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# **HIGHER EDUCATION INSTITUTIONS IN BUILDING INDIA**

**A BENCHMARK WITH THE WORLD'S  
BEST UNIVERSITIES**

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# HIGHER EDUCATION INSTITUTIONS IN BUILDING INDIA

## A BENCHMARK WITH THE WORLD'S BEST UNIVERSITIES

SHIBU JOHN AND SEYED E. HASNAIN

*In the present society, an individual's survival has become crucially dependent on higher education. As per today's academic landscape, which direly needs to be more research-oriented, the mission of higher education is to educate and train individuals in various specializations, improve focus towards research and thus, serve the community. Today, most of the highly ranked institutions in the country are public funded where students need to pay very less fee but admissions in these universities or colleges is strictly merit based and rejection rate is as high as almost 90 per cent. Considering these circumstances, students migrate toward private universities for higher studies. The rising costs of private education and non-availability of seats in good public institutions is impinging upon the choice of many bright students to make compromises. Many students are going abroad straight after secondary school, which shows that there is money, there is demand, and there is the market available. What we need to do is raise the bar of higher education in the country and also create more educational opportunities so that we can retain those who go abroad for higher education. Ranking and evaluation of higher education are two of the main pillars that support the development process of universities, institutes of higher education, R&D facilities, scientific institutes, and all institutions that aim at providing higher education. Formulation of stable, long-term and robust policies and regulatory pathways needs to be undertaken by the government. This will help in the establishment of the trust of various stakeholders in the educational system and will help in a big way to refurbishing the Indian universities.*

### PRELUDE

Higher education is a critical tool that catalyses the overall development and growth of the nation. It is an integral cog to which the dual task of polishing an individual's aptitude and skills in a specific niche and also enhancement of his view of worldly matters in different walks of life, is attributed. In the present society, an individual's survival has become crucially dependent on higher education. As per today's academic landscape, which direly needs to be more research-oriented, the mission of higher education is to educate and train individuals in various specializations, improve focus towards research and thus, serve the community. As the world is morphing into a global village, the scope and demand of higher education have undergone manifold increase, and delivering excellent quality education is the only means to meet this demand. The

current education system, in all its levels, sticks to the ‘mantra’ of quality education which is at par with the global standards. The growth of the nation is propelled further by higher education because it yields a skilled workforce with specialised knowledge and a considerably better status of cognitive and cerebral development.

After USA and China, India is home to the largest higher education system globally. The regulatory roadmap of this sector is laid out by the University Grants Commission, which devises appropriate guidelines and standards, keeps a check on their implementation, and establishes coordination between the central and the state governments. The key stakeholders in the education system, i.e., the students, the faculty, the parents, the institution’s management, policy-makers and even the society as a whole are concerned with the quality of higher education being delivered. Barring a few universities, the Indian higher education is nowhere near the so called ‘global standards’; Indian universities found no place in the list of world’s top hundred universities. It is a matter of concern that even top-notch Indian institutes like the IITs and IIMs fell short in terms of finding a spot in the top 200 universities globally as per the recently released rankings of Times Higher Education, Shanghai Jiao Tong University, and QS World University Rankings. The US universities enjoyed domination in all three rankings, out of which, some universities were privately owned. It is indeed a paradox that despite the absence of such recognitions, students graduating from IITs/IIMs etc. are much sought after internationally and many of them are heading top educational institutions in the US, Europe, and so on. This raises a serious question of gaps/biases in international rankings. Having flagged the above paradoxes, it can be said that the approach adopted by the Indian education system should be multi-dimensional and broad-based. The functioning of various educational institutions should be regularly reviewed either through self-assessment or through the engagement of unbiased, external agencies. The accreditation of institutions by unbiased governmental bodies can also help keep the system in check. With a growth in the number of institutions providing higher education, the education system has also fallen prey to malpractices, like substandard infrastructure, poor faculty and management, exorbitant capitation fee other than the tuition fee, and much more. The rapid privatisation of the education sector has led to an increased involvement of the faculty members, non-teaching staff, managerial staff and other stakeholders in legal matters, which adversely impacts the quality of education.

