Mis-educating India

The 2018 report of Science and Engineering (S&E) Indicators is expected any day now at the time of writing this letter. In anticipation I revisited the 2016 report of Science and Engineering Indicators[1] (henceforth SEI 2016). I was intrigued by the section titled: 'Science and Technology in the World Economy/Workers with S&E Skills', where a nation's innovative capacity and economic competitiveness are linked to the number of workers with S&E skills. To enable this, governments have made increased access to S&E-related post-secondary education a high priority. In 2012, the global estimate of first university degrees in S&E was about 6.4 million, with China (23%) and India (23%) accounting for almost half of these degrees. Another 21% was conferred in the European Union (EU), while the US accounted for only 9% (figure O-1, SEI 2016). Also shown in figure O-1 of SEI 2016 are the estimates for non-S&E first university degrees – here India accounts for 29.3% of the global total of 13.6 million graduates, a figure that I view with some cautious optimism – if true, it means that our higher education system has been remarkably successful in increasing access to post-secondary education across the board (i.e. both S&E and non-S&E).

However, does this translate to better economic performance and better innovative capacity? Again, elsewhere in the same report we have data compiled of all S&E articles in all fields, by region/country/economy for the period 2000–2013 using a fractional count basis (appendix table 5-26) and nominal GDP, again by region/country/economy for the period 1999–2015 in terms of millions of current dollars (appendix table 6-3). These data can be rearranged as shown in Table 1 and Figure 1, so that the world share of publications and the world share of nominal GDP can be compared to the world share of first university degrees awarded in 2012. We can also propose leverage terms – that is, a world share of 100% nominal GDP is correlated to 20 million graduates to give a global leverage (norm) of 5 and a world share of 100% R&D output is correlated to 6.4 million S&E graduates to give a global leverage (norm) of 15.6. We can see from Table 1 and Figure 1 that the US and EU perform far above this global norm, while China and the rest of the World are virtually at the global norm.

Table 1. Extract from figure O-1 and appendix tables 5.26 and 6.3 of SEI 2016

Country, region, economy	First university degrees, 2012 (millions)	S&E first university degrees, 2012 (millions)	Nominal GDP share, 2012	R&D output share, 2012	Nominal GDP leverage, 2012	R&D output leverage, 2012
The United States	1.81	0.59	22.73	19.38	12.54	32.91
EU	2.60	0.74	23.86	27.92	9.18	37.93
China	3.03	1.50	12.28	17.38	4.05	11.61
India	5.46	1.47	2.63	4.12	0.48	2.80
Others	7.09	2.11	38.51	31.19	5.43	14.77
Total	20.0	6.4	100.0	100.0	5.00	15.61

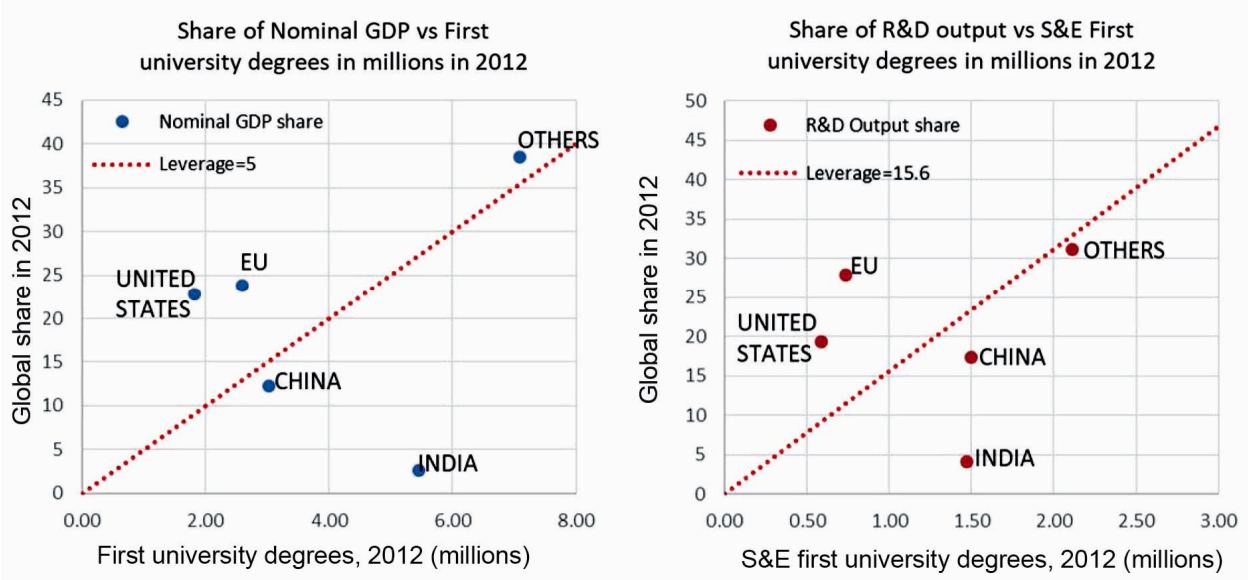

Figure 1. USA and EU perform far above the global norm, while China and the rest of the world are virtually at the global norm. India is performing at a fraction of what the norm could be.

