand we have the so-called high-impact factor tagged journals which often remain beyond the reach of most researchers because of considerations other than merit, and on the other end, we have a rapidly breeding genre of predatory/bogus journals
that would publish ‘anything’ for a fee. Between these two extremes, are the large numbers of ‘hybrid’ as well as online-only journals that may or may not charge authors for publications and/or open access (OA). In recent years, stiff competition has encouraged an increasing number of journals to levy charges of one or the other kind to authors for publication of articles. The very high subscription charges coupled with shrinking library budgets also led to the innovative practice of authors paying the publisher a hefty fee for others to read a given paper. Many of these journals, especially the online journals, actually earn huge profits through the so-called ‘processing’ and/or OA charges. These charges have also become a good source of earning for many scholarly societies and academies as well.

The Plan-S initiative, directed to provide full open-access science publishing and launched by a consortium of the European Research Council and the major national research agencies and funders from twelve European countries, requires that publications coming out of state-funded research activity must be available in open repositories or in journals that are free to read immediately on publication. This plan ostensibly ensures that the current system of paywalls would not deny access to science to anyone. Under the Plan-S, researchers would be required to publish in an OA journal or platform or in a subscription journal provided the final, peer-reviewed or accepted manuscript is immediately made available in an OA repository or to publish in hybrid journals with subscription charges but with an OA option. In the last case, the journal must be committed to move to a fully OA model. Under this plan, the funders of research would defray the OA charges that the journal levies.

As argued elsewhere (Lakhotia 2017), the practice of levying the OA charges is primarily fuelled by commercial interests, rather than by the desire to make the science accessible to all. This practice in fact fuelled the rapid growth of predatory journals. Many of the new online only journals that have been started by publishers of ‘good’ journals consider the manuscripts rejected by the main journal, and often publish them on payment of a fee. This practice may also be close to the border of predatory journals’ practice since the reviewers for online only journals are often warned not to look for originality or novelty! Thus these journals indirectly discourage reviewers from rejecting a manuscript to ensure that the OA charges are not lost. Obviously, although peer-review is claimed to be in place, its rigor is usually missing, which brings them close to the brazenly predatory or bogus journals.

It seems that India is also seriously considering adoption of the plan-S with some modifications. I think adoption of the plan-S would further place researchers in the country to greater disadvantage. The presently available money for research is indeed grossly inadequate (Lakhotia 2018a); if the funding agencies have to make a provision for payment of publication and/or OA charges, as required under the plan-S provision, the grant available for actual research would get further partitioned and may in fact deprive may others in less-endowed institutions of any support. This would further escalate the divide.

Another reason why the Indian government should not support the plan-S is that this would only help publishers from other countries to earn money while the local journals languish. Instead, it should liberally support some of the journals published in India which have
reasonably good publication policies and practices but are not able to make mark due to the ill-founded bias in favor of the so-called ‘international journals’ (Lakhotia 2018b). Journals published independently by learned societies and academies in the country, which have good publication policies and practices and which do not levy any charges, should be liberally supported so that they may develop good infra-structure, at par with those outside the country, and consequently attract good manuscripts, not only from within the country but also from outside on a competitive basis. Promotion of research and dissemination of its output should primarily be a philanthropic activity on part of the state and industry (Lakhotia 2014).

The question of published material remaining behind paywalls existed even when print only journals were available to readers on the basis of institutional or individual subscription. However, we could still read new publications without paying the access or subscription charges. Sending postal requests for hard copy reprints to authors, and evoking a fairly good response, was a common practice till a few decades ago. In principle, the current internet and email era makes it much simpler and quicker to share the pdf file of published work with anyone across the globe. Although posting of the final pdf file on personal or institutional web page is usually not permitted, I am not aware of anything in the copy-right forms signed by authors that prevents free sharing of pdf files with other researchers. Thus the view that science remains behind ‘paywall’ is an unfounded impression created by publishers, and unfortunately accepted by authors without scrutiny. Obviously, publishers do not wish to lose the money that they collect either from authors as OA charges or from readers as licensing fee for reading, and hence it is in their interest to create an impression that sharing of pdf files is not permitted. If we reinvent the old, but legal, practice of exchanging reprints, and widely share pdf files through email, no person desiring to read a published work would have to worry about the paywall. Authors can maintain a list of email addresses of potentially interested researchers and all of them can be sent the pdf file in one click; similarly the pdf file can be emailed to those who request. This does not take much time and no research money is wasted in the form of OA charges.

The practice of authors or their funders paying for readers to read the work remains a fertile ground for may unwarranted practices and consequences. Therefore, the plan-S should not be adopted.

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How can a Young Scientist Help to
Counter the Wave of Pseudoscience?

ANINDITA BRAHMA
Indian Science Congress, pseudoscience
Posted January 20, 2019

Summary

If the majority of the population starts believing in pseudoscience just because we chose to remain silent, and hence the society starts moving backwards, isn’t that is where the motto of practising science loses its meaning?