Today, most of the highly ranked institutions in the country are public institutions where students only have to shell out a minimal fee or the fee is highly subsidised—a situation that is just opposite to what is common in the west. Students’ admissions in these universities or colleges are based on their academic credentials. Due to this, the rejection rate is as high as almost 90 per cent, where the students’ choice of institution is compromised. Considering these circumstances, students migrate toward private universities for higher studies. However, the course of study offered by many colleges is often outdated due to lack of well-skilled faculty and infrastructure. A vast majority of the present higher education institutions are insufficiently equipped to provide services like proper induction/orientation programmes, healthcare facilities, hostels/

accommodation, and career-related direction and counselling. Some other factors which also impact the quality of higher education are a general lack of motivation among the teachers and students, lack of facilitation of the teaching-learning process by the external environment, and relentless adoption of irrelevant and obsolete teaching methods and curriculums, without revision. The factors mentioned above result in low employability and incompetent professionals.

### **HIGHER EDUCATION IN INDIA: PRESENT SCENARIO**

Since independence, the Indian higher education landscape has undergone rapid development. The number of higher educational establishments, students enrollment, number of faculty members, infrastructure, technology, quality of medical, vocational and technical education, and education management have improved substantially. This is credited to a better level of monitoring, stringency in the evaluation and constant quality maintenance being undertaken by various national agencies. It raises socio-political awareness among the people, aids the functioning of the democracy and engages the citizens in the nation-building process. Attaining higher education leads people towards research, which goes on to birth innovation. As said by Pt. Jawaharlal Nehru, the first Prime Minister of India, in his convocation address at Allahabad University (1947), “A university stands for humanism, for tolerance, for reason, for the adventure of ideas and the search of the truth. It stands for the onward march of the human race towards ever-higher objectives. If the universities discharge their duties adequately, then it is well with the Nation and the People.”

As reported by All India Survey on Higher Education (AISHE), 2018-19, in the country, there are 993 Universities, 39931 Colleges and 10725 independent Institutions; 385 universities in this list are privately managed. The Bangalore urban district has the highest number of colleges, which is 880 whereas Jaipur has 566 colleges. In terms of college density, Bihar ranks the lowest, with only seven colleges established per lakh of eligible population (18-23 years of age), whereas Karnataka tops the list with its 53 colleges in contrast to the national average of 28. Around 88 per cent of colleges in Andhra Pradesh & Uttar Pradesh are private-unaided facilities, while 87 per cent and 16 per cent are of the same nature in Tamil Nadu and Assam, respectively. As far as student enrolment trend goes, less than 100 admissions are made in 16.3 per cent colleges, and a meagre four per cent of colleges have an enrolment figure of 3000 students and above. A net estimation of enrolment amounts to about 37.4 million, with figures of 19.2 million and 18.2 million for males and females respectively. The Gross Enrolment Ratio (GER), as calculated for the eligible group, i.e., 18 to 23 years, is also just a little more than 26 per cent, with almost equal figures of 26.3 per cent and 26.4 per cent, for males and females, respectively. The figures for SC and ST candidates are around 23 per cent and 17 per cent, as compared to the national average of 26.3 per cent with Muslims at the lowest of about five per cent. As per the findings of the same report, the number of international students from 164 different countries worldwide enrolled in Indian higher education institutes is 47,427, out of which highest number comes from Nepal (26.88 per cent). Afghanistan (9.8 per cent), Bangladesh (4.38 per cent), Sudan (4.02 per cent), Bhutan (3.82 per

cent) and Nigeria (3.4 per cent), with their respective shares, constitute the most significant proportion of international students enrolled.

- As far as programmes are concerned, out of the total, programmes having relatively higher enrolment were studied to see the students' concentration.
- Bachelor of Arts (BA) has 93.49 lakh students enrolled in it, which is the highest enrolment in any program;
- Bachelor of Science (B Sc) has 46.80 lakh students enrolled in total;
- 40.30 lakh students enrolled in B.Com;
- B Tech has 21.25 lakh enrolled students, out of which 72 per cent are male whereas the per centage of females is 28 per cent;
- Bachelor of Engineering (BE) has 16.45 lakh students enrolled, out of which 71.14 per cent of students are males.
- Master of Arts (MA) has a 15.12 lakh total number of students enrolled with 61.78 per cent female students.
- BA (Hons) has 16.39 lakh students with 44.79 per cent male and 55.21 per cent female students.
- The highest number of PhD students come from the Science section, followed by Engineering and Technology.