India is performing at a fraction (approximately a tenth in the case of GDP) of what the norm could be. So, if the estimates in figure O-1 are correct, it could only mean that we have been miseducating the youth in a way that nearly 90% of our graduates neither contribute to the economy nor enable its innovation. Degrees in India are not without value and the SEI data allow this to be quantified. There is such unevenness that our higher education system is largely ineffective in improving scientific output in particular or economic output in general.

1. https://www.nsf.gov/statistics/2016/nsb20-161/#/ (accessed on 12 January 2018).

GANGAN PRATHAP

Vidya Academy of Science and Technology,
Thrissur 680 501, India and
A. P. J. Abdul Kalam Technological University,
Thiruvananthapuram 695 016, India
e-mail: gangan@vidyaacademy.ac.in

Tricotyledony in *Pterocarpus santalinus* L.f. (red sanders; Faboidae), an endemic and endangered tree species of Kadapa hill ranges, southern Eastern Ghats, India

The presence of three cotyledons among dicots in contrast to the primary characteristic feature of having two cotyledons is rare and is referred as tricotyledony. It may be caused due to genetic variability[1]. The incidence of tricotyledony was also reported among trees like *Acacia mellifera* (Vahl) Benth[2], *Butea monosperma* (Lam.) Taub[3], *Emblica officinalis* Gaertn[4] and shrubs like *Hippophae rhamnoides* L.[5], *Withamnia somnifera* (L.) Dunal[6], *Punica granatum* L.[7] and even in critically endangered plants like *Ceropegia mahabalei* Hemadri et Ansari[8]. In this study we present an observation of tricotyledony in *Pterocarpus santalinus* L.f. (red sanders). It is an economically important and endemic timber tree species with restricted natural habitat in Kadapa and Sheshachalam hill ranges of southern Eastern Ghats, Andhra Pradesh, India. It is also the dominant tree across the reserve forests of Kadapa hill ranges[9]. The tree reproduces mainly by seeds as well as vegetatively by stumps raised from cut stems.

Pods were collected during April–May 2017 from Kadapa hill ranges and seeds were extracted from the pods mechanically using secateurs. A total of 720 pods and 360 seeds were used, and similar kind of germination experiment was carried out for both pods and seeds for a period of six months with an interval of one month. Germination percentage of 53 (range 40–55%) was observed when pods were considered and lower rate was observed (31.3; range 15–33%) when seeds were germinated. Furthermore, out of

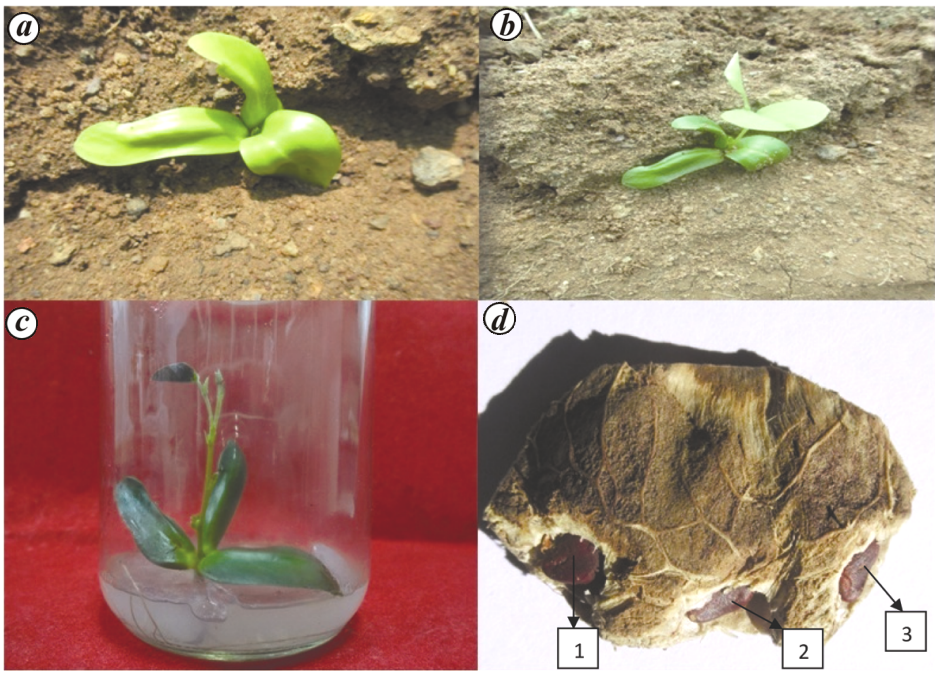

Figure 1. ***a***, Incidence of tricotyledons in *Pterocarpus santalinus* L.f. seed germinated in the soil. ***b***, Healthy seedling with tricotyledony featuring normal first true leaves. ***c***, Seed germination with tricotyledony in basal MS medium. ***d***, Pod showing trilocules filled with one seed.