Full Article

Yet another Indian Science Congress has taken place, and yet again pseudoscientific remarks from a few participants (two in the current year) have instigated the science-pseudoscience debate in this country. This is an ongoing trend since the 102nd Indian Science Congress (ISC) held in Mumbai, which witnessed claims like the presence of interplanetary planes during Vedic age, invention of Pythagoras theorem in India, the ability of cows to turn their food into 24 carat gold etc. Similar claims were made in the subsequent Indian Science Congresses, following which a few scientists and rationalists expressed their discontent and raised concerns about the wave of pseudoscience that has hit the country, one or two articles were published in mainstream media, and after that everyone forgot about it till the time of the next chapter of ISC. In all these, there was and still is a surprising lack of participation from science students and young scientists, who form a major part of the Indian science practitioner’s community. Was it the lack of time (which is a genuine reason at times) or apathy or just a carefully measured step to save one’s back from the wrath of prominent ‘powerful people’?

It is evident from the 106th meeting of the ISC that the concerns raised by a few scientists after the 105th meeting of ISC held in 2018 had no effect at all. So, what is going wrong? I think a major part of the problem lies with the youth in science. Most of us, the young Indian science practitioners choose to remain silent in such cases, although many of us are
very much aware of the issues and realise at the core of our hearts that something needs to be done soon. We scroll through our social media pages, frown on such news, experience some facepalm moments, and get back to our work assuming (most of the time) that we cannot do anything about this. But is it true that we cannot do anything in this regard? No, I do not think so, especially in the era of internet. The easiest thing of all would be to share the news of pseudoscience propagation while simply pointing out that it is not real science. We all have hundreds (maybe thousands for some) of connections in social media, and if at least a few of them read and share the posts, and discuss the issue, even then we would be contributing towards the aim for spreading awareness on what is real science and what is pseudoscience. Most of us are part of various Whatsapp groups (willingly or unwillingly) and have faced a bombardment of pseudoscientific posts. However, most of us succumb to the fear of wasting our time in countering such news and hence choose to remain silent. What we do not understand is that by remaining silent, we are endorsing these news and views. If we start countering such news with logic and data (without getting angry or abusive), and if we could make at least a few of our family members, friends and acquaintances understand the harm of believing and sharing such pseudoscience posts, we will be contributing towards countering pseudoscience.

The next step could be to blog, write popular articles and/or participate in discussions in public forums for debunking pseudoscience. Of course, this might not be possible for everyone because of various constraints, but we should at least try to involve at least a bit of our time and try to help counter the rising wave of pseudoscience. And this is where science communication also comes into the picture. We are indeed in need for well-trained science communicators who have formal training in science, and who will collaborate with scientists to make scientific research accessible to all. In recent times, it is very encouraging to see that there are various training programmes and workshops on science communication, and I think that young science practitioners everywhere should be encouraged to participate in such programmes to receive basic training on communicating science in public forums. This will not only serve as a step towards learning how to take science outside the labs but will also provide encouragement for speaking up against the blatant propagation of pseudoscience.

Finally, I would like to raise one serious concern. If the reason for choosing to keep a distance from any kind of activity and/or discussion concerning countering pseudoscience is because it might be tagged as a ‘political’ one, then the time has come when we might want to start thinking about the pros and cons of remaining ‘apolitical’. Among the pros, the most important one is, of course, avoiding any sort of political wrath and silently practising science behind the closed laboratory doors. However, if the majority of the population starts believing in pseudoscience just because we chose to remain silent, and hence the society starts moving backwards, isn’t that is where the motto of practising science loses its meaning? Too long we have avoided this question and our silence has been regarded as our endorsement towards the false claims in the name of science. As science practitioners, we
have a responsibility towards the society and it is time we take it with some more seriousness.

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Have we Scientists Failed our Society?

ANINDITA BHADRA

Darwin, Evolution, pseudoscience

Posted April 21, 2019

Summary

As scientists, we need to recognize that communicating our research findings to the non-specialist, taking our science to the next-door neighbour or a vendor on the street or a politician, spreading the excitement of science among young people are our responsibilities as much as carrying out our research with sincerity and honesty is.

Full Article

In recent years, there has been some concern among Indian scientists and in the public media about the spread of pseudoscientific ideas in our society. Every time a comment is made in public by a politician or administrator, there is outburst in the media and an even bigger outburst on social media. Sometimes the scientific community is so outraged that statements are put out against the anti-scientific or pseudoscientific statement. A few days later, only the scientists remember the incident as fresh news takes over public attention. Let me take the example of the statement made by a Union Minister, that Darwin was wrong about human evolution; the sages in the Vedic age did not write about apes turning into humans, so this can’t be true. There was considerable media outburst, which lasted longer than expected as the scientific community reacted strongly to this statement. Especially when it was suggested that school curricula be appropriately changed in the light of such an opinion, the community recognized the responsibility to criticize this. Moreover, in spite of a rap on the knuckles by higher authorities, the Minister defended his statement on a later date, creating further controversy. In fact, the clamour reached a level to make international news, with a report published in Nature News. The Minister, I feel, actually did a service to the community in this case, because there was some positive fallout of the controversy.