In the light of the 2018-19 AISHE report, nearly 80 per cent of the colleges are operating privately – both partially aided and unaided – but they provide for only 66.4 per cent of the total students enrolled. Whereas, more than 33 per cent of students come from government educational institutions. The number of universities and similar institutions listed on AISHE portal has increased from 760 in 2014-15 to 993 in 2018-19, which is almost 30.7 per cent, as demonstrated in Fig. 1. Whereas, the number of colleges has gone up from 38,498 in 2014-15 to 39,931 in 2018-19 by more than 3.5 per cent as shown in Fig. 2.

FIG. 1: NUMBER OF UNIVERSITIES

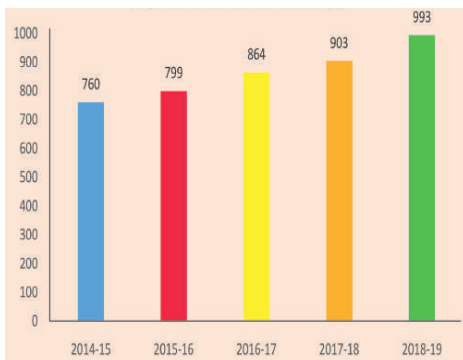
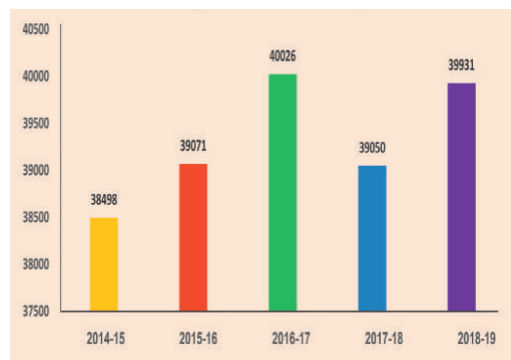
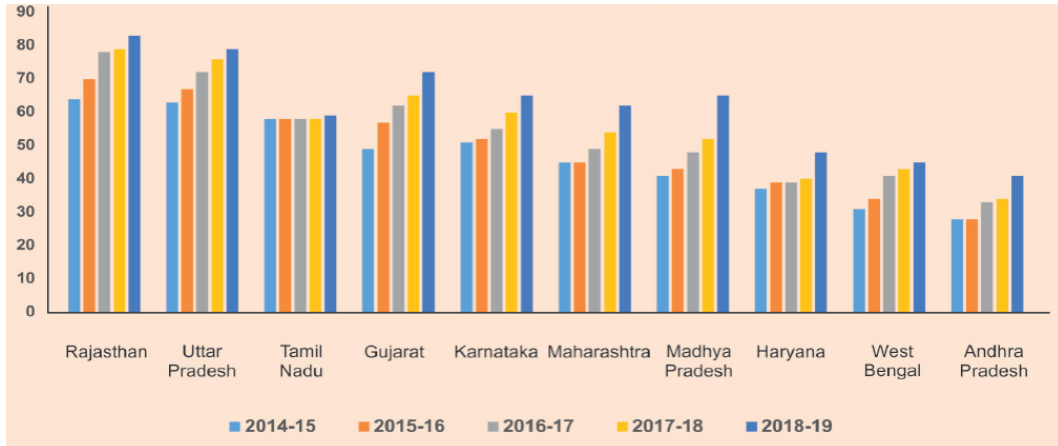


FIG. 2: NUMBER OF COLLEGES



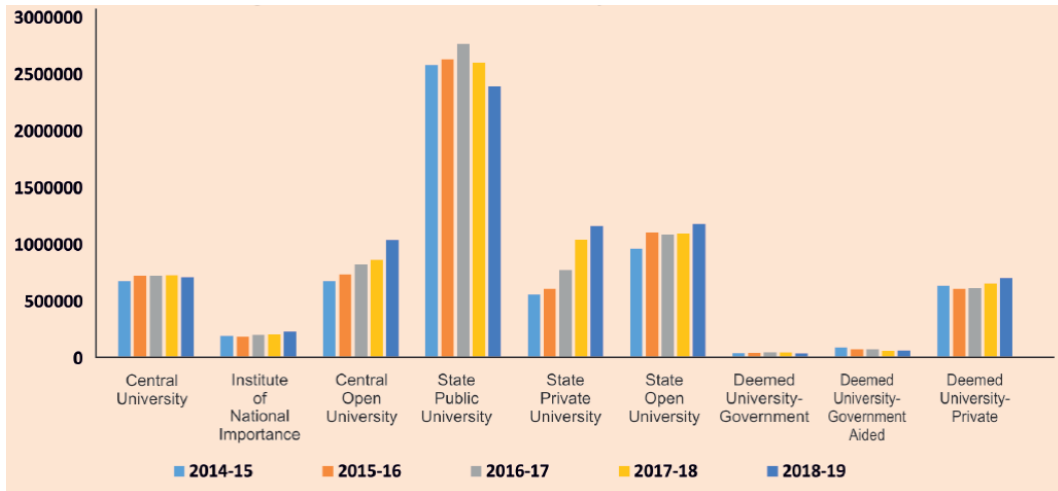
In larger states such as Rajasthan, Uttar Pradesh, Tamil Nadu and West Bengal, very few universities have come up during the period 2018-19 as compared to the previous year (Fig. 3).

FIG. 3: NUMBER OF UNIVERSITIES IN MAJOR STATES



Enrolment at all the levels has increased over the years. The Compound Annual Growth Rate (CAGR) is 1.8 during the last five years, but in case of integrated courses, the CAGR is 11.2.

FIG. 4: ENROLMENT IN VARIOUS UNIVERSITIES & ITS CONSTITUENT UNITS



Gross Enrolment Ratio (GER) has increased during the last five years, from 24.3 in 2014-15 to 26.3 in 2018-19. The increase is more under SC category, which has increased from 19.1 in 2014-15 to 23 in 2018-19. In the case of ST category, the GER has increased from 13.7 to 17.2 during this period. In comparison to males, the increase in GER is higher for females.

## PRIVATE HIGHER EDUCATION SYSTEM IN INDIA

The Indian private higher education sector is getting more competitive with a remarkable increase in the number of academic institutions in the country. Despite the concerted and continuous efforts by private educational institutions, quality has not yet reached the desired level. The rising costs of private education also needs due consideration, and efforts need to be put in order to make it affordable. The goal of higher education is not only to create new knowledge but also to create skilled forces for the country to face developmental challenges. Maintaining quality and balance in the education system is integral to this. Unfortunately, many of the private universities are not research-oriented. The industry has mapped most of the universities in terms of employability skills of graduates. Thus, the job market makes clear distinctions among various university graduates. But products from all universities do not have the same skill sets. Products from only a few universities have goodwill and the high demand in the job market and are capable enough to pursue global job markets. Many private universities of India have gained both national and international reputation; unfortunately, a majority of them are not functioning with the same level of efficiency (Table 1).

TABLE 1: LIST OF BEST EDUCATIONAL INSTITUTIONS OF INDIA  
UNDER PUBLIC AND PRIVATE CATEGORY

S. No.	Public Universities (as per IoE, Government of India)	Private Universities (as per IoE, Government of India)	Private Colleges (as per NIRF, 2018- 2019)
1.	IIT Bombay	BITS Pilani	Miranda House, Delhi
2.	IIT Delhi	Manipal Academy of Higher Education, Karnataka	Hindu College, Delhi
3.	IISc Bangalore	Jio Institute, Maharashtra	Presidency College, Chennai
4.	IIT Madras	Amrita Vishwa Vidyapeetham, Karnataka	St. Stephens College, Delhi
5.	IIT Kharagpur	VIT Vellore, Tamil Nadu	Lady Sriram College for Women, Delhi
6.	Delhi University, Delhi	Jamia Hamdard, New Delhi	Loyola College, Chennai
7.	University of Hyderabad, Hyderabad	Kalinga Instt. of Industrial Technology, Bhubaneswar	Shri Ram College of Commerce, Delhi
8.	Jadavpur University, Kolkata	O.P JINDAL University, Haryana	Rama Krishna Mission Vivekananda Centenary College, Rahara, WB
9.	Anna University, Chennai (Conditional)	Shiv Nadar University, Uttar Pradesh	Hansraj College, Delhi
10.	BHU, Varanasi	Bharti (Satya Bharti Foundation), Delhi	St. Xavier's College, Kolkata

Looking at the size of the country, the number of satisfactory private higher education institutions are very less. Until recently, the funding and provision of higher education in the Indian subcontinent was primarily under government administration. With the advent of the millennium, it became apparent that the government institutions were incapable of adequately meeting the ever-increasing demand for higher education, and so private establishments came into the picture. This was seen as a landmark move for the advancement of the higher education sector. Primarily, the current Indian private universities are established by humanitarians, religious trusts, private corporations and associations, and by NPOs. Many of the private universities in India are renowned for providing world-class education and have created a reasonably competent scenario and enhanced the quality of education they are providing. These universities are playing an essential role in promoting higher education in India. However, in recent years, the high amount of fees charged and a compromised education system have become victims of a significant backlash.