Perhaps it was serendipitous that this statement was made by the Minister towards the end of January. 12th February is Darwin day and typically, this is not celebrated on a large scale in our country. However, following the controversy last year, there was a flurry of activities
around Darwin day, organized by the academies, NGOs, schools, colleges and other institutions. I personally delivered three lectures on Darwin and Darwinism in Darwin week. This sudden interest in Charles Darwin had its roots in that one controversy over an anti-science statement. One year later, this frenzy has died, the activity level on Darwin day has returned to its normal state of absence. Personally, I have interacted with several people over the last year, following this controversy. Unfortunately, most lay people agree with the Minister, in spite of all the statements in the media by the scientific community!

I feel it is time we scientists held a mirror to ourselves and asked, “Where have we gone wrong?” We agree that in India, there is not enough funding for research and education and we need to work towards improving this situation. We need to raise our voices against funding cut for science and to engage with the policy makers to enable higher investment in basic research and education. However, we need to remember that we have a greater responsibility towards the people whose hard-earned money helps us to pursue our research – the taxpayers of the country. As a community, we have failed the people who fund our research by not communicating to them our findings and the excitement of science.

A large number of scientists take pride in the fact that their research is beyond the understanding of the “aam aadmi” and in fact, cannot be communicated beyond the peer group. Many consider research that can be communicated to the uninitiated, shared in the public media, discussed by non-scientists to be of an inferior quality. In fact, some go to the extent of saying that such research cannot qualify as science and at best can be called social science. In making such sweeping statements, one does not denigrate the social sciences but one’s own standing as a scientist, by the sheer display of lack of objectivity.

As scientists, we need to recognize that communicating our research findings to the non-specialist, taking our science to the next-door neighbour or a vendor on the street or a politician, spreading the excitement of science among young people are our responsibilities as much as carrying out our research with sincerity and honesty is. We should take pride in the ability to communicate science to the layperson and not shy away from it. When a piece of research gets highlighted by the public media, we should rejoice and congratulate the researchers instead of mocking them for not doing science that is of “high quality”. If we cannot take our research findings to every classroom and drawing room, every coffee shop and bus stop, we should be shy of demanding more public funding for our research. Why should the shopkeeper in my neighbourhood care about funding science if he cannot understand what it is all about? He would rather fund the building of roads, laying of railway lines, the establishment of hospitals and even buying of more ammunition – all tangible ways of spending his hard-earned money, as opposed to funding some vague scientific project with a meaningless acronym. At least launching of rockets can bring pride to the nation and its people, but why should the people care if someone is peeping into the depths of live cells or growing populations of mutant flies or solving partial differential equations? Why should he care if PhD scholars get a fellowship hike or not? Why should he be bothered if an Indian scientist publishes a paper in the world’s best journal? After all, how many Nobel prizes have we brought to the country as a community, the people ask,
and why shouldn’t they? Neither do we give them something to be proud of, nor do we care to share our knowledge with them. We keep them away from our labs and we treat them as intellectual inferiors who have no right to demand answers from us. Why should the people be interested in supporting an endeavour which doesn’t give them anything tangible in return? When we, as scientists, do not make the effort to reach out to the people, how can we condemn them for believing in pseudoscience? At least the people who spread pseudoscientific and anti-scientific ideas make an effort to reach out to society. How can we expect to counter this from a pedestal of our own creation?

As a community, we have failed to engage with the society and thus, we should hold ourselves responsible for the flourishing of pseudoscience, not the politicians who use this for propaganda. When someone claims that an ape never changed into a man, we don’t make a concerted effort to explain the fallacy in the statement. We don’t bother to explain to the layperson the true essence of evolution. We do not protest when our children are taught to accept anything that is written in the textbook as truth, not through experimentation and reasoning, but through command and faith. We do not bother to “waste” time in reaching out to school children and showing them how they can test the facts written in their books. We do not object to a system of education that is dictated by the vicious loop of examinations based on memory, marks and tutorial businesses. We do not talk to the media and we do not encourage our students to take up science communication as a profession. We do not bother to write popular articles as it is a waste of time and does not get counted in various metrics for promotions and awards. We do not bother to deliver talks and write in the regional languages as this is below our dignity. We are thereby largely ignored by the public media, unless there is some scandal and the science that we do gets filed away in computers and lab notebooks, never reaching beyond the peer group. Yet, we demand that the public should support our research and we expect that young people would be motivated to take up science as a career. It is time that we owned up to ourselves that we need to cleanse our community of the false pride of knowledge. It is time we came down from our pedestals and engaged with the public, taking our science to schools and colleges, cafes and shopping malls, drawing rooms and playgrounds. Only then, can we hope to begin cleansing the society of pseudoscience and anti-science and begin creating a society rooted in the philosophy of science as a way of life.

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The views and opinions expressed in this article are those of the author and do not necessarily reflect the official policy or position of either Confluence or the Indian Academy of Sciences.