While many of the highest-ranked universities in US are private universities, including Harvard University, Massachusetts Institute of Technology, Stanford University and Yale University, the story in India is just the opposite. The American universities are funded primarily through student tuition fees. Private universities also dominated the top 100 of the overall ranking by various ranking bodies. In India, only a few universities like the Vellore Institute of Technology (VIT) – Vellore, Manipal University, Mangalore, Birla Institute of Technology & Science, Pilani, Jamia Hamdard University and SRM Institute of Science and Technology are ranked highly by national ranking agencies. Government's financial assistance to these universities is negligible, and there aren't many good quality private universities in India. Majority of the private universities are providing substandard education and earn revenue.

## UNIVERSITY RANKING SYSTEM

Ranking and evaluation of higher education are two of the main pillars that support the development process of universities, institutes of higher education, R&D facilities, scientific institutes, and all institutions that aim at providing higher education. The universities, up to a great extent, rely on these measures to determine their progress concerning the criteria set by the academic classification bodies. In the case of European universities, in particular, the ranking of universities is of great importance and is also taken into account by students during the admission process.

University rankings have gained much importance across the world. At the national level, Ministry of Human Resource Department, through UGC, has been assessing Indian Universities through the National Assessment and Accreditation Council (NAAC). NAAC, a Central government-sponsored council established to assess and grade 'participating' universities, colleges and professional education institutions, often possibly awards higher rankings to central higher education institutions due to an ex facie bias within the council. There are different criteria based on which every university is evaluated. The ranking bodies also contact its two significant stakeholders—alumni and the recruiters, for their perception about the university.



Finally, every university is scored on the overall performance. The score is valid for five years after which re-assessment must be sought. Another body, National Institutional Ranking Framework (NIRF), ranks every university and their different schools each year. NIRF rankings methodology is based on self-declarations. As far as global ranking is concerned, it went legitimately international in 2003 when Shanghai Jiao Tong University published results of the first global university ranking. The importance of rankings seems to have grown exponentially since then. Various higher education policy-makers increasingly consult ranking results when deciding on the allocation of the resources or the structure of higher education. These rankings strengthen competition and often bring policy changes in the higher education system, which strives to improve their standing among other prominent universities.

Higher education institutions are ranked globally to assess their competitive nature in terms of research, innovation, employability, alumni, perception, and so on. The key stakes for global universities despite their ranking are their teaching curriculum, research orientation, knowledge transfer and global outlook. The global ranking at present covers only a small percentage of around 2-3 per cent of the total global universities. There are numerous reasons for using a ranking system in global higher education organisations, such as the internationalisation of higher education, which means a large number of students enrolled in global higher education institutes outside their country of origin. This number is increasing continuously. Also, other factors are being added such as encouraging global institutions to partake in national and international discussions to nurture student and faculty exchange programmes, and increase research partnerships.

There are three influential and widely observed global ranking systems that have some standing today. The first world-known university ranking is the Academic Ranking for World Universities (ARWU), also known as Shanghai University Ranking. It started in the year 2003; was compiled by the Centre for World-Class Universities at Shanghai Jiao Tong University; financially supported by the Chinese government; and operated by the Shanghai Ranking Consultancy. This ranking uses six important indicators to rank universities globally that are:

1. Staff awards winning Nobel prizes in their respective areas – 20 per cent;
2. Highly cited researchers – 20 per cent;
3. Research papers published in reputed journals like *Nature* and *Science* – 20 per cent;
4. Papers indexed in science index-expanded and social science citation index – 20 per cent;
5. Quality of education (alumni winning Nobel prizes or medals) – 10 per cent; and
6. Per capita performance of an institution – 10 per cent.

As per the latest ARWU results, the highest number of universities from the topmost 20 universities in the world are from the US and Europe. Out of the best 500 universities, the majority of universities are from Europe, followed by universities from America, Asia and then Africa.

The other renowned methodology is the QS World University Rankings produced by the British Quacquarelli Symonds, which is being published for the last 16 years. Presently, it considers over 3,000 institutions and ranks more than 800. Its methodology is spread over four spectrums—research, teaching, employability and international outlook. Based on six indicators, wherein a weightage of:

- 40 per cent is given to Academic Reputation;
- 10 per cent to Employer Reputation;
- 20 per cent to Faculty/Student Ratio;
- 20 per cent to Citations per Faculty; and
- five per cent each to both International Student Ratio and International Staff Ratio.

The most significant percentage in this ranking is for academic reputation, i.e. 40 per cent. Furthermore, it is measured based on a global survey of academics, which asks select academicians all over the world about the top universities in their respective fields. QS uses citations from Scopus databases.

Another renowned world ranking is Times Higher Education. The methodology for Times Higher Education contains 13 performance indicators, which cover five key areas as follows:

1. teaching (30 per cent);
2. research (30 per cent);
3. citations (30 per cent);
4. industry income (2.5 per cent);
5. and international outlook (7.5 per cent).

To calculate the overall rankings, Z-scores are created for all data sets.

Based on the above three ranking processes, US universities dominate the Top 50 Universities' list, followed by Europe. Some of the world's best universities, which are common in all three ranking process are listed below:

- Harvard University, USA
- Stanford University, USA

- Massachusetts Institute of Technology, USA
- University of California - Berkeley, USA
- California Institute of Technology, USA
- University of Cambridge, UK
- University of Oxford, UK
- Imperial College London, UK
- University College of London

Globally, many highly ranked universities fall under the category of Private Universities. These universities thrive on the shoulders of their faculty, research & innovation profile, corpus fund, consultancy projects, international students, reputation, and so on. Indian higher education institutions have not been able to reach to the top 100 universities of the world primarily due to social balancing provisions and obligations towards the Constitution of India.

Government of India has taken the initiative to promote a few good universities to compete with world best universities. Though slightly delayed, this opportunity has been keenly welcomed. Accordingly, MHRD identified ten institutions each from the government and private sectors and recommended them as ‘Institution of Eminence’ to enable them to break into the world’s top 500 in a decade and eventually into the top 100. The Ministry of HRD has taken various steps to implement the scheme of Institutions of Eminence (IoEs). These institutions will be permitted to admit 30 per cent of international students with no restrictions levied on the fee charged from them, and hire foreign faculty to the tune of 25 per cent out of the total faculty. They can enter into academic collaborations with the top 500 global universities without requiring UGC approval. They will also enjoy full flexibility in bringing the evolution in the curricula and syllabi. Public institutions will get the assistance of up to ₹1000 crore over five years, but private universities will not get any financial assistance. ‘Institution of Eminence’ tag frees universities from government interference. The Institutes of Eminence will have added funds for the state-run institutions, and more collaboration opportunities with top global universities, which can revolutionise the higher education sector and build a stronger foundation for a knowledge economy. Universities can entirely focus on their students, faculty, research and social outreach.

## **THE WAY FORWARD**

The rapidly increasing young population of India poses a demand for higher education after finishing their higher secondary education, but the resources in this sector are scarce. Though India has progressed tremendously in the arena of higher education, there are still numerous colleges, institutions and universities which lack even the necessary facilities and provisions. Another serious challenge to the higher education system is the lack of skilled faculty members. Without the presence of appropriate

facilitators, apt knowledge cannot be delivered, and the intended learning outcomes cannot be achieved. The massive demands posed by the ever-growing young population of India towards the higher education sector, need to be urgently fulfilled. To resolve this issue, the existing educational institutions need to be empowered, and new facilities need to be established. At all levels of quality improvement, upgradation of the infrastructure plays a crucial role. The government needs to make sure these institutions are physically accessible to all the communities.

Over the past five years, India has become not only the world's second-largest student exporting country after China, but also one of the fastest-growing sources of outbound students. Newly released data from the Indian Ministry of External Affairs reveals that nearly 753,000 Indian students were studying abroad as of July 2018. As per the latest trend, the number of undergraduate students going abroad has shown an increase, in contrast to the earlier trend where students only went abroad to pursue post-graduation and PhDs; and, many students are going abroad straight after secondary school, which shows that there is money, there is demand, and there is the market available. What we need to do is raise the bar of higher education in the country and also create more educational opportunities so that we can retain those who go abroad for higher education. The steep demand-supply gap for quality education is also another hurdle faced by the Indian education sector. Most Indian colleges only have limited learning resources to offer without much focus on innovation. Poorly maintained libraries, also in terms of the number of books, and lack of educational magazines and specialised journals that are valuable resources for the upgradation and advancement of knowledge are issues that need to be addressed.

Indian government's education expenditure is minuscule compared to other developed countries. Though the government has adopted measures to bridge this gap through the funding of its selected Institutions of Eminence, unfortunately, the funding is only granted to public universities, which is quite unfair. The government should provide some financial support to the private universities to recommended as Institution of Eminence for them to flourish as per the criteria of top-ranked global universities. Those universities spend a substantial portion of their budget on research and innovation alone. Such grants would allow private universities to establish and compete with the best universities by providing substantial financial support, of course, with certain conditions. The current trend of globalisation directly impacts higher education. Hence, the curriculum must be framed, keeping both domestic and global perspectives in mind. Privatisation, to some extent, has contributed significantly to the quality of higher education. Formulation of stable, long-term and robust policies and regulatory pathways needs to be undertaken by the government. This will help in the establishment of the trust of various stakeholders in the educational system.

Universities, teachers and students need to create more forums to widen their interaction. Such interactions would lead to the generation of practically implementable and lucrative ideas and courses. Internship programs for students help in getting hands-on experience in tackling real-world problems and developing

knowledge databases that could be useful for breakthroughs in artificial intelligence. Universities need to set up structures to bring out the people who have the capability and devotion to handle real-world problems and improving productivity. The major R&D facilities of the country can be linked with higher education institutions, to encourage the inclusion of students in research initiatives in the country which will ensure ease in the movement of personnel between universities and industry. For example, the apprenticeship system in Germany has produced excellent results in the existence of a curriculum developed by educational institutions in collaboration with business groups and employees. Collection of data on job market trends, their analysis and dissemination are essential to improve the employability skills of the graduates.

## CONCLUSION

Thus, it can be concluded that education is the key to the progress, especially higher education, which provides the cutting edge and skilled workforce as per the market and societal demands and needs. This can be achieved by having a proper mix of public and private, formal and non-formal institutions. Online programs offered by professional agencies such as Coursera, UpGrad etc. can make a big difference in terms of quality and also inclusivity. Special initiatives are required to enhance employability. Curriculum and content have to be continually renewed through teaching, for which Learning Support Networks and specific skill development network should be set up. Drawbacks mentioned above need to be transformed into the strength of the Indian higher education system, but this can only be done with a strong willpower, determination and readiness to change.

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Prof Shibu John is Head, Department of Healthcare and Pharmaceutical Management Jamia Hamdard, New Delhi. He served the School of Management and Business Studies, Jamia Hamdard for nearly 22 years in the area of Healthcare Management sector. His areas of specialization are Health Economics, Public Health & Hospital Management. He has several publications to his credit.

## Seyed E. Hasnain

Prof. Seyed E. Hasnain is an internationally renowned Microbiologist. Presently, he is the Vice Chancellor of Jamia Hamdard, New Delhi. Earlier, served University of Hyderabad, Hyderabad as Vice Chancellor; Visiting Professor at the Indian Institute of Science Education and Research (IISER), Bhopal; Distinguished Research Professor at Dr Reddy's Institute of Life Sciences, University of Hyderabad; Visiting Professor at the Institute of Liver and Biliary Sciences (ILBS), New Delhi, Visiting Professor at the King Saud University in Riyadh, Saudi Arabia; Invited Professor at the Indian Institute of Technology, Delhi (IIT). He is Member of the Scientific Advisory Board, Indian Council of Medical Research (ICMR), Ministry of Health and Family Welfare, India.

He is the recipient of several honours and awards including the Padma Shri, one of the highest National Civilian Awards in India; Dr. B. R. Ambedkar Award for Excellence in Biomedical Sciences, Indian Council of Medical Research (ICMR); Order of Merit of the Federal Republic of Germany; Fellow, American Academy of Microbiology, American Society of Microbiology (ASM), USA; and Doctor of Medical Sciences (H C), Queen's University Belfast, UK; Humboldt Research Prize, Alexander Von Humboldt Foundation, Germany; J.C. Bose Fellowship, Department of Science and Technology of the Indian Government; Shanti Swarup Bhatnagar Prize in Biological Sciences, Council of Scientific and Industrial Research (CSIR) of the Indian Government.